UNIVERSITY OF DELHI

CNC-II/093/1(25)/2023-24/72
Dated: 21.06.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 60-1/(60-1-6/-) dated 03.02.2023]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-III of the following departments under Faculty of Science based on Under Graduate Curriculum Framework -2022 implemented from the Academic Year 2022-23.

FACULTY OF SCIENCE

DEPARTMENT OF ANTHROPOLOGY

BSC. (HONS.) ANTHROPOLOGY

DISCIPLINE SPECIFIC CORE COURSE -7 (DSC-7)
Fundamentals of Human growth and development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Fundamentals of Human growth and development - DSC-7	04	03	Nil	01	Passed 10+2 with Science	NIL

Learning objectives

- Students will be able to learn about various stages and environmental factors involved in human growth and development which help them in understanding growth monitoring of a child.
- They will understand the role played by balance diet in leading a healthy life.

Learning outcomes

By studying this course, students will be able to

- Differentiate the term- growth, maturation and development.
- Understand the basic principles of human growth and development
- Comprehend the significance of growth studies

Syllabus of DSC-7

Unit 1: Introduction to Human growth and development (6 hours)

Concept of human growth, development, differentiation and maturation. Evolutionary perspective of human growth (including living primates and fossil hominid ancestors)

Unit 2 : Stages and process involved in growth and development (9 hours)

Prenatal (conception till birth) and postnatal (birth till senescence) periods of growth, physical, cognitive and psycho-social development from conception through adulthood, patterns of normal growth curves, variation from normal growth (canalization, catch-up growth and catch-down growth), secular trend

Unit 3 : Factors and Methods related to growth and development (8 hours)

Bio-cultural factors (genetic, socio-cultural and ecological factors) influencing patterns of human growth and variation, methods and techniques to study growth, significance/ applicability of growth studies; Impact of life-changing health parameters on development of infants, children, adolescents and adults

Unit 4: Relevance of Nutrition in growth studies (7 hours)

Importance of Nutrition in various stages of growth and development, Balanced diet, Malnutrition, Assessment of Nutritional status

Unit 5: Role of body physique and composition in growth process (9 hours)

Human physique and body composition - models and techniques; bisexual and endogamous group differences; Somatotyping and human physique with reference to Sheldon, Parnell, Heath and Carter methods

Unit 6: Adaptation in growth and development (6 hours)

Impact of bio-cultural adaptation to environmental stresses on human growth. Homeostasis and thermoregulation

Practical (30 Hours)

Somatometry:

Stature, Body weight, Mid upper arm circumference, Minimum waist circumference, Maximum hip circumference, Upper extremity length, Lower extremity length, Biacromial breadth, Bicristal breadth), Assessment of chronological age, Percentile, z-score, height for age, weight for age, BMI for age

Obesity assessment

General adiposity indices: BMI, body fat %, Conicity index,

Regional adiposity indices: WC, WHR, WHtR

Assessment of body composition with skinfold thickness and bioelectric impedance

References

Growth, maturation & physical activity (2004) Malina, Robert M; Bouchard, Claude, Bar-Or, Oded. Human Kinetics.

Human growth and development by Cameron Noel (2002). St. Louis, Academic Press.

Patterns of human growth by Bogin, Barry (1999). Cambridge University Press.

Human biology: An introduction to human evolution, variation, growth & adaptability by Harrison, GA; Tanner, JM; Pilbeam, DR; Baker PT (1988). Oxford, England, Oxford University Press.

Proceeding on Human Physical Growth and Maturation by eds. Johnson, FE, Roche, AF, Susanne, C, (1980). Plenum Publishing Corporation.

Applied body Composition Assessment (2009) Heyward, VH; Wagner DR. Human Kinetic.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

ANTHROPOLOGICAL THEORIES

DISCIPLINE SPECIFIC CORE COURSE -8 (DSC-8) – Anthropological Theories

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Anthropological theories- DSC-8	**04**	**03**	**Nil**	**01**	Passed 12	**NIL**

Course Objective

- This is an introductory course on the main theoretical approaches which historically and traditionally guided anthropological research and understanding of society and culture.
- The course would involve theory as well as practical.
- The practical will skill the students to apply the approaches critically to study of actual social issues and problems.

Course Learning Outcomes

- The students will be able to explain the major theoretical paradigms in anthropology and link it with the social, political and economic contexts in which they have emerged.
- They should also be able to explain clearly how these ideas have contributed to the process, structure, pattern and search for meanings by human beings.

Syllabus of DSC-8

Unit 1 (15 Hours)

Anthropological Paradigms, Nature of Anthropological Knowledge, Interface with evolutionary theory and colonialism, changing perspectives on Evolutionism, Diffusionism and Culture area theories.

Unit 2 (10 Hours)

Durkheim and social integration, Functionalism and Structural-functionalism and British Social Anthropology; Culture and Psychology

Unit 3 (10 Hours)

Structuralism: Claude Levi-Strauss and Edmund Leach

Unit 4 (10 Hours)

Symbolic and Interpretative approaches; Decolonization and Antistructure, and Contemporary anthropology

Practical (30 Hours)

Practical would focus upon developing skills wherein following exercises will be undertaken by the students so as to enable them to connect the anthropological theories to the empirical world of living.

1. Identify a topic relating to contemporary issue and formulate research questions and clearly identify the theoretical perspectives from which they are derived.
2. Identification of variables of a study.
3. Various types of hypothesis ; Formulation of hypothesis; hypothesis testing and exploratory research
4. Identification of universe and unit of study with justifications.
5. Choice of appropriate research technique and method in the context of theoretical framework. Data collection and analysis

References

Applebaum H.A. (1987) Perspectives in Cultural Anthropology. Albany: State University of New York.
Barnard A. (2000). History and Theory in Anthropology. Cambridge: Cambridge University.
Bernard, H. R. (2017). Research methods in anthropology: Qualitative and quantitative approaches. Rowman & Littlefield.
Mark Moberg (2013). Engaging Anthropological Theory : London and NY: Routledge McGee
Pelto, P. J., & Pelto, G. H. (1978). Anthropological research: The structure of inquiry. Cambridge University Press.
R.J. and Warms R.L. (1996) Anthropological Theories: An Introductory History.

Additional Readings

Geertz, Clifford. 1973. The Interpretation of Cultures. New York: Basic Books

Moore M. and Sanders T. (2006). Anthropology in Theory: Issues in Epistemology, Malden, MA: Blackwell Publishing.

Teaching Learning Process

The students will be encouraged to reflect and apply the ideas introduced to them. Case studies and ethnographies will be read and students will be taught to how to analyze the theoretical perspectives used therein. Wherever possible documentaries and short ethnographic movies will also be shown and discussed in the class

Keywords: Evolutionism, Diffusionism, Durkheim and social integration, Functionalism and Structural- functionalism and British Social Anthropology Durkheim and social integration, Functionalism and Structural-functionalism and British Social Anthropology, Symbolic and Interpretative approaches.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

INDIAN PREHISTORY

DISCIPLINE SPECIFIC CORE COURSE -9 (DSC-9) – Indian Prehistory

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Indian Prehistory-DSC-9	04	03	Nil	01	Passed 12^{th}	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course aims to understand the evolutionary perspective of human prehistoric society in India with the help of archaeological cultural remains.
- To learn tool typology and its classification for the reconstruction of prehistoric societies.

Learning Outcomes

By studying this course, students will be able to:

- Understand the landscape of Indian archaeological sites and their relevance in studying prehistoric Indian societies.
- Identify the tools, appreciate the tool typology and classify it appropriately

Syllabus of DSC-9

Unit-1: Understanding culture (12 Hours)

Technique of tool manufacture and estimation of their relative efficiency; Classification of tools: primary and combination fabrication techniques; Typology and cultural nomenclature

Unit-2: Methods of climatic reconstruction (8 Hours)

palynology, paleontology, soil pH estimation.

Unit-3: Prehistoric India (10 Hours)

Pleistocene chronology of India: A critical assessment

Unit-4: Character, distribution and interpretation of habitat and economy of (15 Hours)

Lower Palaeolithic; Middle Palaeolithic; Upper Palaeolithic; Mesolithic culture; Art, ritual and belief

Practical (30 Hours)

Identification of tools:

(a) Handaxe varieties, chopper/chopping tools

(b) Cleaver varieties

(c) Side scraper varieties

(d) Knives

(e) Burins

Identification of lithic technology:

(f) End scrapers

(g) Borers

(h) Microlithic tools

(i) Bone tools

References

Renfrew Colin and Bahn Paul, Archaeology: Theories, Methods and Practice. New York:Thames & Hudson, 6th Edition, 2012.

Fagan Brian M. and Nadia Durrani, In the Beginning: An Introduction to Archaeology, London: Routledge, 14th Edition 2014.

Chakrabarati, Dilip K. India - An Archaeological History: Paleolithic Beginnings to Early History. Oxford: Oxford University Press, 2009.

Additional Resources:

Allchin, Bridget and Allchin, Raymond F. The Rise of Civilization in India and Pakistan. Cambridge: Cambridge University Press, 2003.

Odell, G.H. Stone Tools: Theoretical Insights into Human Prehistory, New York: Plenum press, 1996.

Moloney and Shott, M.J. Lithic Analysis at the Millennium, New York: Routledge, 2016.

Teaching Learning Process

The process of learning will involve acquisition of domain knowledge and understanding of skills required for conducting research in Indian archaeology. Process will involve lectures, assignments, class-room discussions, practicals and appropriate inference of results and practical file preparation.

Keywords: Geochronology, India archaeology, Cave paintings

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF DSE
Palaeoanthropology

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1) – Palaeoanthropology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Palaeoanthropology - DSE-1	04	03	Nil	01	Passed 12th with Science	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To understand the fundamentals of palaeoanthropology
- To understand the evolutionary process, assessment of skeletal variability of fossil remains, and modern humans.
- To learn the role of palaeodemography and paleopathology in studying human origins

Learning Outcomes

- Student should understand the fundamental of palaeoanthropology
- Should understand the evolutionary journey of early to modern humans
- Student should learn the role of palaeodemography and paleopathology in studying human origins

Syllabus of

DSE-1 Unit 1

(08 Hours)

Dating methods, geological time scale, taphonomy and interpretation of the paleontological and archaeological records, taxonomic and chronological problems of fossils records.

Unit 2 (08 Hours)

Primate speciation and extinctions: adaptive primate radiation

Unit 3 (10 Hours)

Evolutionary biology: Human origins: Development, distribution and fossilized evidence of Australopithecines, Paranthropus (Zinjanthropus), Homo habilis, Homo erectus, Archaic H. sapiens.

Unit 4 (07 Hours)

Primate and Non-Primate Models for Early Hominid Behaviour; hominization process- Evolution of hominid-human bipedalism

Unit 5 (06 Hours)

Palaeodemography- reconstruction of population patterns from skeletal analysis, determination of demographic variables in prehistoric populations and post-Neolithic population growth.

Unit 6 (06 Hours)

Palaeopathology- bioarchaeological approach of disease; effects of agriculture, urbanization and slavery on health and disease; colonization and disease with special emphasis on the New World.

Practical (30 Hours)

1. Comparative primate osteology
2. Description and identification of the disarticulated skeleton of non-human primates
3. Identification and description of fossil casts

References

CS Larson (2016). Essentials of Physical Anthropology. W. W. Norton & Company. [Unit-1: Page- 165-190; Unit-2: Page-124-143; Unit-3: Page-223-230, 234-240, 253- 268, 274-291]

Craig Stanford et al. (2013). Biological Anthropology. Pearson, New York. [Unit-4: Page-197-220; Unit-5: Page-1-11; Unit-6: Page-318-330]

Tattersall I. (2009). The Fossil Trail: How We Know What We Think We Know about Human Evolution. New York: Oxford University Press.

Additional Resources:

Waldron T. (2008): Palaeopathology. Cambridge University Press

Cela-conde CJ and Frisancho J. (2007). Human Evolution: Trails from the past. Ayala Oxford University Press.

Barnes E. Diseases and Human Evolution. (2005). University of New Mexico Press.

Pinhasi R and Mays S (2008). Advances in Human Palaeopathology. Chichester: John Wiley & Sons, Inc. (PM).

Hoppa RD and Vaupel JW. (2002). Paleodemography: Age Distributions from Skeletal Samples. Cambridge University Press.

Lansen CS, Matter RM and Gebo DL. (1998). Human Origin: The fossil Record.

Teaching Learning Process

The process of learning will involve acquisition of subject knowledge and understanding of skills required for a paleoanthropologist. Process will involve lectures, class-room discussion, assignments and practicals.

Keywords

palaeoanthropology, paleopathology, anthropology, and evolution

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Anthropology of Tourism

DISCIPLINE SPECIFIC ELECTIVE COURSE -2 (DSE-2) – Anthropology of Tourism

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Anthropology of Tourism - DSE-2	04	03	Nil	01	Passed 12th	NIL

Learning Objectives

- Tourism is an important industry in India, valued and promoted by most of the states. Anthropologists have a close association to tourism, with an understanding of both the guest as well as the host community.
- The anthropology of tourism introduces the various aspects of tourism and anthropological approaches to it. It looks at the impact of tourism on the host community, its economy, culture, identity and ecology as well as how the experience of a culture can be transformative for the tourists also.
- Some of the key issues dealt in this paper are cultural aspects of tourism economy, cultural promotion and cultural preservation and its impact on authenticity and commodification of culture, fair and its management, ecotourism and sustainability.
- Types of tourism as well as well as leisure, culture learning, communication and promotion are explored in this paper.

Learning Outcomes:

The students should be able to

- explain the various aspects of tourism and the relationship between culture and tourism economy.
- place anthropology of tourism in relationship to other sub-disciplines within anthropology and allied disciplines like tourism management.
- identify those aspects of culture which can draw in the tourists, as well as allow the communities to express itself and promote their culture.
- use their skills to identify the best practices for sustainable ecotourism, mutually beneficial for the host as well the guest.

UNIT 1: Tourism and Leisure: Theoretical overview (10 Hours)

Anthropology of Tourism: Historical roots, objectives and scope. Interconnections between tourism history and the rise of the socio-cultural study of tourism; Concept of leisure and recreation.

UNIT 2: Types of Tourism (12 Hours)

Pilgrimage, medical tourism, education and tourism, recreational visits, heritage tourism, nature visits, wildlife tourism, visiting relatives, fairs and festival in tribal and rural India., Tourism industry in India : Recent trends and challenges.

UNIT 3: Tourism and Consuming Culture (13 Hours)

Tourism and cross-cultural communication and interaction; role of symbolism, semiotics, and the imagination in tourism; tourism and the commodification of culture or cultural degradation, Issues of staged authenticity

UNIT 4: Society, Tourism and Sustainability (10 Hours)

Ecotourism and sustainable development; tourism policy, applied aspects of anthropology in tourism development and planning

Practical (30 Hours)

1. Identification of three important tourist destinations including heritage, historical, religious, educational (Museum) and recreation spots and understand the historical, cultural, economic, religious and ecological aspects of tourism.

2. Case studies of any two ethnic fairs (frequented by tourists) to understand the representation of culture and culture as an industry. Case studies should focus upon the cultural creators (local people) and cultural consumers (visitors) to understand concepts like souvenir, commodification and cross- cultural communication.

References

Chambers E. (2000). Native Tours: The Anthropology of Travel and Tourism. Prospect Heights: Waveland.

Crick M. (1995). The Anthropologist as Tourist: An Identity in Question. In Lanfant MF, Allcock JB, Bruner EM (eds.)International Tourism: Identity and Change. London: Sage. pp. 205-223.

Dann GMS, Nash D and Pearce PL. (1988). Methodology in Tourism Research. Annals of Tourism Research. 15:1-28.

Gmelch SB. (2004). Tourists and Tourism: A Reader. Long Grove: Waveland.

Graburn NHH. (1977). Tourism: The Sacred Journey. Hosts and Guests: The Anthropology of Tourism. Valene L. Smith, ed. Philadelphia: University of Pennsylvania Press. Pp. 33-47.

Dann G. (2002). The Tourist as a Metaphor of the Social World. Wallingford: CAB International.

Nash D. (1996). Anthropology of Tourism. New York: Pergamon

Additional Resources:

Picard M and Wood R. (1997). Tourism, Ethnicity, and the State in Asian and Pacific Societies. University of Hawaii Press. 88

Crick M. (1994). Anthropology and the Study of Tourism: Theoretical and Personal Reflections. In Crick M (eds.). Resplendent Sites, Discordant Voices: Sri Lankans and International Tourism. Chur, Switzerland: Harwood Publishers.

Wood R. (1997). Tourism and the State: Ethnic Options and the Construction of Otherness. In Picard and Wood Tourism, Ethnicity and the State in Asian and Pacific Societies. University of Hawaii Press

Keywords: Tourist and traveller, Leisure Pilgrimage, Health tourisms, Ecotourism, Heritage, Culture industry, Commodification of Culture. Cross cultural communication.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Forensic Anthropology

DISCIPLINE SPECIFIC ELECTIVE COURSE -3 (DSE-3) – Forensic Anthropology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Forensic Anthropology - DSE-3	04	03	00	01	Passed 12th with Science	NIL

Learning Objectives

- To understand the basic tenets and applications of forensic anthropology
- To learn the methods and techniques involved in solving the criminal cases
- To appreciate the recent developments in the field of forensic anthropology

Learning Outcomes

- Student should be able to identify and collect the biological materials found at crime scenes
- Student should be able to use the methods and techniques in forensic anthropology
- Student should have the understanding of current knowledge of latest developments in forensic anthropology

Syllabus of DSE-3

Unit 1 (08 hours)

Introduction to Forensic Anthropology: Definition, Brief History, Scope, Applications and relationship with other sciences

Unit 2 (09 hours)

Basic Human Skeletal Biology, Identification of Human and Non-Human Skeletal Remains, Ancestry, age, sex and stature estimation from bones.

Unit 3 (11 hours)

Personal Identification, Complete and Partial Identification, Methods of Identification in Living Persons: Somatometry, Somatoscopy, Occupational Marks, Scars, Bite Marks, Tattoo Marks, hair, fingerprints, footprints, lip prints, nails, handwriting, deformities.

Unit 4 (08 hours)

Serology: Identification and Individualization of bloodstains, urine, semen and saliva strains.

Unit 5 (09 hours)

Individualization: Forensic Odontology-Tooth Structure and Growth, Bite Marks, Facial Reconstruction. DNA Profiling.

Practical (30 Hours)

1. Study of human long bones. Estimation of age, sex and stature from bones.
2. Somatometric and Somatoscopic Observation on living persons.
3. Identification of bloodstain, urine, semen and saliva.
4. Examination of Fingerprints and Handwriting.

References

A M Christensen et al. (2014). Forensic Anthropology: Current methods and Practice. Elsevier, New York. [Unit-1: Page-1-10; Unit-2: Page- 25-50; 199-216, 243-274]

ARW Jackson and JM Jackson (2011). Forensic Science, 3rd edition. Pearson, New York. [Unit-3: Page-61-65; 107-126; 254-260]

Bass W.M. (1971). Human Osteology: A Laboratory and Field manual of the Human Skeleton. Columbia: Special Publications Missouri Archaeological Society.

Black S. and Ferguson E. (2011). Forensic Anthropology 2000 to 2010. CRC Press, London. Byers, S.

N. (2008). Forensic Anthropology. Boston: Pearson Education LTD.

Gunn A. (2009) Essential Forensic Biology (2nd ed). Chichester: Wiley-Blackwell. [Unit-4: Page-45-82; Unit-5: Page-85-97]

Modi, R. B. J. P. (2013). A Textbook of Medical Jurisprudence and Toxicology. Elsevier. Reddy V. R.

(1985). Dental Anthropology, Inter-India Publication, New Delhi.

Spencer, C. (2004). Genetic Testimony: A Guide to Forensic DNA Profiling, Pearson, New Delhi.

Vats Y., Dhall J.K. and Kapoor A.K. (2011). Gender Variation in Morphological Patterns of Lip Prints among some North Indian Population. J. Forensic Odontology, 4: 11-15.

Wilkinson, C. (2004). Forensic facial reconstruction. Cambridge University Press. Klepinger LL (2006).

Fundamentals of Forensic Anthropology. Wiley-Liss Publications

Forensic Anthropology Laboratory Manual 4Th Edition 2016 Edition by Steven N. Byers, T&F India.

Forensic Anthropology: A Comprehensive Introduction 2Ed (Hb 2017) by Langley N.R., Taylor & Francis.

Additional Resources:

Modi, R. B. J. P. (2013). A Textbook of Medical Jurisprudence and Toxicology. Elsevier. 6. Reddy V.

R. (1985). Dental Anthropology, Inter-India Publication, New Delhi.

Spencer, C. (2004). Genetic Testimony: A Guide to Forensic DNA Profiling, Pearson, New Delhi.

Wilkinson, C. (2004). Forensic facial reconstruction. Cambridge University Press.

Black S. and Ferguson E. (2011). Forensic Anthropology 2000 to 2010. CRC Press, London.

Teaching Learning Process

The process of learning will involve the acquisition of subject knowledge and understanding of the skills required for a forensic anthropologist. The learning process will involve lectures, submission of assignments, classroom discussions, reliably conducting the experiments and inferring the results.

Assessment Methods

The theoretical understanding of the student will be assessed using time constrained examination. The assessment of the practicals will be based on conducting the experiment and presenting the results in appropriate manner.

Keywords

forensic, personal identification, DNA profiling, fingerprints

Note: Examination scheme and mode shall be as prescribed by the Examination Branch,

University of Delhi, from time to time.

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Environmental Anthropology

DISCIPLINE SPECIFIC ELECTIVE COURSE -4 (DSE-4) – Environmental Anthropology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Environmental Anthropology - DSE-4	04	03	Nil	01	Passed 12^{th}	NIL

Learning Objectives:

The objective of the paper is to understand about the importance of environment, the problems due to environmental degradations, etc

Learning Outcomes:

By studying the paper, the students will be able to:

- understand the nature and scope of studying environmental anthropology, basic concepts in it etc.
- know the importance of traditional ecological knowledge in conserving environment
- analyze the problems of contemporary environmental issues in the society.

Syllabus of

DSE-4 Unit 1

(13 Hours)

Concepts and Approaches: Environmental Determinism and Possibilism, Ecosystem, Cultural Ecology, Deep Ecology and Political ecology

Unit 2 (12 Hours)

Environment and Women: Nature and Culture debate, Eco-Feminism; Indigenous Knowledge and Gender

Unit 3 (10 Hours)

Issues of Climate Change in Anthropocene, Mobilization of Resource, Green Ecology & the idea of sustainability

Unit 4 (10 Hours)

Community response to recent environmental challenges: Mining, Dam, and other mega projects; resettlement and rehabilitation issues

Practical (30 Hours)

1. Prepare an evaluative study/ a project based on any contemporary environmental issues in India by employing various sources viz. books, journals, magazines, government reports newspaper articles, etc.

2. Presentation of the project and group discussion

References

Ellen, Roy, Peter Parkes, Alan Bicker (ed). 2000. Indigenous Environmental Knowledge and its Transformation: Critical Anthropological perspectives. Harwood Academic Publishers.

Descola, P., and Gisli P. (eds) 1997. Nature and Society: Anthropological Perspectives. London: Routledge

Dove, M. R., and Carol C. (eds) 2008. Environmental Anthropology: A historical reader, Blackwell Publication

Hardesty, D. 1977. Ecological Anthropology. John Wiley. New York

Inglis, Julian, T(ed). (1993). Traditional Ecological Knowledge: Concepts and Cases. Canada. International Program on Traditional Ecological Knowledge and International Development Research Centre

Orlove, B. 1980. Ecological Anthropology. Annual Review of Anthropology. Vol.9.pp.235-73

Mathur, Hari Mohan. 2005. Managing Resettlement in India: Approaches, Issues and Experiences. OUP

Merchant, Carolyn. 1994. Key Concepts in Critical Ecology. Humanity Press. New Jersey

Ramakrishnan, PS., 2001 (2015). Ecology and Sustainable Development: Working with Knowledge systems.New Delhi. National Book Trust, India

Schulkowski, H. 2006. Human Ecology: Biocultural Adaptation in Human Communities. Springer

Suggested Readings

Cohen, Yehudi A. 1968. Man in Adaptation: The cultural Present. Chicago: Aldine

Pub. Co. Harris, M. 1971. Culture, Man and Nature, New York: Thomas Y

Cormbell.

Kopnina, H. and Eleanor Shoreman-Ouimet. 2011. Environmental Anthropology Today, London: Routledge.

Palmer, Joy A (ed). 2004. Fifty Great Thinkers on the Environment. Routledge. New York

Mukherjee Neela.1997. Participatory Appraisal of Natural Resources. New Delhi. Concept Publishing House Company.

Rappaport, Roy A. 1967. Pigs for the Ancestors: Rituals in the Ecology of a New Guinea People. New Haven: Yale University Press.

Steward, J. 1955. Theory of Culture Change, Illinois: University of Illinois Press.

Teaching Learning Process

Classroom teachings

Presentations and group

discussion Practical classes

Keywords: Environment, Ecology, Sustainable Development, Resource, Political ecology

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF GENERIC ELECTIVE (GE) COURSES FOR ODD SEMESTERS

Forensic and Criminal investigations

GENERIC ELECTIVE -1 (GE-1)

Forensic and Criminal investigations

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Forensic and Criminal investigations – GE-1	04	03	Nil	01	Passed 12th with Science	NIL

Course Objectives:

- Give exposure of Forensic Science to students which focuses on the investigation process of a crime.
- Enhance understanding of forensic applications and criminal investigations by teaching and research.
- Develop skills in forensic identification and problem-solving methods.
- Keep up to date knowledge about all recent developments and emerging trends in Forensic science and criminal investigation.

Course Learning Outcomes:

- Understand the aim, concept and significance of Forensic Science and Criminal Investigation.
- To make aware about recent techniques and developments of Forensic Science and Criminal Investigation.

Unit 1: Forensic Science, Crime Scene Management and criminal investigation (10 Hours)

Introduction, history, development, laws and branches of Forensic Science.

Organizational set-up of Forensic science laboratories.

Crime scene protection, isolation, documentation, sketching, field notes and photography.

Definition, concept, types and scope of crime, various control and prevention methods of crime.

Criminology, criminal anthropology and criminal law

Unit 2: Forensic Ballistics and Explosives (5 Hours)

History, background, classification and characteristics of Firearms

Internal, External, Terminal (wound) ballistics

Classification, synthesis and characteristics of explosives.

Examination and identification of firearms and explosives evidences.

Unit 3: Forensic Chemistry and toxicology (10 Hours)

Introduction, sampling, presumptive, screening and analytical techniques in Forensic Chemistry.

Definition, classification and extraction of poisons.

Toxicological techniques used in poisoning cases.

Classification of drugs, Field and laboratory tests of drugs of abuse.

Unit 4: Questioned Documents and fingerprint examination (10 Hours)

Classification of forensic documents, importance of natural variation and disguised writing

Class and individual characteristics of handwriting and documents examination.

History and classification of fingerprints, Conventional and modern methods of developing latent fingerprint.

Automated Fingerprint Identification System (AFIS).

Unit 5: Forensic anthropology, Serology and DNA profiling (10 Hours)

Personal identification of living and non- living individual through various anthropological techniques.

Forensic morphometric techniques of skeleton remains, Human and non-human identification.

Sex determination, stature and age estimation from skeleton remains

History, biochemistry and genetics of ABO, Rh, MN and other blood systems. Blood pattern analysis and blood stains ageing.

DNA profiling and its application in criminal and civil investigations.

Practical (30 Hours)

1. Descriptive study of organizational structure of a forensic science laboratory.
2. Interpretation of crime scene notes, photos, sketches, crime scene reconstruction and mock crime scene investigation.
3. Linkage of suspected bullet and cartridge case with the class and individual characteristics of firearms.
4. TLC and spot test for different toxic and drugs substances
5. Forensic identification of class and individual characteristics of handwriting
6. Examination of passports and currency notes
7. Various powder and chemical methods used for latent fingerprints.
8. Ridge characteristics, counting, and fingerprint comparison
9. Morphometric examination of skeleton remains
10. Sex determination, age and stature estimation from skeleton remains.
11. Examination of blood groups from fresh and dried blood stains
12. Preliminary and confirmatory tests for blood stains.

References

Sharma, B.R; Forensic Science in Criminal Investigation & Trials, Universal Publishing Co., New Delhi, 2003

Saferstein; Criminalistics- An Introduction of Forensic Science, Prentice Hall Inc, USA,2007.

Swansson, C.R, Chamelin, N.C, &Territ, L; Criminal Investigator, McGraw hHll, New York, 2000.

The Indian Evidence Act (1872), Amendment Act (2002); Universal Law Publishing Co., 2003.

The Code of Criminal Procedure (1973) Amendment Act, (2001); Universal Law Publishing Co., 2002.

Rattan Lal & DhirajLal; The Indian Penal Code, 28th Ed. Wadhwa & Co. Nagpur, 2002.

Clark E.G.C; Isolation and Identification of drugs, Academic Press, London, 1986

Feigl, F; Spot Test in Inorganic Analysis, Elsevier Publ. New Delhi, 2002

Sharma, B.R.; Firearms in Criminal Investigation & Trials, 4th Ed, Universal Law Publishing Co Pvt Ltd, New Delhi, 2011.

Hilton, O; Scientific Examination of Questioned Documents. Revised Edition, Elsevier, New York, 1982.

Singh, I.P. & Bhasin M.K; A manual of biological Anthropology, Kamla Raj Enterprises, New Delhi, 2004.

Eveleth, P.B. & Tanner, J.M; Worldwide Variation in Human Growth, Cambridge University Press, London, 1976.

Seigel, J.A, Sukoo, R.J, & Knupfer, G.L; Encyclopaedia of Forensic Science, Academic Press, London, 2000.

Pickering, R. & Bachman D; The use of Forensic Anthropology, CRC Press, Costa Rica, 2009.

Butler, J; Advanced Topics in Forensic DNA Typing: Methodology, 1st Ed., Academic Press, London, 2009.

Cummins, H., & Midlo, C. (1961). Finger Prints, Palms and Soles. New York: Dover Publications.

Teaching Learning Process:

1. Class room teaching
2. Presentation and assignment
3. Practical classes
4. Workshops

Keywords: Forensic, Crime scene, Fingerprint, Anthropology, Serology and DNA Profiling

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Anthropology of Sustainable Development

GENERIC ELECTIVE -2 (GE-2)

Anthropology of Sustainable Development

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Anthropology of Sustainable Development - GE-2	04	03	Nil	01	Passed 12th	NIL

Course Objectives:

The objective of the paper is to understand the discourse around the idea of sustainable environment along with relevant issues and emerging challenges in managing the planetary crisis and the problems due to environmental degradations.

Course Learning Outcomes:

By studying the paper, the students will be able to:

- Understand the nature and scope of sustainable development, basic concepts in it.
- Know the importance of traditional ecological knowledge in sustainable development
- Contemporary issues and challenges in sustainable development and environmental degradation, biodiversity and conservation.

Unit 1 (10 Hours)

Notion of Sustainable Development, Genesis and Approaches; Economy, Equity and Environment: Idea of Triple Bottom-line

Unit 2 (15 Hours)

United Nation's Sustainable Development Goals, Interconnections and Integration, Cultural diversity and Execution of SDG: Ethnographic Cases, Frameworks of Assessment

Unit 3 (10 Hours)

Issues of planetary Crisis and idea of sustainable livelihood, Alternative and Sustainable use of natural resources: water, energy, mines and materials

Unit 4 (10 Hours)

Environmental Issue: Biodiversity, Indigenous Knowledge, Traditional Practices associated with sustainable nature

Practical (30 Hours)

Prepare an evaluative study/ a project based on any contemporary issue in India by employing various sources viz. books, journals, magazines, government reports newspaper articles, etc.

1. Presentation of the project and group discussion

References

- Brightman, Marc. and Lewis, Jerome. (2021). Anthropology of Sustainability: Beyond development and progress. Palgrave Macmillan.
- Carroll, Bryce. (2017). An Introduction to Sustainable Development. Larsen & Keller Education.
- Corsi, Patrick. (2017). Going Past Limits to Growth: A Report to the Club of Rome EU-Chapter. John Willey & Sons Inc.
- Elliott, Jennifer A. (2013). An introduction to sustainable development. New York: Routledge.
- Eversole, Robyn. (2018). Anthropology for Development: From Theory to Practice. Routledge.
- Meadows, Donella H; Meadows, Dennis L; Randers, Jorgen; and William, W. Behrens III. (1972). The Limits to growth: A report for the Club of Rome's project on the predicament of mankind. New York: Universe Books.
- Sachs, Jeffrey. D. (2015). The age of sustainable development. New York. Columbia University Press

Teaching Learning Process

Classroom teachings

Presentations and group discussion

Practical classes

Keywords

Sustainable development, natural resources, livelihood, biodiversity, Economy

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Biodiversity and Indigenous Knowledge

GENERIC ELECTIVE -3 (GE-3)

Biodiversity and Indigenous Knowledge

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Biodiversity and Indigenous Knowledge – GE-3	04	03	Nil	01	Passed 12^{th}	NIL

Course Objective

- The course will help the students in understanding how indigenous knowledge and biodiversity are complementary phenomena essential to human development.
- Students will recognize indigenous knowledge as an important national resource and understand the collective knowledge of biodiversity and its use.

Course Learning Outcomes

- Students will learn basic concepts of biodiversity and indigenous knowledge along with the rich traditional resources in management and conservation of biological diversity.
- The course will help students to understand concepts pertaining to conservation of biodiversity and protection of indigenous knowledge including the indigenous management strategies of farmers.
- They will also learn policies and laws relating to biodiversity conservation including protection of intellectual property rights relating to indigenous knowledge.

Unit 1 (10 Hours)

Biodiversity: basic concept, UN Convention on biodiversity, health implications of biological diversity; conservation of biological diversity- policies and law.

Unit 2 (10 Hours)

Human-animal interface- interface between human and animal world; Zoonotic diseases- types, etiology and prevention, biodiversity and genetic resources.

Unit 3 (12 Hours)

Indigenous Knowledge: basic concept, critique of western scientific knowledge, historical context of the emergence of indigenous knowledge, contemporary relevance of indigenous knowledge, indigenous knowledge in biodiversity conservation.

Unit 4 (13 Hours)

Problems of Indigenous Knowledge: issues pertaining to transfer of indigenous knowledge, debates for making indigenous knowledge universal, politics of indigenous knowledge, notion of identity and property; Intellectual Property Rights related to biodiversity and indigenous knowledge, protection of plant varieties.

Practical (30 Hours)

Project Report on Indian Cases pertaining to Indigenous Knowledge, Intellectual Property Rights and Biodiversity

References

Antweiler, C. (2004). Local Knowledge Theory and Methods: An Urban Model from Indonesia. In Investigating Local Knowledge: New Directions, New Approaches (eds.) Alan Bicker, Paul Sillitoe & John Pottier. Ashgate. 1-34

Ellen, R. (2003). Variation and Uniformity in the Construction of Biological Knowledge across Cultures. In Nature Across Cultures: Views of Nature and Environment I Non Western Cultures (eds.) H. Selin, Great Britain: Kluwer Academic Press.

Eldredge, N. (2002). What Is Biodiversity? In Life on Earth: An Encyclopedia of Biodiversity, Ecology, and Evolution Volume 1 A–G. ABC-CLIO, Inc. Santa Barbara, California. 1-30

Gadgil, M., Berkes, F & Folke, C. (1993). Indigenous Knowledge for Biodiversity Conservation. AMBIO, Springer, 22 (2/3): 152-156

Leveque, C. & Mounolou, J. (2003). Brief History of a Concept: Why be concerned by Biological Diversity? In Biodiversity. John Wiley & Sons Ltd. 5-12

Leveque, C. & Mounolou, J. (2003). The Dynamics of Biological Diversity and the Consequences of Human Activities. In Biodiversity. John Wiley & Sons Ltd. 131-164

Leveque, C. & Mounolou, J. (2003). The Dynamics of Biological Diversity and Implications for Human Health. In Biodiversity. John Wiley & Sons Ltd. 165-184

Leveque, C. & Mounolou, J. (2003). Genetic Resources and Biotechnology. In Biodiversity. John Wiley & Sons Ltd. 185-206

Leveque, C. & Mounolou, J. (2003). The Conservation of Biodiversity. In Biodiversity. John Wiley & Sons Ltd. 225-248

Mandal, M. (2009). Internal Displacement in India: Status, Condition & Prospects of Return. Refugee Watch, 33: 33-47

Marselle, M. R. (2021). Pathways linking biodiversity to human health: A conceptual framework. Environment International, Elsevier. 150: 106420

Murray Li, T. (2007). Articulating Indigenous Identity in Indonesia: Resource Politics and Tribal Slot. In Environmental Anthropology: A Historical Reader (eds.) Michael Dove & Carol Carpenter. Blackwell.

Palsson, G. (2007). Bio-value: Appropriating Genomes. In Anthropology and the New Genetics. Cambridge University Press. ¬¬

Posey, D. (2008). Indigenous Management of Tropical Forest Ecosystem: The Case of the Kayapo Indians of the Brazilian Amazon. In Environmental Anthropology: A Historical Reader (eds.) Michael Dove & Carol Carpenter. Blackwell.

Sillitoe, P. (1988). The Development of Indigenous knowledge: A New Applied Anthropology. Current Anthropology 19 (2):

United Nations, (1992). Convention on Biological Diversity (1992). 1-17

Wadehra, B.L. (2012). Protection of Plant Varieties and Farmers' Rights. In Law Relating to Intellectual Property 5 (eds.) Universal Law Publishing Co. New Delhi. 517-528

Vayda, A. P., Walters, B.B. & Setyawati, I. (2004). Doing and Knowing: Questions about Studies of Local Knowledge. In Investigating Local Knowledge: New Directions, New Approaches (eds.) Alan Bicker, Paul Sillitoe & John Pottier. Ashgate. 35-58.

Teaching Learning Process

Lectures and Discussions

Seminars and Presentations

Keywords:

Indigenous Knowledge, Biodiversity, Intellectual Property Rights, Scientific Knowledge

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Health Systems, Promotion and Management

GENERIC ELECTIVE -4 (GE-4)

Health Systems, Promotion and Management

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Health Systems, Promotion and Management – GE-4	04	03	Nil	01	Passed 12th	NIL

Course Objectives

- To understand basic idea of health systems, health promotion
- To assess the health care management strategies
- To understand the public health value of health promotion in different health systems

Course Learning Outcomes

The students will learn the basic concepts of health system research, creatively design health promotion strategies and understand various challenges of health care management.

Unit 1 (10 Hours)

Introduction to the basic concepts of health systems, health promotions and health management

Unit 2 (10 Hours)

Models, Contexts and Agents of health promotion; practice framework of health promotion: lifestyle, diet, and physical activity

Unit 3 (12 Hours)

Health system of (India vs International), health system framework: private and state functioning, health system spending and financing

Unit 4 (13 Hours)

Health care institutes/centre management: health care resource, clinical and technological challenges, cost containment, hospital waste management, health care emergency management

Practical (30 Hours)

Project report based on activity related health promotion, or data collection related to health systems or management

References

Josep Figueras, Martin McKee, Jennifer Cain &; Suszy Lessof. Health Systems in Transition: Learning from Experience. World Health Organization, 2003.

Bruce R. Schatz, Richard B. Berlin Jr. (auth.). Healthcare Infrastructure: Health Systems for Individuals and Populations [1 ed.]. Springer-Verlag London, 2011

Pruss, E. Giroult, Philip Rushbrook. Safe management of wastes from health-care activities. World Health Organization, 1999

Michael J. Reilly, David S. Markenson. Health Care Emergency Management: Principles and Practice [1 ed.], 2010

Teaching Learning Process

The process of learning will involve acquisition of domain knowledge and understanding of skills required for conducting research in health systems, promotion and management. Process will involve lectures and presentations and report submission.

Keywords

Health, Promotion, Health system, health management

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Anthropology and Fieldwork

GENERIC ELECTIVE -5 (GE-5)

Anthropology and Fieldwork

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Anthropology and Fieldwork – GE-5	04	03	Nil	01	Passed 12th	NIL

Course Objectives

- The objective of the course is to introduce the students to the technique of fieldwork, a highly sophisticated qualitative research method developed in the discipline over a century.
- The students shall learn the innovative ways of designing and doing fieldwork in different anthropological settings.

Course Learning Outcomes

- The students will learn how to design and undertake fieldwork using anthropological tools of research.
- They will also learn the intellectual trajectory of the field work tradition affecting various disciplines.

Unit 1 (10 Hours)

Fieldwork Tradition in Anthropology:

The Beginning: Reports of travellers, administrators and missionaries; Invention of the 'non western others' and the colonial agenda

Unit 2 (12 Hours)

Designing Field Research:

Conceiving the universe of study; Identifying techniques of data collection; Pre-testing and Pilot study; Community immersion and researchers' identity

Unit 3 (10 Hours)

The Changing notion of Anthropological Field:

Anthropological field in the era of globalisation; Mobility and interconnection: multi-sited ethnography

Unit 4 (13 Hours)

Data Analysis and Report Writing:

Qualitative and thematic analysis, content analysis; Analysis of metaphors and narratives; Language of representation and persuasion

Practical (30 Hours)

The students shall prepare a project report using fieldwork as a method of data collection. Practical exercises will include task such as identification of units and universal study, designing tools of field research and to pre-test it for ensuring reliability and validity.

References

Madan & Beteille. (1975). Encounter and Experience: Personal Accounts of Fieldwork. University Press of Hawaii.

Brewer, D. John. (2000). Ethnography. McGraw Hill Companies.

Malinowski, B. (1922). Argonauts of Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagos of Melanesian New Guinea. London: Routledge & Kegan Paul Ltd.

Oakley, J. (2012). Anthropological Practice: Fieldwork and Ethnographic Method. Routledge.

Spradley, J. P. (2016). Participant observation. Waveland Press.

Evans- Pritchard, E.E. (1994). Social Anthropology. New Delhi: Universal Book Stall

Srivastava, V. K. Edited (2005). Methodology and Fieldwork. New Delhi: Qxford University Press.

Patnaik, S. M. (2011). Culture, Identity and Development: An Account of Team Ethnography among the Bhil of Jhabau. Jaipur: Rawat Publications.

Teaching Learning Process Lectures and Discussion Seminars and presentation

Keywords

Fieldwork, universe of the study, research design, data analysis, report writing

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Genetic Research in Anthropology

GENERIC ELECTIVE -6 (GE-6)

Genetic Research in Anthropology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Genetic Research in Anthropology – GE-6	04	03	Nil	01	Passed 12th with Science	NIL

Course Objectives

To introduce human genetics through anthropological perspectives where impetus will be laid on building an understanding of biochemical and molecular markers and their relevance in anthropology.

The course focuses on application of anthropological genetics in mendelian populations and molecular basis of complex diseases.

The course also focuses on aspects of field work, data collection, ethical, legal and social issues in genetic research in anthropology.

Course Learning Outcomes

The students will be trained to use biochemical markers with respect to disease profile.

The students can be better equipped to understand the importance of mendelian populations in genetic research that can be applied to disease genetics.

The students will be skilled with basic laboratory techniques for molecular markers.

The students will be better equipped to comprehend fieldwork and data collection along with an understanding of ethical and legal aspects of genetic research.

Unit 1 (08 Hours)

Basic concepts

History and relevance of genetic research in anthropology, evolution of genetic markers as a tool in human research, concept of Hardy-Weinberg Equilibrium principle.

Unit 2 (12 Hours)

Methods of genetic research in anthropology

Twin studies, genetic linkage studies, pedigree analysis, candidate gene studies, cohort studies, cross-sectional studies, hypothesis and technology driven research

Unit 3 (08 Hours)

Data collection in human genetic studies

Field work and data collection strategies, quantitative and qualitative data collection in field

Unit 4 (08 Hours)

Techniques in human genetics

Agglutination, electrophoresis, PCR, sequencing techniques

Unit 5 (09 Hours)

Ethical, legal and social issues in genetic research

Ethical guidelines and practices in genetic research, legal and social issues in genetic research, Indian national guidelines for collaborative research in genetics.

Practical (30 Hours)

1. Pedigree analysis
2. ABO blood group
3. DNA extraction
4. Identification of genetic mutation through specific technique

References

Speicher, M. R., Motulsky, A. G., & Antonarakis, S. E. (Eds.). (2010). Vogel and Motulsky's human genetics. Berlin, Heidelberg: Springer Berlin Heidelberg.

Crawford, M. H. (Ed.). (2007). Anthropological genetics: theory, methods and applications. Cambridge University Press.

Mange, E. J., & Mange, A. P. (1999). Basic human genetics. Sinauer Associates Inc.,U.S.

Reich, D., Thangaraj, K., Patterson, N., Price, A. L., & Singh, L. (2009). Reconstructing Indian population history. Nature, 461(7263), 489-494.

DePristo, M. A. (2010). The $1,000 genome: The revolution in DNA sequencing and the new era of personalized medicine. The American Journal of Human Genetics, 87(6), 742.

Jaworski, E., Routh, A., Head, S. R., Ordoukhanian, P., & Salomon, D. R. (2018). Next Generation Sequencing: Methods and Protocols. Springer New York.

Indian Council of Medical Research. (2017). National ethical guidelines for biomedical and health research involving human participants. National Ethics Guidelines for Biomedical and Health Research involving Human Participants.

Kumar, M., Sandhu, H., & Roshan, R. (2020). Indian Council of Medical Research's International Collaboration & Partnerships; Health Ministry's Screening Committee: Facts, figures & procedures. The Indian Journal of Medical Research, 151(6), 550.

Teaching Learning Process

Theoretical concepts will be covered through classroom/online lectures and presentations. Hands-on training on various laboratory techniques pertaining to biochemical and molecular techniques will be provided in the scheduled practical classes.

Keywords

Anthropological genetic research, pedigree analysis, fieldwork and data collection, PCR and sequencing techniques

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF GEOLOGY
BSc (H) Geology

Category I

Geology Courses offered for UG Programme of study with Geology as single core discipline
(B.Sc. Honours in Geology in three years)

DISCIPLINE SPECIFIC CORE COURSE -7 (DSC-7) – : Palaeontology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Palaeontology (DSC-7)	4	3	0	1	Class 12th with Science	Studied Stratigraphy, Sedimentology, and Earth System Science (or equivalent)

Learning Objectives
To learn about the life forms of the geological past. To understand the diversity and evolution of past life. To know the evolutionary transitions and functional adaptations in different groups of animals and plants.

Learning outcomes

On successful completion of the course, the student will be able to: Appreciate how fossils get preserved in rocks, the nature of fossil record and how fossils are named in a taxonomic framework. Get to know different invertebrate fossil groups, their palaeobiology, and how they can be used in relative dating of rocks. Learn how vertebrates originated and their evolution through time. Understand important floral changes over time and the flora of the Indian coal-bearing sedimentary basins. Analyse the indirect evidences preserved in the rocks for the past existence of life. Critically analyse the role of fossils in relative dating of rocks, in interpreting past environments, past distribution of land and sea, and changes in ecosystems over time.

SYLLABUS OF DSC-7

UNIT – I (9 hours)
Detailed content
Fossilization processes and modes of preservation; nature and importance of fossil record

UNIT – II (9 hours)

Detailed contents

Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda, Graptolites, Trilobites) and their biostratigraphic significance. Significance of ammonites in Mesozoic biostratigraphy and their palaeobiogeographic implications. Functional adaptation in trilobites and ammonoids.

UNIT – III (9 hours)

Detailed contents

Vertebrates: Origin of vertebrates and major steps in vertebrate evolution; Vertebrate evolution in the Palaeozoic Era; Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs

UNIT – IV (9 hours))

Detailed contents

Introduction to Palaeobotany; fossil record of plants through time; Gondwana Flora.

UNIT – V (9 hours)

Detailed contents

Introduction to Ichnology; Application of fossils in Stratigraphy, Fossils and paleobiogeography; Fossils as a window to the evolution of ecosystems.

Practical Component- (30 Hours)

Study of fossils showing various modes of preservation. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.

Essential/recommended readings

Raup, D. M. & Stanley, S.M. (1985). Principles of Paleontology, W.H.Freeman & Company
Clarkson, E. N.K. (2012) Invertebrate Paleontology and evolution 4th Edition by Blackwell

Suggestive readings

Raup, D. M. & Stanley, S.M. (1985). Principles of Paleontology, W.H.Freeman & Company
Clarkson, E. N.K. (2012) Invertebrate Paleontology and evolution 4th Edition by Blackwell.
Foote, M. & Miller, A. I. (2006). Principles of Paleontology, third edition.
Benton, M. (2014). Vertebrate Palaeontology, fourth edition.
Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
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Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 8 (DSC-8): Sedimentary Geology

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sedimentary Geology (DSC-8)	4	3	0	1	Class 12th with Science	Studied Stratigraphy, Earth System Science (or equivalent)

Learning Objectives

Main objective of the course is to provide basic and advance knowledge to students about sediments origin, transport, and depositions and formation of the sedimentary rocks and their distribution in space and time.

Learning outcomes

Students will learn and appreciate the concepts of weathering and sedimentary flux, the basic concepts of sediment transport and formation of sedimentary structures. Grain size scales and analysis. Students will be able to appreciate sedimentary facies, classification of sedimentary rocks, sedimentary environments and provenance.

SYLLABUS OF DSC- 8

UNIT – I (9 hours)

Detailed contents

Introduction to Sedimentary Geology. Chemistry of weathering processes. Sediments: origin, transportation, deposition, consolidation and diagenesis

.

UNIT – II (9 hours)

Detailed contents

Sediment granulometry: Grain size scales Udden-Wentworth and Krumbein (phi) scale, particle size distribution; mean, median, mode, standard deviation, skewness. Environmental connotation.

UNIT – III (9 hours)

Detailed contents

Sedimentary fabric, textures, Porosity and permeability. Sedimentary structures: Syn-sedimentary, Penecontemporaneous

UNIT – IV (9 hours)

Detailed contents

Ichnofossils: Sediment-organism interaction. classification of sedimentary rocks. Tectonics and Climate Diagenesis of terrigenous and chemical sediments

UNIT – V (9 hours)

Detailed contents

Concept of sedimentary facies, paleoenvironment and paleocurrent analyses. Introduction to sedimentary environment: aeolian, glacial, fluvial, near-shore and deep-marine environments. Introduction to carbonate rocks: classification

Practical Component- (30 Hours)

Study of megascopic characters of major sedimentary rocks:

Sketching of primary sedimentary structures in laboratory and museum specimen: ripple marks, cross beddings, sole marks, biogenic structures.

Microscopic study of textures and diagenetic features in sedimentary rocks:

Essential/recommended readings

Prothero, D.R., and Schwab, F. 2003. Sedimentary Geology. Freeman & Co.

Boggs Sam Jr. 1995. Principles of Sedimentology and Stratigraphy, Prentice Hall

Suggestive readings (if any)

Prothero, D.R., and Schwab, F. 2003. Sedimentary Geology. Freeman &Co.

Boggs Sam Jr. 1995. Principles of Sedimentology and Stratigraphy, Prentice Hall.

Stanley, S. M. 1985. Earth and Life through time. Freeman & Co.

Tucker, M., 1988 Techniques in sedimentology Blackwell scientific publications

Nicols, G., 2009 Sedimentology and Stratigraphy Wiley-Blackwell

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE– 9 (DSC-9): Metamorphic Geology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Metamorphic Geology (DSC-9)	4	3	0	1	Class 12th with Science	Studied Earth System Science, Structural Geology, and Mineralogy (or equivalent)

Learning Objectives
This course focuses on teaching about mineralogical and textural transformations in solid state. The main aim is to learn estimating natural state variables at the time of transformation as well as inferring the geodynamic settings of such changes.

Learning outcomes
This course will enable students to identify the mineral assemblages in hand specimen and through microscopic studies utilizing the concept of textural equilibrium, teach them to consider the rocks as chemical systems and apply the principle of phase rule as the major tool for the study of metamorphic rocks. Students will specially learn to infer orogenic processes through metamorphic assemblages and textures.

SYLLABUS OF DSC-9

UNIT – I (9 hours)
Detailed contents

Metamorphism: Definition of metamorphism. Factors controlling metamorphism, Types of metamorphism. Structure and textures of metamorphic rocks, Relationship between metamorphism and deformation

UNIT – II (12 hours)
Detailed contents

Phase rule and Goldschmidt mineralogical phase rule. Chemographic projections, concept of compatible and incompatible assemblages, bulk composition influence on metamorphic assemblages.

UNIT – III (12 hours)

Detailed contents

Metamorphic zones, index minerals and isograds. Continuous and discontinuous reactions, basics of geothermobarometry.

UNIT – IV (12 hours)

Detailed contents

Metamorphism of various protoliths, metamorphic rock associations-schists, gneisses, charnockites and eclogites. Melting and migmatites. Tectonic setting of metamorphic rocks, paired metamorphic belts, concept of P-T-t path.

Practical Component- (30 Hours)

Hand specimen study of metamorphic rocks.
Textural and mineralogical study of metamorphic rocks in thin sections.
Inferring mineral growth versus deformation in metamorphic rocks
Graphical plots of metamorphic mineral assemblages using chemographic projections.
Application of mineral formula calculations in metamorphic rocks

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Essential/recommended readings

Winter, J. D. (2014).Principles of igneous and metamorphic petrology, Pearson.
Yardley, Bruce, and Clare Warren. (2021). An introduction to metamorphic petrology. Cambridge University Press.

Suggestive readings

Winter, J. D. (2014).Principles of igneous and metamorphic petrology, Pearson.
Yardley, Bruce, and Clare Warren. (2021). An introduction to metamorphic petrology. Cambridge University Press.
Philpotts, A. R., and Ague, J. J. (2022). Principles of igneous and metamorphic petrology. Cambridge University Press.
Metamorphic Phase Equilibria And Presure-Temperature-Time-Paths
Frank S. Spear (reprinted 1995)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Discipline Specific Elective: **DSE-1: Earth Surface Processes (L3, P1)** ***or*** **DSE-2: Surveying Techniques (L3, P1)**

Or

One GE from GE pool (GE-3): Fossils and Applications (L3, P1)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-1 **Earth Surface Processes (L3, P1)**	4	3	0	1	Class 12th with Science	Studied Earth System Science and Structural Geology or Equivalent

Learning Objectives

The course "Earth Surface Processes" is intended to provide a holistic approach to study the surficial features and the processes with emphasis on links and feedbacks between its components. The subject will serve as a dynamic and physical based account of the processes at planets surface with an integrated approach involving the principles of geomorphology and sedimentology.

Learning outcomes

After going through this course students will have sound idea about the Earth's Energy Balance, Hydrological cycle, Topography and bathymetry. This will enable them to learn about the sedimentary flux: origin, transport and deposition and the geomorphic and sedimentological processes related to fluvial, coastal, aeolian, and glacial regimes. Students will also appreciate about the environmental changes and its impact on surface processes and landforms.

SYLLABUS OF DSE-1

UNIT – I (9 Hours)

Detailed contents

Introduction to Earth Surface System. Earth's energy balance, hydrological cycle, carbon cycles, heat transfer, topography and bathymetry.

UNIT – II (9 Hours)

Detailed contents

Earth's critical zone, weathering and formation of soils, sediment routing systems, sediment and solute in drainage basins, importance and impact of climate change and tectonics on sediment yield and transport.

UNIT – III (9 Hours)

Detailed contents

Fluid and sediment dynamics and transport: Natural substances, settling of grains, types of flows and boundary separation layers, sediment continuity, modes of sediment transport, bedforms and stratification.

UNIT – IV (12 Hours)

Detailed contents

Sediment transport and deposition associated with fluvial, aeolian, glacial, coastal and marine regimes.

UNIT – V (6 Hours)

Detailed contents

Impact of environmental changes on Earth Surface processes.

Practical Component- (30 Hours)

Exercises on flexural isostasy.

Exercises related to settling of sediments.

Sediment flux exercises.

Preparation of river profiles (Hack Profile, calculation of SL index, Ksn).

Exercises related to fluvial geomorphology.

Exercises on rate of uplift and incision.

Essential/recommended readings

P. A. Allen, 2009, Earth Surface Processes. Wiley

John Bridge and Robert Demicco: Earth Surface Processes and Landforms and Sediment Deposits

Suggestive readings

P. A. Allen, 2009, Earth Surface Processes. Wiley

John Bridge and Robert Demicco: Earth Surface Processes and Landforms and Sediment Deposits

Bloom, A.L., 1998. Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Pearson Education

Summerfield, M.A., 1991. Global Geomorphology, Prentice Hall.

Jon D.Pelletier.2008. Quantitative Modelling of Earth Surface Processes. Cambridge University Press

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE-2 Surveying Techniques (L3, P1)	4	3	0	1	Class 12th with Science	Studied Earth System Science and Structural Geology (or equivalent)

Learning Objectives

The course "Surveying Techniques" is intended to teach the students basic techniques to operate modern surveying instruments and develop skill to carry out topographic mapping.

Learning outcomes

After going through this course students will have sound idea about the Surveying Method and various types mapping skills. For examples: (i) Principles of surveying techniques, (ii) Operate modern surveying instruments, (iii) Prepare maps

SYLLABUS OF DSE-11

UNIT – I (9 Hours)

Basics of Surveying: Fundamental concepts and principles; Types of surveys; Classes of surveys; Surveying Instrumentation; Units of measurement; Locating position; Errors.

UNIT – II (12 Hours)

Levelling – Theory and Methods: Coordinate system; Geoid; Datum; Curvature and refraction; Categories of levels; Traversing; Differential levelling; sources of error in levelling; Distance measurement; Angles, azimuth and bearings.

UNIT – III (12 Hours)

Surveying Techniques: Principles and use of – Chain survey, Plane Table survey, Compass survey, Dumpy level survey, Theodolite survey, Total Station survey, Global Positioning System (GPS)

UNIT – IV (12 Hours)

Map Preparation: Introduction to QGIS; Map design; Map layout; Basic map plotting procedures; Plotting contours; Lettering; Cartographic map elements; Sources of error in mapping.

Practical Component- (30 Hours)
Chain survey
Plane Table survey
Total Station survey
Survey using GPS
Survey using Drone (if drone is available)
Map making

Essential/recommended readings
Surveying – Vol – I – By S.K.Duggal, Tata McGraw Hill Book Co.
Surveying – Vol – II – By S.K. Duggal, Tata McGraw Hill Book Co

Suggestive readings
Surveying – Vol – I – By S.K.Duggal, Tata McGraw Hill Book Co.
Surveying – Vol – II – By S.K. Duggal, Tata McGraw Hill Book Co

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Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
GE-3 Fossils and Applications (L3, P1)	**4**	**3**	**0**	**1**	**12th Pass (with science stream)**	**Nil**

Learning Objectives

To provide some basic knowledge on fossils, their preservation in rocks and different groups of invertebrate, vertebrate and plant fossils. To impart knowledge on the utility of some of these fossils in determining the relative age of sedimentary rocks and implication in palaeoecological, palaeoenvironmental, palaeobiogeographical reconstruction. To equip the student with basic understanding of the role of fossils in hydrocarbon exploration.

Learning outcomes

Student will learn about different types of life forms that existed in the geological past. Students will learn about the evolutionary rates of certain important fossil groups and their role in dividing the rocks into distinctive units based on their stratigraphic ranges. Learn how fossils can be used in understanding the past environments, ecosystems, climate and distribution of land and sea. Student will also learn about the role of fossils in the exploration of fossil fuels.

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SYLLABUS OF GE-3

UNIT – I 9 hours)

Detailed contents

Introduction to fossils: Definition of fossil, fossilization processes (taphonomy), taphonomic attributes and their implications, modes of fossil preservation, role of fossils in development of geological time scale and fossil sampling techniques.

UNIT – II (9 Hours)

Detailed contents

Species concept: Definition of species, species problem in palaeontology, speciation, methods of description and naming of fossils, code of nomenclature.

UNIT – III (9 hours)

Detailed contents

Introduction to various fossils groups: Brief introduction of important fossils groups: invertebrate, vertebrate, microfossils, spore, pollens and plant remains. Important fossiliferous horizons of India

UNIT – IV (9 Hours)

Detailed contents

Application of fossils: Principles and methods of paleoecology, application of fossils in the study of paleoecology, paleobiogeography and paleoclimate; Role of fossils in palaeoenvironmental reconstructions.

UNIT – V (9 Hours)

Detailed contents

Societal importance of fossils: Implication of larger benthic and microfossil in hydrocarbon exploration: identification of reservoirs and their correlation. Application of spore and pollens in correlation of coal seams, spore and pollens as indicator of thermal maturity of hydrocarbons reservoirs, fossils associated with coal deposits, fossils as indicators of pollution.

Practical Component- (30 Hours)

Exercises on flexural isostasy.

Exercises related to settling of sediments.

Sediment flux exercises.

Preparation of river profiles (Hack Profile, calculation of SL index, Ksn).

Exercises related to fluvial geomorphology.

Exercises on rate of uplift and incision.

Essential/recommended readings

Clarkson, E.N.K.1998. Invertebrate Paleontology and Evolution, George Allen &Unwin

Prothero, D.R. 1998. Bringing fossils to life - An introduction to Paleobiology, McGraw Hill.

Suggestive readings

Clarkson, E.N.K.1998. Invertebrate Paleontology and Evolution, George Allen &Unwin

Prothero, D.R. 1998. Bringing fossils to life - An introduction to Paleobiology, McGraw Hill.

Benton, M.J. 2005. Vertebrate Palaeontology (3rd edition), Blackwell Scientific, Oxford.

Colbert's Evolution of the Vertebrates: A History of the Backboned Animals Through Time, Edwin H. Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.

Benton, M.J. & Harper, D.A.T. (2016). Introduction to Palaeobiology and the fossil record. Wiley.

Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies

Raup, D.M. & Stanley, S.M. (1985), Principles of Paleontology, W.H. Freeman and Company

Shukla, A. C. & Mishra, S.P. (1982). Essentials of Palaeobotany

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SRI VENKATESWARA COLLEGE

Biological Science

B.Sc. (HONOURS) BIOLOGICAL SCIENCE

DISCIPLINE SPECIFIC CORE COURSE – 7:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Physics for Biologists (BS-DSC-301)	4	2	0	2	Class XII pass with Biology and chemistry, as one of the papers in Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the basic concepts of physics and their applications in biology.
- To empower the students to develop a basic understanding about the principles and concepts of Physics
- To enable the students to develop quantitative approaches to solve physical/biological problems
- Provide a better understanding of various biophysical processes

Learning outcomes

On successful completion of course, the student will:

- Learn about various aspects of mechanics, centrifugal forces, mechanical forces with examples.
- Understand and explain molecular theory, Gauss's law, medical significance and applications of the dielectric properties of biological materials.
- Describe simple harmonic motion, diffraction, lasers and its applications in medical science.
- Appreciate the Doppler effect and the effects of vibrations in humans with respect to physics of hearing, heartbeat etc.
- Learn to investigate the light absorption properties of molecules through spectrophotometry, for qualitative and quantitative analysis of biomolecules

SYLLABUS OF DSC-7

Unit 1: Mechanics **6 Hours**

Conservation of momentum and energy, work energy theorem, Angular momentum, Torque, motion of a particle in the central force field. Influence of mechanical forces (Pressure, shear or elongation) on bone. Viscosity and viscous force, surface tension and viscoelasticity with examples such as, biopolymers, human tissues etc.

Unit 2: Dielectrics **6 Hours**

Dielectrics: Non polar/Polar dielectrics, Molecular theory of Dielectrics, Dielectric Constant, Gauss's Law in presence of dielectric, Three electric vectors and their relations, Electric susceptibility, Energy stored in dielectrics. Behaviour of dielectric in alternating field. Medical significance and applications of the dielectric properties of biological materials.

Unit 3: Waves and Optics **14 Hours**

Simple harmonic motion, Linearity and superposition Principle. Lissajous figures with equal and unequal frequencies and their uses. Effects of vibrations in humans: physics of hearing, heartbeat. Modern Optics: Superposition of waves: Young's double slit interference, Fraunhofer diffraction: diffraction through a single slit/double slit and grating, Resolving power, Resolution of the eye, Lasers: Principle, Population inversion, He-Ne Laser, characteristics of laser, Applications of lasers in medical science, Polarization by double refraction, Nicol prism. Doppler effect.

Unit 4: Spectroscopic techniques **4 Hours**

Beer-Lambert law, light absorption and its transmittance. UV and visible spectrophotometry-principles, instrumentation and applications. Fluorescence spectroscopy, static & dynamic quenching. light scattering in biology.

PRACTICALS

TOTAL HOURS: 60 **CREDIT: 2**

1. Determination of acceleration due to gravity using Kater's pendulum.
2. Determination of the acceleration due to gravity using bar pendulum.
3. Study of Lissajous figures using CRO.
4. Determination of the frequency of an electrically maintained tuning fork by Melde's Experiment.
5. Determination of the wavelength of laser source by through diffraction of (1) Single slit (2) Double slit.
6. Comparison of capacitances using De'Sautty's bridge.
7. Determination of the coefficient of Viscosity of water by capillary flow method (Poiseuille's method).
8. To determine wavelength of sodium light using Newton's Rings.
9. To determine the wavelength of sodium/mercury light using diffraction grating.
10. Verification of Beer Law.
11. Determination of Molar Extinction coefficient.

REFERENCES

1. D. Kleppner, R. J. Kolenkow (1973). An introduction to Mechanics. McGraw Hill.
2. N. K. Bajaj (2008). The Physics of Waves and Oscillations. 5th edition. Tata McGraw Hill.
3. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill.
4. David Freifelder (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Bioogy. 2nd edition. W.H. freeman and Company.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Protein Structure and Enzymology (BS-DSC-302)	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**Should have studied Chemistry of Biomolecules**

Learning Objectives

The Learning Objectives of this course are as follows:

- Designed with an aim to introduce the students to proteins, most remarkable biomolecules in terms of diversity of structure and function
- Impart knowledge regarding various techniques employed to purify and characterize proteins
- Introduce them to the world of enzymes, biological catalysts with remarkable properties
- Enable them to understand important aspects of enzyme kinetics, mechanism of enzyme action and their regulatory properties
- Introduce the role of proteins and enzymes in medicine

Learning outcomes

Upon completion of the course, the students will be able to:

- Describe the functional diversity of proteins and the different levels of structural organization of proteins
- Explain the relationship between protein structure and function.
- Appreciate and analyse the data from techniques used to purify and characterise proteins.
- Explain enzyme classification, activity, kinetics, inhibition, regulation and mechanism of action of different classes of enzymes
- Acquire knowledge about the application of enzymes in medicine and industry.

SYLLABUS OF DSC- 8

Theory

Unit I: Protein structure and folding **11 Hours**

Amino acids: structure and their properties; Peptides and proteins; Diversity of proteins; Organization of protein structure- primary, secondary, tertiary and quaternary structures; Protein sequencing- Edman degradation. Peptide bond- dihedral angles; Ramachandran plot; Secondary structure elements: Helices, sheets and turns. Motifs and domains; Structures of myoglobin and Hemoglobin. Oxygen binding curves of myoglobin and hemoglobin Influence of 2,3-BPG, CO_2. Denaturation and renaturation of proteins and introduction to thermodynamics of folding. Role of chaperones in protein folding.

Unit II: Purification and analysis of proteins **4 Hours**

Ammonium sulphate fractionation, dialysis. Chromatographic techniques: Ion exchange chromatography, molecular sieve chromatography. Gel electrophoresis: SDS-PAGE.

Unit III: Introduction to Enzymes and enzyme kinetics **8 Hours**

Protein and non-protein nature of enzymes. Cofactor and prosthetic groups. Classification of enzymes; Fischer's lock & key and Koshland's induced fit hypothesis. Enzyme activity and specificity. Enzyme Kinetics-Michaelis-Menten equation and Lineweaver-Burk plot. Determination of Km, Vmax, Kcat. Types of enzyme inhibitions- competitive, uncompetitive, non-competitive, mixed.

Unit IV: Mechanisms of enzyme action and regulation **7 Hours**

Acid-base and covalent catalysis (chymotrypsin); Allosteric regulation and feedback inhibition (ATCase); reversible covalent modification (glycogen phosphorylase); Zymogen; Multi-enzyme complex (PDH). Isoenzymes. Applications of enzymes in medicine, industry and research

PRACTICALS (60 Hours)

1. Introduction to spectrophotometer and verification of Beer law.
2. Estimation of proteins by Biuret method.
3. Estimation of proteins by Lowry's method.
4. Ammonium sulphate fractionation of crude homogenate from germinated mung beans.

5. Assay for acid phosphatase activity and specific activity.
6. Progress curve of enzyme
7. Effect of pH on enzyme activity.
8. Determination of Km and Vmax using Lineweaver-Burk plot.
9. Calculation of Ki for an enzyme

REFERENCES

1. Nelson, D.L., Cox, M.M. (2021). Lehninger: Principles of Biochemistry (8th ed.). New York, WH: Freeman and Company. ISBN: 13: 978-1319381493 / ISBN-10:1319381499.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.
3. Cooper, T. G. (2011) The Tools of Biochemistry (2nd ed.), Wiley-Interscience Publication (New Delhi); ISBN13: 9788126530168.
4. Price, N. C. and Stevens, L. (1999). Fundamentals of enzymology (3rd ed). Oxford: Oxford University Press; ISBN13: 978-0198502296

Additional Resources

1. Sheehan, D. (2013). Physical biochemistry: Principles and applications (2nd ed). Chichester: Wiley-Blackwell; ISBN13: 978-0470856024

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DISCIPLINE SPECIFIC CORE COURSE –9 :

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Functional Ecology (BS-DSC-303)	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NA**

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the basic concepts in ecology and levels of organization in an ecosystem
- Obtain a basic understanding of the various aspects of a 'population' and interactions among individuals of the same as well as different species.
- To understand the structure and functions of the community and its processes.
- To comprehend the components of an ecosystem, energy flow and nutrient cycling.
- To appreciate the applied aspects required in restoration of degraded ecosystems.
- To understand trade-offs in life history characteristics of organisms and various behaviors shownby organisms.

Learning outcomes

By the end of the course, the student will be able to:

- To comprehend the principles and applications of ecology and ecosystem.
- Know about the importance of ecosystem in general and the effects of changes inecosystem.
- Understand the techniques used for the quantitative and qualitative estimation of bioticand abiotic components of an ecosystem.
- Gain knowledge about the density, frequency and diversity of species in an ecosystem.
- Understand about key interactions between organisms like competition , predation ,parasitism etc.
- Participate in citizen science initiatives from an ecological perspective

SYLLABUS OF DSC-9

Theory

Unit 1: Introduction to Ecology **03 Hours**

History of ecology, Autecology and synecology, levels of Organisation, Laws of limiting factors (Liebig's law of minimum, Shelford's law of tolerance), ecological range (Eury and Steno).

Unit 2: Population Ecology **12 Hours**

Population: Unitary and Modular populations; Metapopulation: Density, natality, mortality, life tables, fecundity tables, survivorship curves, sex ratio, age pyramids, dispersal and dispersion; carrying capacity, population dynamics (exponential and logistic growth equation and patterns), r and K selection, density-dependent and independent population regulation; Niche concept, Population interactions: Positive and negative interactions; Competition, Gause's Principle for competition with laboratory and field examples, Lotka-Volterra equation for predation.

Unit 3: Community Ecology 08 Hours

Community structure: Dominance, diversity, species richness, abundance, stratification; Diversity indices; Ecotone and edge effect; Community dynamics (succession): Primary and secondary succession, Succession on a bare rock. Climax: monoclimax and polyclimax concepts (preclimax, postclimax, disclimax etc.). Concept of keystone, indicator and flagship species with plant and animal examples.

Unit 4: Ecosystem Ecology 07 Hours

Concept, components, and types of ecosystems (example of Pond ecosystem in detail showing abiotic and biotic components), BOD, eutrophication. Energy flow (Grazing and Detritus food chain), linear and Y-shaped energy flow model, black box model, food web. Ecological pyramids and Ecological efficiencies.

PRACTICALS

CREDITS: 2 **Total weeks: 60 Hours**

1. To understand the principle and working of ecological instruments such as Anemometer, Hygrometer, Luxmeter, Rain gauge, turbidity meter, pH meter, Soil thermometer, Min-Max thermometer.
2. To study biotic interactions using specimens/ photographs/ permanent slides of Parasitic angiosperms, Saprophytic angiosperms, root nodules, velamen roots, lichens , corals
3. 3.To study plant-microbe interactions by preparing temporary stained mounts of VAM fungi / mycorrhizal roots/ root nodules.
4. Mark recapture method for determining population density of animals
5. 5.To determine a minimal quadrat area for sampling
6. To determine density, frequency and abundance of herbaceous vegetation by quadrat method
7. To estimate dissolved oxygen content of a given water sample using Winkler's method.
8. Plotting of survivorship curves from hypothetical life table data.

REFERENCES

1. Barrick, M., Odum, E. P., Barrett, G. W., (2005).*Fundamentals of Ecology*.5th Edition.Cengage Learning.
2. Smith, T. M..& Smith, R. L.(2012). *Elements of Ecology* 8th Edition. Pearson.
3. Ricklefs, R. E., & Miller, G. L., (2000).*Ecology*, 4thEdition W.H. Freeman.
4. Sharma, P. D. (2017). *Ecology and Environment*.13th Edition. Meerut: Rastogi Publications.

MOOCs

1. 'Ecology: Ecosystem Dynamics and Conservation from American Museum of Natural History on Coursera https://www.classcentral.com/course/coursera-ecology- ecosystem-dynamics-and- conservation-10618
2. https://alison.com/course/diploma-in-ecology-studies
3. https://swayam.gov.in/ Any ecology based online course that may be available during the semester, depending on its relevance to the present syllabus

POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSEs)

DISCIPLINE SPECIFIC ELECTIVE COURSE –DSE-1 :

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Medicinal And Ethnobotany (BS-DSE-1)	4	2	0	2	Class XII pass with Biology and chemistry, as one of the papers in Class XII	NA

Learning Objectives:

Plants are imperative to mankind with almost all plants known to possess medicinal values. There is an increased emphasis on indigenous system of medicine which has lent prime focus on medicinal plants. Keeping the therapeutic importance of medicinal plants in mind this course is designed to provide education and training on diverse perspectives of medicinal plants. The course also offers comprehensive knowledge about understanding the difference between ancient wisdom and the modern system of medicine.

Learning Outcomes:

On successful completion of the course, a student will:

- Be able to identify the common medicinal plants in their vicinity.
- Learn about the traditional healing sciences namely Ayurveda, Siddha and Unani, which have been used since the ancient times.
- Appreciate the importance of conservation strategies for medicinal plants.
- Be able to understand the importance of medicinal plants, significance of ethnobotany, role of ethnic groups in the conservation of medicinal plants.

Course Contents - Theory

Unit 1: History, Scope and Importance of Medicinal Plants

10 Hours

Introduction to indigenous systems of medicines- Ayurveda, Unani and Siddha system of medicine)- Ayurveda: History, origin, Panchamahabhutas, Saptadhatu and Tridosha concepts, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system. Unani: History, concept: Umoor-e- tabiya. Plants used in Ayurveda, Siddha and Unani medicine with special reference to *Carum carvi, Plantago ovata, Allium sativum, Asparagus racemosus, Vitis vinifera, Linum usitatissimum, Amaranthus paniculatus.* Polyherbal formulations (with special reference to Safi, Chyawanprash, Trifala, Swalin, Amukkara Choorna, Gandhak rasayana). Natural products – Compounds responsible for biological activity of medicinal plants: their biology, and pharmacology (*Curcumin, Vinblastine, Vincristine, Ecliptine, Cinchonine, Azadirachtin, Artemisinin*).

Unit 2: Conservation of Endangered and Endemic Medicinal Plants

08 Hours

Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanical Gardens, herbal gardens, Ethnomedicinal plant gardens. Germplasm conservation, cryopreservation (Cryo banks and DNA banks), Role of NBPGR and JNTBGRI in conservation of plants, Propagation of Medicinal Plants: *In vitro* and *In vivo* strategies. Adulteration of Herbal drugs. Organoleptic, microscopic and phytochemical evaluation of plant drugs.

Unit 3: Ethnobotany and Folk Medicines 12 Hours

Introduction, concept, scope and objectives; Ethnobotany in India: Methods to study ethnobotany; Folk medicines of ethnobotany, Role of ethnobotany in modern medicine with special reference to *Rauvolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania.* Major and minor ethnic groups of India and their lifestyles. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases. Role of ethnic groups in conservation of plant genetic resources; Brief account of biopiracy and IPR.

PRACTICAL

Credit: 2 Total 60 Hours

1. Identification of any ten common medicinal plants in the surrounding area and study their characteristic features.
2. Collection, identification and preparation of herbarium of any five medicinal plants.
3. Extraction and qualitative estimation of active principle compounds (alkaloids, tanins, saponins and flavanoids) from any four medicinal plants. (*Aloe vera, Ocimum, Azadirachta, Catharanthus, Adhatoda, Withania*)
4. Study of components and medicinal uses of common polyherbal formulations used in the traditional system of medicine (Ayurveda, Unani and Siddha).
5. Study of organoleptic, macroscopic and microscopic parameters of any two medicinal plants.
6. To compare the total phenolic content of few locally available medicinal plants

7. Field trip: Industries/Institutes/herbal garden/ medicinal gardens/ nurseries/tribal museum.
8. e-presentations (System of medicine, Conservation strategies, propagation of medicinal plants, folk medicines, application of natural products to certain diseases listed in the syllabus)

Essential readings:

1. Abdin, M. Z. and Abrol, Y. P., (2006). *Traditional Systems of Medicine.* Narosa Publishing House, New Delhi.
2. Kumar, S., (2018). *Ethnobotany*. Kojo press, New Delhi.
3. Purohit and Vyas, (2008). *Medicinal Plant Cultivation: A Scientific Approach,* Agrobios.
4. Trivedi, P. C. (2006). *Medicinal Plants: Ethnobotanical Approach.* Agrobios.

Additional Readigs

1. Colton, C. M., (1997). *Ethnobotany: Principles and Applications*. John Wiley and Sons.
2. Jain, S. K., (1990). *Contributions to Indian Ethnobotany*. Scientific publishers, Jodhpur.
3. Jain, S. K., (1995). *Manual of Ethnobotany.* Scientific Publishers, Jodhpur.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE –DSE-2

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Hormone biochemistry (BS-DSE-2)	4	2		2	Class XII pass with Biology and chemistry, as one of the papers in Class XII	NA

Learning Objectives:

The course is designed to enable the students to understand and appreciate the delicate network and balance of hormones required for the healthy functioning of the human body. The course emphasizes on studying the different types of hormones along with their physiological action.

The students will be taught the consequences of any hormonal imbalances (over and underproduction of hormones) with special emphasis on human diseases. It provides an understanding of the different endocrine factors that regulate metabolism, growth, electrolyte and mineral homeostasis, glucose homeostasis, stress physiology and reproductive function. It also prepares a student for postgraduate studies in any course related to molecular medicine.

Learning Outcomes:

On successful completion of the course, a student will:

- Understand the role of endocrine system in maintaining ionic and glucose homeostasis
- Should be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.
- Understand the integrative communications that regulate, growth, appetite, metabolism and reproduction
- Prepares the student for interpreting clinical parameters in a real-life situation.

Course Contents -Theory

Unit 1: Introduction to hormones and Hypothalamic-hypophyseal system : 5 Hours

Introduction to hormones; Hypothalamic - pituitary axis- anatomy, histology, vasculature, and secretions. Physiological and biochemical actions of hypothalamic hormones and Anterior pituitary hormones; Hormone feed- back regulatory cascade. Posterior pituitary hormones –structure, physiology and biochemical actions of AVP and Oxytocin; Diabetes insipidus

Unit 2: Hormones regulating growth, energy metabolism and calcium homeostasis 10 Hours

Regulation of Growth: growth hormone and somatomedin, Endocrine disorders - gigantism, acromegaly, dwarfism, pygmies. Thyroid gland- Biosynthesis of thyroid hormone and its regulation: Role of TRH, TSH in T_4 synthesis and response. Physiological and biochemical action of Thyroxine. Pathophysiology of thyroxine secretion: Goiter, Graves' disease, cretinism, myxedema.
Regulation of calcium homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit 3: Hormones regulating glucose homeostasis, stress physiology and electrolyte balance: 10 Hours

Hormones of the Pancreas: structure, synthesis, regulation of release, incretins, physiology and biochemical actions of insulin and glucagon. Role of these hormones in blood glucose homeostasis; Pathophysiology - diabetes type I and type II. GIT hormones: Secretin, gastrin and incretins.
Physiology and action of Aldosterone; the Renin Angiotensin System. Physiology and Biochemical actions of Cortisol; Role of POMC and CRH in cortisol synthesis;

Adrenal medullary hormones: epinephrine and norepinephrine. The Fight or flight response; Dual receptor hypothesis. General adaptation syndrome: acute and chronic stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.

Unit 4: Reproductive hormones: **5 Hours**

Male and female sex hormones. Role of testosterone in male secondary sexual characteristics. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based Contraceptives.

PRACTICAL

Credit: 2 **Total Hours- 60**

1. Glucose tolerance test.
2. Estimation of serum Ca^{2+} by o-CPC method
3. Determining the thyroid profile by estimating T_4 and TSH under normal and pathophysiological conditions.
4. Estimation of estrogen during different days of the menstrual cycle.
5. HCG based pregnancy test.
6. Estimation of serum electrolytes.
7. Presentation on GI Tract hormones and Adipokines
8. Case studies: Diabetes Insipidus, Acromegaly and dwarfism, Diabetes Mellitus, Rickets, Osteoporosis, Cushing syndrome

Essential readings:

1. Vander's Human Physiology (2008) 11th ed.,Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
2. Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.
3. Victor Rodwell, David Bender, et al. (2018) ISE Harper's Illustrated Biochemistry Thirty-First Edition, McGraw Hill (A and L Lange series), ISBN-10. 1259837939 ; ISBN-13. 978-1259837937

Suggested readings:

1. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
2. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE –DSE-3 :

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Applied entomology (BS-DSE-3)	4	2	0	2	Class XII pass with Biology and chemistry, as one of the papers in Class XII	NA

Learning Objectives:

The study of Applied Entomology provides an insight about the role of insects as powerful competitors of man as they cause enormous injury to crops and animals and also act as vectors of many diseases. This course will help the students to understand the concept of insect pests and their population dynamics in relation to changing environmental conditions as well as the role of economically important insects in tremendous commercial benefits to humans. The students will learn about various types of pests, their distinguishing features, life cycle, damage to crops and human health by them. This will be of help in choosing the appropriate control measures to manage the pest population in nature and to avoid heavy economic losses.

Learning Outcomes:

Upon completion of the course, students will be able to:

- Learn about the concept of pest and pest status.
- Understand the difference between various types of pests and Crop losses and extent of damage caused by them.
- Gain knowledge about economically important insects; important pests of crops, fruits, vegetables, stored grains and also about medically important insects.
- Analysis of varied types of control measures for management of pest populations and list suitable control measures- specific for every pest.

Course Contents- Theory

Unit 1: Pests and Economically important Insects (05 Hours)

Introduction, Factors responsible for emergence of pest, Pest status, Pest population dynamics. Economically important Insects; Honey Bee and Silkworm

Unit 2: Bionomics and Control of Crop pests (07 Hours)

Rice pest (*Leptocorisa acuta*); Wheat pest (*Sesamia inferens*); Pulse pest (*Helicoverpa armigera*); Cotton pests (*Pectinophora gossypiella*); Vegetable pest (*Raphidopalpa foveic*

Unit 3: Stored Grain Pests (6 Hours)

Bionomics and strategies for the management of stored grain pests; *Sitophilus oryzae*, *Corcyra cephalonica*, *Trogoderma granarium*, *Callosobruchus chinensis*.

Unit 4: Medically Important Pest (05 Hours)

Bionomics and Management of the Medically Important pests; Fleas, Mosquitoes, Housefly.

Unit 5: Pest Management Tactics (7 Hours)

Methods of Physical, Mechanical, Cultural, Biological, Genetic control of insects; Chemical controls. Integrated Pest Management (IPM).

PRACTICAL (Total Hours 60)

1. Identification of Agricultural Pests and Damage caused by them: *Leptocorisa acuta, Sesamia inferens, Helicoverpa armigera, Raphidopalpa foveicollis*.
2. Identification of Stored Grain Pests and Damage caused by them: *Sitophilus oryzae, Corcyra cephalonica, Trogoderma granarium, Callosobruchus chinensis.*
3. Study of the Morphological Features of Rat flea, Mosquitoes, Housefly and their Medical Importance.
4. Determination of LD50 or LC50 of Insecticides based on the data provided.
5. Instruments used in chemical control of pests.
6. Project report on any one economically important insect/ rearing of a pest.
7. Field Trips to Entomological Institutes/Museums/Laboratories

3.3 Essential Readings:

1. Atwal, A.S. (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, New Delhi.
2. Dennis, S. Hill (2005) Agricultural Insect Pests of the Tropics and Their Management, Cambridge University press. Suggested Readings:
3. S. Pradhan. Insect Pest of Crops. National Book Trust, New Delhi.

Suggested Readings:

1. Pedigo, L.P. (1996) Entomology and Pest Management. Prentice Hall, New Delhi.

Online Tools and Web Resources:

- https://swayam.gov/appliedentomology
- http://mesamalaria.org/updates/mooc-medical-entomology-organized-institut-pasteur
- https://www.pasteur.fr/en/mooc-medical-entomology-insect-vectors-andtransmission-pathogens
- https://www.entsoc.org/resources/education/online-courses

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF ENVIRONMENTAL SCIENCE

Category-I

BSC (H) ENVIRONMENTAL SCIENCE

DISCIPLINE SPECIFIC CORE COURSE – 7 (DSC-EVS-7): ENVIRONMENTAL BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-EVS-7: ENVIRONMENTAL BIOTECHNOLOGY	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Provide theoretical and practical biotechnological skills for environmental goals
- Evolve ecological foundations of using microorganisms in biodiversity assessment, ecosystems restoration, and environmental remediation
- Relate the microbial ecophysiology with biogeochemical cycles that govern the terrestrial ecosphere
- Emphasize the relevance of biotechnological processes in environmental applications and sustainable development

Learning outcomes

After this course, students will be able to learn the following skills.

- Apply the biotechnological methods to improve environmental management
- Perform comparative protein and DNA sequence analyses to elucidate the phylogenetic relationship
- Analyze non-culturable microbial diversity in the environment and classify microbes based on energy and carbon metabolism
- Plan methods for combined biological nutrient removal (BNR), treat wastewater, and remedify soils and water contaminated with organic and inorganic pollutants

SYLLABUS OF DSC-EVS-7

UNIT – I The Structure and Function of DNA, RNA and Protein (7 Hours)

DNA: structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation, and renaturation kinetics; biological significance of different forms; Synthesis.

RNA: structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different types of RNA; synthesis.

Protein: hierarchical structure (primary, secondary, tertiary, quaternary), types of amino acids; post-translational modifications and their significance; synthesis; types and their role: structural, functional (enzymes).

Central dogma of biology; genetic material prokaryotes, viruses, eukaryotes and organelles; mobile DNA; chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin).

UNIT – II Recombinant DNA Technology (7 Hours)

Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes; nucleic acid microarrays

UNIT – III Ecological restoration and bioremediation (10 Hours)

Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; treatment schemes for wastewater: dairy, distillery, tannery, sugar, antibiotic industries; solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment); specific bioremediation technologies: land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wetlands, use of bioreactors for bioremediation; phytoremediation; remediation of degraded ecosystems; advantages and disadvantages; degradation of xenobiotics in the environment, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.

UNIT – IV Ecologically safe products and processes (6 Hours)

PGPR bacteria: biofertilizers, microbial insecticides, and pesticides; bio-control of the plant pathogen, Integrated pest management; development of stress-tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation, and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Undertake comparative analyses of the ultrastructure of cells and cellular organelles of prokaryotes and eukaryotes.

2. Analyze UV absorption spectra of DNA, RNA and protein
3. Determine denaturation and renaturation of dsDNA
4-5. Estimate contents of DNA and protein in the given samples
6. Visit contaminated or degraded habitats and analyze their vegetation characteristics and compare them with pristine habitat
7. Characterize and analyze plants documented in practical 6 to identify species having the potential for phytoremediation
8-10. Isolate phosphate-solubilizing bacteria from different soils and assess morphological and functional variations in phosphate-solubilizing bacteria
11. Determine bacterial density in soils sampled from contaminated and pristine habitat
12. Visit and analyze various steps of Sewage/Wastewater treatment processes (STP/WTP).
13-15. Explore and use different molecular databases for application in environmental science

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Essential/recommended readings

- Furlong, J. and Evans, G.G., 2011. Environmental Biotechnology: Theory and Application. John Wiley & Sons.
- Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: Concepts and Applications. John Wiley& Sons.
- Nelson, D.L. & Cox, M.M. 2013. Lehninger's Principles of Biochemistry. W.H. Freeman.
- Rittman, B.E. & McCarty, P.L. 2020. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
- Snustad, D.P. & Simmons, M.J. 2011. Principles of Genetics (6th edition). John Wiley& Sons.
- Vallero, D., 2015. Environmental Biotechnology: A Biosystems Approach. Academic Press.
- Wainwright, M., 2012. An introduction to Environmental Biotechnology. Springer Science & Business Media.

Suggestive readings

- Lodish, H., Berk, A., Kaiser, C.A., Kaiser, C., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P., 2008. Molecular Cell Biology. Macmillan.
- Moo-Young, M., Anderson, W.A. and Chakrabarty, A.M. eds., 2013. Environmental Biotechnology: Principles and Applications. Springer Science & Business Media.
- Petre, M. ed., 2013. Environmental Biotechnology: New Approaches and Prospective Applications. InTech, Crotia.
- Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press.
- Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management*. Elsevier Publications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 8 (DSC-EVS-8): ATMOSPHERE & GLOBAL CLIMATE CHANGE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ATMOSPHERE & GLOBAL CLIMATE CHANGE	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Analyze dynamics of atmospheric processes, which include their composition, meteorological phenomena, and atmospheric chemistry.
- Gain knowledge on the development of the Earth's atmosphere, its dynamic nature, and variability in turns of the global energy balance.
- Describe air masses and formation and impacts fronts and how they affect local weather patterns,
- Develop a better understanding of the elements of the climate and climate change and human impacts on climate initiative policies.
- Train on different methods to understand the functioning of atmospheric processes and their importance in supporting life on Earth

Learning outcomes

After this course, students will be able to

- understand the underlying physical and chemical basis of the natural and anthropogenic greenhouse effect
- develop pathway analysis to develop linkages between various human-induced emissions of natural greenhouse gases and the formation of aerosols
- appreciate the variability in the Earth's climate and correlate the changing climate with different human activity
- critically evaluate the complexities and uncertainties about scientific evidence for climate change
- analyze Earth's past and Anthropocene and global climate
- correlate effects of global climate changes on human communities and impacts of policy and technology initiatives taken at global and regional levels to combat the climate change

SYLLABUS OF DSC-EVS-8

Theory (02 Credits: 30 lectures)

UNIT – I Introduction and Global Energy Balance (4 Hours)

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere in making the Earth, the only biosphere; Milankovitch cycles. Earth's energy balance; energy transfers in the atmosphere; Earth's radiation budget; greenhouse gases (GHGs); greenhouse effect; global conveyor belt.

UNIT –II Atmospheric circulation (5 Hours)

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; *El Nino* and *La Nina*; tropical cyclone; Indian monsoon and its development, changing monsoon in Holocene in the Indian subcontinent, its impact on agriculture and Indus valley civilization; effect of urbanization on microclimate; Asian brown clouds.

UNIT –III Meteorology and atmospheric stability (4 Hours)

Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model.

UNIT –IV Atmospheric chemistry (4 Hours)

Chemistry of atmospheric particles and gases; smog – types and processes; photochemical processes; ions and radicals in atmosphere; acid-base reactions in atmosphere; atmospheric water; roles of hydroxyl and hydroperoxyl radicals in atmosphere.

UNIT –V Global warming and climate change (5 Hours))

Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing the climate change; atmospheric windows; impacts of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO_2 fertilization and agriculture; impact on the economy and spread of human diseases.

UNIT –VI Ozone layer depletion (5 Hours)

Ozone layer or ozone shield; Importance of ozone layer; Ozone layer depletion and causes; Chapman cycle; Orocess of springtime ozone depletion over Antarctica; Ozone-depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols.

UNIT –VII Climate change and policy (3 Hours)

Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; Clean development mechanism.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Analyze the atmospheric chemistry of a given area with respect to target greenhouse gas(es) and its changes over time
2. Identify weather patterns and climate of the given region
3. Calculate the carbon footprint of the given institution (homes and/or college)
4. Evaluate the perception of climate change in developed and developing countries
5. Identify the critical factors governing global climate change and relate with the goals of different international governmental and non-governmental organizations

6-7. Compare the targets and achievements in global efforts to combat global climate change during the past three decades

8-9. Estimate the difference in carbon stock between soil and trees of a given area

10. Understand and correlate annual tree ring data with a historical account of climate
11. Identify the critical factors governing global climate change and relate them with the goals of different international governmental and non-governmental organizations
12. Compare climate change policies of selected developed and developing countries

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
- Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
- Hoffman, S., Eriksen, T.H. and Mendes, P. eds., 2022. Cooling Down: Local Responses to Global Climate Change. Berghahn Books.
- Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
- Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.

- Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
- Salby, M.L., 2012. Physics of the Atmosphere and Climate. Cambridge University Press.
- Speight, J.G., 2019. Global Climate Change Demystified. John Wiley & Sons.
- Wang, Y (2020). Atmosphere and Climate, 2nd Edition, Handbook of Natural Resources Vol VI, CRC Press.

Suggestive readings

- Crate, S.A. and Nuttall, M., 2016. Anthropology and Climate Change: From Actions to Transformations. Routledge.
- Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
- Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
- Hering, E., 2010. Atmosphere and Climate: Studies by Occultation Methods. Springer.
- Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.
- Sauer, T.J. and Norman, J.M. eds., 2011. Sustaining Soil Productivity in Response to Global Climate Change. Wiley-Blackwell.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 9 (DSC-EVS-9): MARINE ECOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MARINE ECOLOGY	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into the dynamic processes that affect oceans, i.e., water, seafloor, and abundant life forms
- Identify the role being played by ocean-atmosphere interaction in the climate processes.
- Investigate the role of ocean processes in coastal and marine landform creation.

Learning outcomes

After this course, students will be able to

- Analyze the role of physical processes in the dynamic process of ocean circulation.
- Formulate solutions ailing the current state of the coastal and marine environment in terms of chemical and biological interactions.
- Implement the knowledge base to promote ocean awareness in light of human exploitation of its resources.
- Assess the impacts of environmental and anthropogenic variables on marine ecosystems and biodiversity with time and space
- Use ecological data to predict the impact of a given factor on marine biodiversity and ecology

SYLLABUS OF DSC-9

Theory (02 Credits: 30 lectures)

UNIT – I Introduction (4 Hours)

A short history of the oceans and continents, History of marine ecology, Morphologic and tectonic domains of the ocean floor; Ocean basins, Ocean sediments; Composition of seawater, carbon dioxide-carbonate system; Atmospheric circulation, Ocean circulation, Life in the ocean, Pelagic communities, Benthic communities, Uses and abuses of the ocean.

UNIT – II Geography and physical forcing of Marine Ecosystems: (4 Hours)

Climate and Circulation of the World Ocean, Geostrophic flow and the central ocean gyres, Convergence zones and fronts, Thermohaline circulation and the origins of deep-water coasts, shallows, and their consequences; Global distribution of ocean productivity, Vertical structure of the pelagic water column, The spring bloom, High-nitrogen low-chlorophyll (HNLC) regions

UNIT – III Biodiversity and biogeography of Ocean (6 Hours)
Magnitude of Biodiversity; Biodiversity on Land and Sea, Phylogenetic Classification of Marine Biodiversity, Functional Organization of Pelagic and Benthic Life, Major Patterns in the Distribution of Marine Life (Spatial, latitudinal, longitudinal, depth, bottom type); Biogeography of Functional Traits, Evidence for Island Biogeography, Integrative Models of Marine Diversification, Biogeographic Classifications of the Ocean, Biogeography of the Anthropocene Ocean.

UNIT – IV Macro- and trait-based ecology of marine organisms (6 Hours)
Species Interactions, Functional groups of phytoplankton, benthic macrophytes, and grazers; Pelagic food webs, microbial loop, Metabolic scaling and life history, Abundance and the energetic equivalence rule, Macroecology of range size Specialization and resource partitioning, Nonequilibrium dynamics; Biological pump and the global carbon cycle, Trophic control in pelagic ecosystems.

UNIT – V Anthropocene Ocean (5 Hours)
Marine populations in the Anthropocene, Marine defaunation and trophic skew, Empirical evidence for regime shifts in marine ecosystems, Mechanisms of marine regime shifts, Ocean Warming and its effects on community and sea level rise, Ocean Acidification and its effects on organisms and communities, Ecological stoichiometry, Climate change and redistribution of global marine fauna, Tropicalization, The Arctic opening

UNIT – VI Ocean Conservation and Management (5 Hours)
Maximum sustainable yield in fisheries, Strategic conservation of vulnerable life stages, Life history and the effectiveness of marine reserves, Organismal Fitness and Adaptation to the Environment, Dispersal, Recruitment, and Metapopulations, Tagging and tracking, Geochemical tags.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Construct microcosm for marine ecology studies
2-3. Determine environmental partitioning of target chemicals in the constructed microcosm
4-5. Determine physico-chemical properties of given sediment sample
6-7. Examine methods to analyze phytoplankton and zooplanktons in the given water samples and its application in analyzing marine ecology
8. Analyze relationships between soil particle characteristics and biological properties of sediment
9. Analyze oceanographic data by GIS and identify ecologically-relevant oceanographic data using remote sensing
10. Isolate bacteria from the freshwater river and estimate their growth in

seawater

11. Determine microbial density in a given marine water sample
12. Compare the biodiversity of freshwater bodies and marine ecosystems by examining a review/research paper
13. Analyze plate tectonic theory and understand the variations in global marine ecosystems
14. Evaluate merit and demerits of ocean acidification manipulation experiments conducted globally
15. Compare and contrast the benefits of using a storage tank, mixing tank, header tank and experimental tank to understand marine ecology

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Arias, A.H. and Menendez, M.C. eds., 2013. Marine Ecology in a Changing World. CRC Press.
- Garrison, T.S., 2014. Essentials of Oceanography. Cengage Learning.
- Kennish, M.J., 2019. Practical Handbook of Marine Science. CRC Press.
- Kaiser, M.J., Jennings, S., Thomas, D.N. and Barnes, D.K., 2011. Marine Ecology: Processes, Systems, and Impacts. Oxford University Press.
- Mann, K.H. and Lazier, J.R., 2013. Dynamics of Marine Ecosystems: Biological-Physical Interactions in the Oceans. John Wiley & Sons.
- Speight, M.R. and Henderson, P.A., 2013. Marine Ecology: Concepts and Applications.
- Thrush, S., Hewitt, J., Pilditch, C. and Norkko, A., 2021. Ecology of Coastal Marine Sediments: Form, Function, and Change in the Anthropocene. Oxford University Press.

Suggestive readings

- Gray, J.S. and Elliott, M., 2009. Ecology of Marine Sediments: from Science to Management. Oxford University Press.
- Miller, C.B., 2009. Biological Oceanography. John Wiley & Sons.
- Pittman, S.J. ed., 2017. Seascape Ecology. John Wiley & Sons.
- Riley, J.P. and Chester, R. eds., 2016. Chemical Oceanography. Elsevier.
- Talley, L.D., 2011. Descriptive Physical Oceanography: An Introduction. Academic press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-01): ENVIRONMENTAL ECONOMICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-01: ENVIRONMENTAL ECONOMICS	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Appreciate critical linkages between fundamentals of environmental economics and environmental conservation
- Evaluate five megatrends involving climate, development, ecology, economy, and technology
- Inculcate market-based instruments in designing sustainable development approaches
- Gain insights into intricacies of economic valuation of biodiversity and ecosystems for making evidence-based conservation and development priorities
- Empower with the integrated use of economics & ecology in decision-making and law-making processes.

Learning outcomes

After the course, the students will be able to

- Use cost-benefit analysis and valuation techniques for environmental economics and natural resource management
- Implement economic and ecological concepts to influence society and policymakers for environmental and biodiversity conservation
- Act as a consultant to industries and government ministries aiming for sustainability
- Serve as a catalyst for developing ecoliterate industry and evolving sustainable policies
- Evolve ideas and economics-based techniques to design policy instruments for pollution control and management

SYLLABUS OF DSE-EVS-01

Theory (02 Credits: 30 lectures)

UNIT – I Introduction to microeconomics (7 Hours)

Definition and scope of environmental economics; environmental economics versus traditional economics; brief introduction to major components of economy: consumer, firm and their interaction in the market, producer and consumer surplus, market failure, law of demand and supply, tangible and non-tangible goods; utilitariasm; Pareto optimality; compensation principle.

UNIT – II Environmental economics (8 Hours)

Main characteristics of environmental goods; marginal analysis; markets and market failure; social benefit, costs and welfare functions; meaning and types of environmental values; measures of economic values; tangible and intangible benefits; Pareto principle or criterion; Hardin's Thesis of 'The Tragedy of Commons'; Prisoner's dilemma game; methods of abatement of externalities; social cost-benefit analysis; cost-effectiveness analysis.

UNIT – III Economic solutions to environmental problems (7 Hours)

Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginal social cost of abatement; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards vs. emissions charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.

UNIT – IV Natural resource economics (3 Hours)

Economics of non-renewable resources; economics of fuels and minerals; Hotelling's rule and extensions; taxation; economics of renewable resources; economics of water use, management of fisheries and forests; introduction to natural resource accounting.

UNIT –V Tools for environmental-economic policy (5 Hours)

Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis, assessing benefits and cost for environmental decision making; cost-benefit analysis and valuation: discounting, principles of Cost-Benefit Analysis, estimation of costs and benefits, techniques of valuation, adjusting and comparing environmental benefits and costs.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Conduct cost-benefit analysis of any developmental project
2. Investigate underlying pattern of behavioural economics of selected environmental problem and suggest appropriate solution
3. Calculate energy requirements for decent living in a given country in the background of climate change
4. Determine the potential economic challenges of decarbonization policies and practices being adopted by a country of your choice
5. Apply LCA tools to calculate the energy of construction and manufacturing for appliances, buildings and infrastructure and assess sustainability of the given country
6. Analyze demand and supply curve using
7. Use demand or supply concept and provide empirical evidence on the effects of climate change on the macroeconomy
8. Compare and contrast the demand for and supply of EQ in developed and developing countries
9. Use Marginal Curve Analysis for a given pollution and determine the efficient level of pollution to maximize the net benefits of pollution
10. Determine the social cost of carbon (SCC) to minimize the climate change damages in the cost-benefit analysis of a given project that increase or reduce carbon emission
11. Calculate the value of damages incurred due to release of an additional tonne of carbon into the atmosphere
12. Use Demand for and supply of environmental quality (EQ) in the Environmental Kuznets Curve (EKC) hypothesis
13. Show the usefulness of (a) utility curve analysis, (b) indifference curve analysis, (c) production possibility frontier, (d) market failure or market equilibrium, and (e) Prisoners' dilemma game
14. Conduct an environmental audit of your institution and suggest strategies to improve its sustainability status

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Callan, S.J. and Thomas, J.M., 2013. Environmental economics and management: Theory, policy, and applications. Cengage learning.
- Hanley, N., Shogren, J.F. and White, B., 2016. Environmental economics: in theory and practice. Macmillan International.
- Hawken, P., Lovins, A.B. and Lovins, L.H., 2013. *Natural Capitalism: The Next Industrial Revolution*. Routledge.
- Kolstad, C.D. 2010. Environmental Economics. Oxford University Press.
- Thomas, J.M. & Callan, S.J. 2007.Environmental Economics. Thomson Learning Inc.
- Thampapillai, D.J. and Ruth, M., 2019. Environmental Economics: Concepts, Methods and Policies. Routledge.
- Tietenberg, T. and Lewis, L., 2018. Environmental and Natural Resource Economics. Routledge.

Suggestive readings

- Stahel, W.R. and MacArthur, E., 2019. The Circular Economy: A User's Guide. Routledge, NY, USA.
- Frodermann, L., 2018. *Exploratory Study on Circular Economy Approaches*. Springer, Fachmedien Wiesbaden.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE-EVS-2): SOLID WASTE MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-2: SOLID WASTE MANAGEMENT	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Understand physical and chemical processes for classifying, segregating, and managing solid wastes
- Characterize the different solid waste types and apply interdisciplinary knowledge for effective solid waste collection and processing of solid waste
- Compare methods of collection, transfer, storage, treatment, disposal, and use of solid waste in developed and developing nations
- Management, construction, and operations of landfill and other solid waste management facilities

Learning outcomes

After successful completion of this course, students will be able to:

- Conduct the life cycle assessment of solid waste and its impact on the urban metabolisms
- Identify and select landfill sites using GIS and other analytical techniques
- Examine and apply technical and legal solutions for sustainable management of solid waste
- Plan and design waste recycling programmes, compost and incineration facilities, and landfills
- Mine and analyze the relevant data and apply multiple criteria decision-making systems for a sustainable integrated solid waste management plan

SYLLABUS OF DSE-EVS-02

Theory (02 Credits: 30 lectures)

UNIT – I Effect of solid waste disposal on the environment (6 Hours)

Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste. Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effects of landfill leachate on soil characteristics and groundwater pollution.

UNIT – II Common methods to manage solid waste (4 Hours)

Different techniques used in the collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques.

UNIT – III Industrial waste management and resource recovery (8 Hours)

Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant. 4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

UNIT – IV Integrated waste management and waste-to-energy (8 Hours)

Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management. Concept of energy recovery from waste; refuse-derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification. Life-cycle assessment (LCA): Cradle to grave approach; lifecycle inventory of solid waste; role of LCA in waste management; advantage and limitation of LCA; case study on LCA of a product.

UNIT – V Policies for solid waste management (4 Hours)

Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Ecofriendly or green products.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Conduct life cycle assessment of solid waste generated in your institute/residential area/city
2. Design a composting pit for solid waste management in your institute or its nearby area
3. Conduct geotechnical characterization of the selected solid waste generated in the given area
4. Determine microbial density in the given solid waste collected from your institute
5. Estimate environmental impacts of greenhouse gases released and energy recovery from solid waste being collected in a given landfill
6. Assess cost-benefit analysis of various processing options of the given solid waste being managed in your city
7. Field survey of solid waste dumping site of your city, document the quantum of waste being collected and stored, and identify the hidden environmental issues
8. Analyze the site plan of the waste dumping site visited in 7, and compare and contrast it with the most successful design being used in the given developed country
9. Screen a documentary on solid waste management of national or international relevance. Identify and analyze socio-economic impacts and suggest scientific solutions to address the concerned environmental challenges.
10. Critically evaluate the recent plastic management policy of your country and make specific recommendations for immediate amendment aiming for environmental sustainability
11. Select a type of solid waste and prepare a documentary of its management in your city highlighting the merit/demerit of current practices, associated socio-economic and environmental issues and possible solutions suggested by experts
12. Compare and contrast solid waste management practices being adopted in two areas of your city with photographic and videographic evidence

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.
- Blackman Jr, W.C., 2016. Basic Hazardous Waste Management. CRC press.
- Chang, N.B. and Pires, A., 2015. Sustainable Solid Waste Management: A Systems Engineering Approach. John Wiley & Sons.

- Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F., 2018. What A Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Publications.
- McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.
- Rada, E.C. ed., 2016. Solid Waste Management: Policy and Planning for a Sustainable Society. CRC Press.

Suggestive readings

- Asnani, P.U. and Zurbrugg, C., 2007. Improving Municipal Solid Waste Management in India: A Sourcebook for Policymakers and Practitioners. World Bank Publications.
- Christensen, T. ed., 2011. Solid Waste Technology and Management. John Wiley & Sons.
- Tchobanoglous, G. and Kreith, F., 2002. Handbook of Solid Waste Management. McGraw-Hill Education.
- Vanatta, B., 2000. Guide for Industrial Waste Management. Diane Publishing.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-3): ENVIRONMENTAL MODELLING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-3: ENVIRONMENTAL MODELLING	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into the concepts, methods, tools and application of environmental modelling
- Appreciate modelling approach with a clear understanding of its scope, limitations and complexity
- Improve knowledge of fate and transport of pollutants and important natural processes and events
- Empower with the application of modelling in ecosystem management via better environmental management, decision making and policy development

Learning outcomes

After the course, students will be able to:

- Choose the appropriate model for a given ecological question or environmental concern
- Overcome the common challenges of model building for improved predictability
- Evolve a better plan to implement and validate model outputs
- Apply models while keeping in view the strength and weaknesses of different model types
- Practice sustainability management, implement cleaner technologies, and argue in favour of environmental protection.

SYLLABUS OF DSE-EVS-3

Theory (02 Credits: 30 lectures)

UNIT – I Working with models (8 Hours)

Goals, objectives, scope and process of modelling in the environment. Modelling approach: deterministic, stochastic and physical. How to choose, construct and interpret statistical models, Statistical frameworks, Philosophy of statistical modeling, Fitting models to real-world data, Techniques–from simple (distribution fitting) to complex (state-space modeling), Techniques for data manipulation and display. Uncertainties in model development: Design, analysis, documentation, and communication; Data availability and optimal modelling, Reliability of ecological models

UNIT – II Modelling in Science and Environment (12 Hours)

Science models: Visual models, Mathematical models, and Computer models. Model types: Conceptual, Mathematical, and Computational Models; Individual- or agent-based models, Unstructured population models, and Stage-structured matrix models, Single-, two-, and three-state variable models. Environmental models: Fate and transport models, Emissions and activities models, Exposure models, and Impact models; Models of common ecosystems (aquatic, terrestrial, and man-managed) for biodiversity conservation and ecosystem management; Model of the socio-ecological system.

UNIT – III Models for "out of balance" or environmental problems (10 Hours)

Acidification models in water pollution, Eutrophication models, Models of oxygen depletion, Fire and the spread of fire, Air pollution, Toxic substance pollution, Climate, weather and global warming, Environmental/ecological modeling for regulatory risk assessments and hazard predictions.

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Test and practice different steps of model development
2. Validate the functioning of the model developed at 1
3. Apply the model to predict outcomes of different environmental scenarios
4. Formulate mathematical and computational models to visualize solar radiance on Earth
5. Develop model wind speed at a given area for establishing wind energy and power plant
6. Evaluate the given multiple leaf-layer model
7. Formulate, implement and evaluate the discrete model for population dynamics
8. Develop a model to predict predator-prey dynamics
9. Analyze competition between different species using an appropriate model
10. Model hydrological networks of the given area
11. Visualize digital elevation data for hydrological network analysis
12. Compare and contrast commonly used software for environmental and ecological modelling

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Beven, K., 2018. Environmental modelling: an uncertain future? CRC press.
- Essington, T.E., 2021. Introduction to Quantitative Ecology: Mathematical and Statistical Modelling for Beginners. Oxford University Press.
- Holzbecher, E., 2012. Environmental Modelling: Using MATLAB. Springer Science & Business Media.
- Jørgensen, S.E., 2009. Ecological Modelling: An Introduction. WIT press.
- Kelly, R.E., Drake, N.A. and Barr, S.L. eds., 2004. Spatial Modelling of the terrestrial environment. John Wiley & Sons.
- Sang, N. ed., 2020. Modelling Nature-Based Solutions: Integrating Computational and Participatory Scenario Modelling for Environmental Management and Planning. Cambridge University Press.
- Skidmore, A., 2017. Environmental Modelling with GIS and Remote Sensing. CRC Press.
- Wainwright, J. and Mulligan, M. eds., 2013. Environmental Modelling: Finding Simplicity in Complexity. John Wiley & Sons.

Suggestive readings

- Clark, J.S. and Gelfand, A.E. eds., 2006. Hierarchical modelling for the environmental sciences: statistical methods and applications. OUP Oxford.
- Emetere, M.E., 2019. Environmental Modeling Using Satellite Imaging and Dataset Re-processing. Springer International Publishing.
- Fort, H., 2020. Ecological Modelling and Ecophysics: Agricultural and Environmental Applications. IOP Publishing.
- Parnis, J.M. and Mackay, D., 2020. Multimedia Environmental Models: The Fugacity Approach. CRC Press.
- Soetaert, K. and Herman, P.M., 2009. A Practical Guide to Ecological Modelling: Using R as a Simulation Platform (Vol. 7, No. 7). New York: Springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-4): BIOPROSPECTING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-4: BIOPROSPECTING	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Learning the concepts and practices of bioprospecting.
- Empower with traditional and modern knowledge related to bioprospecting
- Gain insights into the discovery of novel chemicals of industrial and ecological significance
- Link between the traditional knowledge and the current state of development
- Approaches being used for bioprospecting and regulations relevant to safeguard biodiversity and traditional knowledge

Learning outcomes:

After the course, students will be able to

- Inventorize and monitor biodiversity in different agro-ecological regions
- Act as a catalyst in the discovery of novel compounds from biodiversity across the ecosystems
- Identify alternative sources of chemicals/genes relevant to industry and society
- Evolve combinatorial approaches for screening and isolation of targeted compounds/genes
- Implement relevant policies and laws for safeguarding biodiversity and ancient knowledge

SYLLABUS OF DSE-EVS-4

Theory (02 Credits: 30 lectures)

UNIT – I Concept and Scope (4 Hours)

Definition, Types, and Current practices; Relevance for society, industry, environment, ecosystems, biodiversity and policy; Global status and national efforts

UNIT – II Targets of Bioprospecting (6 Hours)
Novel chemicals, genes, genotypes, population, idea, and design. Plants, microbes, animals, bioactive compounds, and chemicals. Relevant case studies focusing on different target; Success and failure of bioprospecting in sustainable development

UNIT – III Approaches and Methods of Bioprospecting (10 Hours)
Traditional knowledge, ehnopharmaceutical, ecological, and phylogenetic; Biosynthesis and chemical modification, Genetic engineering, Expression of the target gene, Cultivation and mass propagation of target organism; Choice of approach and its limitations or strength. Tools and techniques to practice bioprospecting; Biochemical, physiological, molecular, and chemical assays; Genomic, proteomic, Computational biology and combinatorial.

UNIT – IV Application of Bioprospecting (6 Hours)
Novel drug development, Species and genetic resource conservation, Sustainable use and conservation of biodiversity, Ecosystem management, Industrial sustainability, Agriculture sustainability, Sustainable health, Disease regulation, and culture conservation, Bridge between ancient knowledge to a modern approach to sustainable development.

UNIT – V Laws and Policies Relevant to Bioprospecting (4 Hours)
Convention on biodiversity; Benefit-sharing, Biodiversity Act, Intellectual Property Rights, Biopiracy; Case studies on neem, turmeric, and basmati rice;

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Field visit to a local nursery and document medicinal plants having importance in pharmaceutical industry nationally and globally and identify the bioactive compounds
2. Isolate alkaloids from target species using differential solvent fractionation techniques
3. Analyze the separated bioactive compound from 2 using wavelength spectra and chromatographic technique
4. Determine the antimicrobial activity of the given compound or compound fractionated in 2
5. Screen microbes and plants for their ability to produce different glycosides of ecological and economic significance
6. Isolate and prospect microbes of ecological significance, especially for promoting plant growth
7. Test the given plant extract or microbial culture for their ability to control phytodiseases causing organism
8. Fractionate pigments from targeted plants and microbes and determine their potential industrial use

9. Apply computational biology and phylogenetic approach to identify the novel source of targeted compound/gene/protein or enzyme
10. Screen plants for their antioxidant potential and reduce the oxidative stress
11. Visit laboratories / Industries / Institutes engaged in bioprospecting and submit the report in a prescribed format
12. Analyze policies related to bioprospecting and identify the areas for amendments to improve their applicability

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Bull, A.T., 2004. Microbial Diversity and Bioprospecting. ASM Press.
- Hayden, C. 2020. When Nature Goes Public: The Making and Unmaking of Bioprospecting in Mexico (Vol. 1). Princeton University Press.
- Paterson, R. and Lima, N. eds., 2016. Bioprospecting: Success, Potential and Constraints (Vol. 16). Springer.
- Sampath, P.G., 2005. Regulating Bioprospecting: Institutions for Drug Research, Access, and Benefit-Sharing. United Nations University Press.
- Harvey, A.L. and Gericke, N., 2011. Bioprospecting: creating a value for biodiversity. Research in Biodiversity–Models and Applications, InTech Open, pp.323-338.

Suggested readings

- Hewlett, J., 2000. Bioprospecting: Purifying Protein by Design. Hofstra University, New York State Education Department
- Hsu, E. and Harris, S. eds., 2010. Plants, Health and Healing: On the Interface of Ethnobotany and Medical Anthropology (Vol. 6). Berghahn Books.
- Pavlinov, I. ed., 2011. Research in Biodiversity: Models and Applications. BoD–Books on Demand. InTech Open.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF CHEMISTRY
Category-I
B Sc. (Hons) Chemistry

DISCIPLINE SPECIFIC CORE COURSE -7 (DSC-7): Chemistry of d- and f-block Elements & Quantitative Inorganic Analysis

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of d- and f- Elements & quantitative Inorganic Analysis (DSC-7)	**04**	**02**	**0**	**02**	Passed Class 12^{th} with Physics, Chemistry, Mathematics	**NIL**

Learning Objectives

The Objectives of this course are as follows:

- To provide thorough knowledge about the d- and f- block elements with respect to the general group trends, physical and chemical properties of these elements.
- To familiarize the students with the d- and f-block elements and get an idea about horizontal similarity in a period in addition to vertical similarity in a group.
- To impart the knowledge about inorganic polymer
- To give an idea about the principles of gravimetric analysis.

Learning outcomes

By studying this course, the students will be able to:

- List the important properties of transition metals, lanthanoids, and actinoids
- Use Latimer diagrams to predict and identify species which are reducing, oxidizing and tend to disproportionate and calculate skip step potentials.
- Describe the classification, structure and applications of Inorganic Polymers.
- List and use the principles of gravimetric analysis for quantitative analysis

SYLLABUS OF DSC-7

UNIT – 1: Transition Elements **(12 Hours)**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic properties, catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams), Frost diagrams of Mn and Cr.

A brief discussion of differences between the first, second and third transition series

UNIT – 2: Lanthanoids and Actinoids (8 Hours)

A brief discussion of electronic configuration, oxidation states, colour, spectral and magnetic properties. Lanthanoid contraction (causes and effects) separation of lanthanoids by ion exchange method.

UNIT – 3: Inorganic Polymer (8 Hours)

Comparison with organic polymers, classification, structure and applications of following inorganic polymers:

- Borates
- Silicates, silicones
- Phosphates
- Phosphazenes (for cyclic polymers, only trimer is to be discussed)

UNIT – 4: Principles of gravimetric analysis (2 Hours)

Particle size, Precipitation, Coagulation, Peptization, Co-precipitation, Digestion, Filtration and washing the precipitate, Drying and ignition the precipitate

Practical component (60 Hours)

(Laboratory periods:15 classes of 4 hours each)

(A) Gravimetry

1. Estimation of Ni(II) using dimethylglyoxime (DMG).
2. Estimation of copper as CuSCN.
3. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$. (by homogeneous and heterogeneous method)
4. Estimation of Al(III) by precipitating with oxime and weighing as $Al(oxime)_3$ (aluminiumoxinate).

(B) Inorganic Preparations

1. Potassium aluminium sulphate $KAl(SO_4)_2.12H_2O$ (potash alum) or Potassium chromium sulphate $KCr(SO_4)_2.12H_2O$ (chrome alum).
2. Manganese phosphate and
3. Sodium peroxoborate

(**C) Paper chromatographic separation of following metal ions (minimum two should be done):**

1. Ni(II) and Co(II)

2. Cu(II) and Cd(II)
3. Fe(III) and Al(III)

Essential/recommended readings

Theory:

1. Lee, J.D.(2010),**ConciseInorganicChemistry**,WileyIndia.
2. Huheey,J.E.;Keiter,E.A.;Keiter;R.L.;Medhi,O.K.(2009),**InorganicChemistry-PrinciplesofStructureandReactivity**,PearsonEducation.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
4. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
5. Pfennig, B. W. (2015), **Principles of Inorganic Chemistry**. John Wiley & Sons.
6. Cotton, F.A.; Wilkinson, G. (1999), **Advanced Inorganic Chemistry,** Wiley-VCH.
7. Das, A. K.; Das, M. (2014), **Fundamental Concepts of Inorganic Chemistry**, 1st Edition, Volume 1-3, CBS Publishers & Distributors Pvt. Ltd.
8. Chandrashekhar,V. (2005), **Inorganic and Organometallic Polymers** , 5th Edition, Springer Publications

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis,** John Wiley and Sons,
2. Harris, D. C.; Lucy,C. A.(2016), **Quantitative Chemical Analysis,** 9th Edition, Freeman and Company.
3. Day, R. A.; Underwood, A. L. (2012), **Quantitative Analysis**, Sixth Edition, PHI Learning Private Limited.
4. Marr, G.; Rockett, B.W. (1972), **Practical Inorganic Chemistry**, Van Nostrand Reinhold.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE -8 (DSC-8): Carbonyls, Carboxylic acids, Amines, Nitro compounds, Nitriles, Isonitriles and Diazonium salts

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Carbonyls, Carboxylic Acids, Amines, Nitro Compounds, Nitriles, Isonitriles and Diazonium salts (DSC-8)	04	03	0	01	Passed Class 12th with Physics, Chemistry, Mathematics	NIL

Learning objectives

The objectives of this course are as follows:

- To infuse students with the details of the chemistry of aldehydes, ketones, carboxylic acids and their derivatives, nitro, amines and diazonium salts.
- To make students aware of the chemical synthesis, properties, reactions and key applications of the listed classes of compounds and develop understanding of detailed mechanistic pathways for each functional group to unravel the spectrum of organic chemistry and the extent of organic transformations.
- To aid in the paramount learning of the concepts and their applications.

Learning outcomes

By studying this course, students will be able to:

- Explain the chemistry of oxygen and nitrogen containing compounds.
- Use the synthetic chemistry learnt in this course to do functional group transformations.
- Propose plausible mechanisms for the reactions under study.

SYLLABUS OF DSC-8

UNIT – 1: Carbonyls, Carboxylic acid & their derivatives (27 Hours)

Carbonyl Compounds: Reaction of carbonyl compounds with ammonia derivatives, Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and

Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC), addition reactions of α,β-unsaturated carbonyl compounds: Michael addition.
Carboxylic acids and derivatives: Effect of substituents on acidic strength on carboxylic acids, HVZ reaction, typical reactions of dicarboxylic acids and hydroxy acids. Comparative study of nucleophilic acyl substitution for acid chlorides, anhydrides, esters and amides, Mechanism of acidic and alkaline hydrolysis of esters, Dieckmann and Reformatsky reactions, Hoffmann-bromamide degradation and Curtius rearrangement.
Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT – 2: **Nitro Compounds, Amines, Diazonium salts, Nitriles and Isonitriles (18 Hours)**

Nitro compounds: General methods of preparation: from alkyl halides, alkanes, oxidation of amines and oximes. Henry reaction, Nef reaction, Reduction-electrolytic reduction, reaction with nitrous acid, reduction in acidic, basic and neutral medium (for aromatic compounds)

Amines: Preparation**,** chirality in amines (pyramidal inversion), Basicity of amines: Effect of substituents, solvent and steric effects, distinction between Primary, secondary and tertiary amines using Hinsberg's method and nitrous acid, Gabriel Phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction and Cope elimination.

Diazonium Salts**:** Synthetic applications of diazonium salts including preparation of arenes, haloarenes, phenols, cyano and nitro compounds; Coupling reactions of diazonium salts (preparation of azo dyes).

Nitriles: Preparation using following reactions: Dehydration of amides and aldoximes, substitution reaction in alkyl halides and tosylates, from Grignard reagents and from dehydrogenation of primary amines. Properties: Physical properties, discussion on the following reactions with mechanism: Reaction with Grignard reagent, hydrolysis, addition reaction with HX, NH_3, reaction with aqueous ROH, Reduction reactions-catalytic reduction and Stephen's reaction, Condensation reactions-Thorpe Nitrile Condensation.

Isonitriles: Preparation from the following reactions: Carbylamine reaction, substitution in alkyl halides and dehydrogenation of N-substituted formamides. Properties: Physical properties, discussion on the following reactions with mechanism: Hydrolysis, reduction, addition of– HX, X_2 and sulphur, Grignard reaction, oxidation and rearrangement.

Practical component (30 Hours)
(Laboratory periods:15 classes of 2 hours each)

1. Preparation of oximes for aldehydes/ketones (like benzaldehyde, ethyl methyl ketone, cyclohexanone etc.)
2. Preparation of semicarbazone derivatives for aldehydes/ketones (like benzaldehyde, ethyl methyl ketone, cyclohexanone etc.)
3. Hydrolysis of amides/esters.
4. Selective reduction of *m*-dinitrobenzene to *m*-nitroaniline.
5. Preparation of S-benzylisothiouronium salts for water soluble and water insoluble carboxylic acids.
6. Systematic qualitative analysis of the given organic compounds containing monofunctional groups (aromatic hydrocarbons, alcohols, phenol) and preparation of one suitable derivative.

Students should be exposed to preparative routes for the synthesis of 3,5-dinitrobenzoate, benzoates, acetate derivatives.

Note: The above derivatives should be prepared using 0.5-1.0 g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and compound analysis**.**

Essential/recommended readings

Theory:

1. Morrison, R. N., Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
2. Finar, I.L. **Organic Chemistry** Volume 1, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
3. Finar, I.L. **Organic Chemistry** Volume 2, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
4. Solomons, T.W.G., Fryhle, C.B.; Snyder, S.A. (2017), **Organic Chemistry**, 12th Edition, Wiley.

Practical:

1. Vogel, A.I. (2012), **Quantitative Organic Analysis**, Part 3, Pearson Education.
2. Mann, F.G., Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, 5th Edition, Pearson.
4. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
5. Ahluwalia, V.K., Aggarwal, R. (2004), **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**, University Press.
6. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi.
7. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–II**, I K International Publishing house Pvt. Ltd, New Delhi.

Suggestive Readings

1. Mukherji, S.M., Singh, S.P. (2017), **Reaction Mechanism in Organic Chemistry**, Trinity Press.
2. Singh,J., Awasthi, S. K., Singh, Jaya, **Fundamentals of Organic Chemistry-III**, Pragati Prakashan (2023)
3. Carey, F.A., Sundberg, R. J. (2008), **Advanced Organic Chemistry: Part B: Reaction and Synthesis**, Springer.
4. Bruice, P.Y. (2015), **Organic Chemistry,** 3rd Edition, Pearson.
5. Patrick, G. (2003), **BIOS Instant Notes in Organic Chemistry**, Viva Books.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 9 (DSC-9): Chemical equilibrium, Ionic equilibrium, conductance and solid state

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical equilibrium, Ionic equilibrium, conductance and solid state (DSC-9)	**04**	**03**	**0**	**01**	**Passed Class XII with Physics, Chemistry and Mathematics**	**NIL**

Learning Objectives:

The Learning Objectives of this course are as follows:

- To make students understand the concept of chemical equilibrium and ionic equilibrium.
- To introduce the concept of electrolytes, ionization of various electrolytes, pH.
- To explain the applications of ionization in buffer, hydrolysis, acid-base titrations and indicators.
- To introduce the concept of electrolytic conductance with respect to strong and weak electrolytes and then extend it to understand concepts like ionic mobility, transference and related properties.
- To develop the advance concept of solid state with emphasis on crystal structures in general and cubic crystals in details.

Learning Outcomes:

By studying this course, students will be able to:

- Apply the concept of equilibrium to various physical and chemical processes.
- Derive and express the equilibrium constant for various reactions at equilibrium.
- Use Le Chatelier's principle to predict the thermodynamic conditions required to get maximum yield of a reaction
- Apply the concept of equilibrium to various ionic reactions.
- List different types of electrolytes and their properties related to conductance in aqueous solutions.
- Use conductance measurements for calculating many properties of the electrolytes.

- Prepare buffer solutions of appropriate pH.
- Explain the crystal properties and predict the crystal structures of cubic systems form the XRD.
- Use the instruments like pH-meter and conductivity meters.

SYLLABUS OF DSC-9

UNIT – 1: Chemical Equilibrium **(6 Hours)**

Criteria of thermodynamic equilibrium, degree of advancement of reaction, Chemical equilibria in ideal gases, Thermodynamic derivation of relation between Gibbs free energy of a reaction and reaction quotient, Equilibrium constants and their dependence on temperature, pressure and concentration, Le Chatelier's Principle (Quantitative treatment), Free energy of mixing and spontaneity (qualitative discussion).

UNIT – 2: Ionic equilibrium **(12 Hours)**

Strong, moderate and weak electrolytes, Arrhenius theory of electrolytic dissociation, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves. Theory of acid–base indicators; selection of indicators and their limitations.

UNIT – 3: Conductance **(12 Hours)**

Quantitative aspects of Faraday's laws of electrolysis, Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch's law of independent migration of ions. Debye-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rule. Ionic velocity, mobility and their determination, transference number and its relation to ionic mobility, determination of transference number using Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations (v) hydrolysis constants of salts.

UNIT – 4: Solid state **(15 Hours)**

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary idea of symmetry, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

Practical component (30 Hours)
(Laboratory periods: 15 classes of 2 hours each)

pH metry:

1. Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.
2. Preparation of buffer solutions of different pH values
   a. Sodium acetate-acetic acid
   b. Ammonium chloride-ammonium hydroxide
3. pH metric titration of
   a. Strong acid with strong base
   b. Weak acid with strong base. Determination of dissociation constant of a weak acid.

Conductometry:

1. Determination of cell constant
2. Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations:
   a. Strong acid vs. strong base
   b. Weak acid vs. strong base
   c. Mixture of strong acid and weak acid vs. strong base
   d. Strong acid vs. weak base

p-XRD *(p-XRD crystal pattern to be provided to the students)*

1. Differentiate and classify the given set of the diffraction pattern as crystalline materials or amorphous (Glass) substance.
2. Carry out analysis of a given set of p-XRD and determine the type of the cubic crystal structure
   a. NaCl
   b. CsCl
   c. KCl
3. Determination of approximate crystal size from a given set of p-XRD

Essential/recommended readings
Theory

1. Peter, A.; Paula, J. de. (2011), **Physical Chemistry**, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
3. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 2, 6th Edition, McGraw Hill Education.
4. McQuarrie, D. A.; Simon, J. D. (2004), **Molecular Thermodynamics**, Viva Books Pvt. Ltd.
5. Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGraw Hill Education.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Suggestive readings

1. Levine, I.N. (2010), **Physical Chemistry**, Tata Mc Graw Hill.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF DISCIPLINE SPECIFIC ELECTIVE COURSE

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1): Nuclear and Environmental Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nuclear and Environmental Chemistry (DSE-1)	**04**	**03**	**0**	**01**	Passed Class 12th with Physics, Chemistry	**NIL**

Learning Objectives

The Objectives of this course are as follows:

- To make students know more about nuclear chemistry
- To familiarise the students about environmental chemistry, especially with respect to air and water

Learning outcomes

By studying this course, the students will be able to:

- Gain knowledge about Nuclear chemistry, radioactive decay, nuclear disasters, and nuclear waste and their disposal.
- Describe the composition of air, various air pollutants, effects and control measures of air pollutants.
- List different sources of water, water quality parameters, impacts of water pollution, water treatment.
- Identify different industrial effluents and their treatment methods.

SYLLABUS OF DSE-1

Unit-1 : Nuclear Chemistry **(21 Hours)**

The nucleus: subatomic particles, e liquid drop model; forces in nucleus-mesons; stability of nucleus-n/p ratio, binding energy; radioactive elements.
Radioactive decay- α-decay, β-decay, γ-decay; neutron emission, positron emission; unit of radioactivity (curie); half life period; radioactive displacement law, radioactive series.
Measurement of radioactivity: ionization chamber, Geiger Counters, Scintillation counters.
Nuclear reactions: Nuclear fission-theory of nuclear fission; chain reaction; nuclear fusion; nuclear reactors-fast breeder reactors, fuels used in nuclear reactors, separation of isotopes, moderators, coolants; nuclear reactors in India.
Applications: Dating of rocks and minerals, carbon dating, neutron activation analysis, isotopic labeling studies, nuclear medicine- ^{99m}Tc radio pharmaceuticals.
Nuclear disasters – Chernobyl disaster, Three Mile Island Disaster, Disposal of nuclear waste and its management.

UNIT – 2: Air Pollution **(12 Hours)**

Major regions of atmosphere, chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature, Major sources of air pollution, Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul-smelling gases, methods of estimation of CO, NO_x, SO_x and control procedures.

Chemistry and environment impact of the following: Photochemical smog, Greenhouse effect, Ozone depletion

Air pollution control, Settling Chambers, Venturi Scrubbers, Electrostatic Precipitators (ESPs).

UNIT – 3 : Water Pollution: **(12 Hours)**

Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological cycle and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for wastewater, industrial water and domestic water.

Practical component (30 Hours)
(Laboratory periods:15 classes of 2 hours each)
(At least four experiments to be performed)

1. Determination of dissolved oxygen in a given sample of water.
2. Determination of Chemical Oxygen Demand (COD) in a given sample of water.
3. Determination of Biological Oxygen Demand (BOD) in a given sample of water.

4. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
5. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
6. Measurement of dissolved CO_2 in a given sample of water.
7. Determination of hexavalent Chromium Cr(VI) concentration in tannery wastes/ waste water sample using UV-Vis spectrophotometry technique.

Essential/recommended readings

Theory:

1. Stanley E. Manahan, 10th edition, **Environmental chemistry,** CRC Press, Taylor and Francis Group, US, 2017
2. Baird, C. and Cann,M., **Environmental Chemistry,**(2012), Fifth Edition, W. H. Freemann & Company, New York, US.
3. VanLoon, G.W. and Duffy, J.S.(2018) **Environmental Chemistry - A global perspective**, Fourth Edition, Oxford University Press
4. Brusseau, M.L.; Pepper,I.L. and Gerba, C., (2019) **Environmental and Pollution Science**, Third Edition, Academic Press.
5. Masters, G.M., (1974) **Introduction to Environmental Science and Technology**, John Wiley & Sons.
6. Masters, G.M., (2015) **Introduction to Environmental Engineering and Science.** JPrentice Hall India Learning Private Limited.

1. 7.Arnikar, H.J., (1987), Second Edition, **Essentials of Nuclear Chemistry,** Wiley Blackwell Publishers

7. Arnikar, H.J.; Rajurkar, N. S.,(2016) **Nuclear Chemistry through Problems,** New Age International Pvt. Ltd.
8. De, A.K.(2012), **Environmental Chemistry,** New Age International Pvt., Ltd.
9. Khopkar, S.M.(2010), **Environmental Pollution Analysis**, New Age International Publisher.
10. Das, A. K. (2010), ***Fundamentals of Inorganic Chemistry***, Volume 1, Second Edition, CBS Publishers & Distributors Pvt Ltd.
11. Das, A. K. (2012), ***Environment Chemistry with Green chemistry***, Books and Allied (P) Ltd.

Practical:

1. Vowles, P.D.; Connell, D.W. (1980),**Experiments in Environmental Chemistry: A Laboratory Manual**, Vol.4, Pergamon Series in Environmental Science.
2. Gopalan, R.; Anand, A.; Sugumar R.W. (2008),**A Laboratory Manual for Environmental Chemistry**, I. K. International.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

DISCIPLINE SPECIFIC ELECTIVE COURSE - 2 (DSE-2): Inorganic materials of industrial importance

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Inorganic Materials of Industrial Importance (DSE-2)	**04**	**03**	**0**	**01**	Passed Class 12^{th} with Physics, Chemistry	**NIL**

Learning Objectives

The objectives of this course are as follows:

- To make students understand the diverse roles of inorganic materials in the industry and to give an insight into how these raw materials are converted into products used in day-to-day life.
- To make students learn about silicates, fertilizers, surface coatings, batteries, engineering materials for mechanical construction.
- To develop the interest of students in the frontier areas of inorganic and material chemistry.

Learning outcomes

By studying this course, the students will be able to:

- State the composition and applications of the different kinds of glass.
- State the composition of cement and discuss the mechanism of setting of cement.
- Defend the suitability of fertilizers for different kinds of crops and soil.
- Explain the process of formulation of paints and the basic principle behind the protection offered by the surface coatings.
- Describe the principle, working and applications of different batteries.
- Evaluate the synthesis and properties of nano-dimensional materials, various semiconductor and superconductor oxides.

SYLLABUS OF DSE-2

Unit 1: Silicate Industries **(6 Hours)**

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, different types of safety glass, borosilicate glass, fluorosilicate glass, coloured glass, photosensitive glass, photochromic glass, glass wool and optical fibre.

Cement: Manufacture of Portland cement and the setting process, Different types of cements: quick setting cements, eco-friendly cement (slag cement), pozzolana cement.

Unit 2: Fertilizers (6 Hours)

Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime and potassium nitrate.

Unit 3: Surface Coatings (18 Hours)

Brief introduction to and classification of surface coatings, paints and pigments: formulation, composition and related properties, pigment volume concentration (PVC)and critical pigment volume concentration (CPVC), fillers, thinners, enamels and emulsifying agents. Special paints: heat retardant, fire retardant, eco-friendly paints, plastic paints, water and oil paints. Preliminary methods for surface preparation, metallic coatings (electrolytic and electroless with reference to chrome plating and nickel plating), metal spraying and anodizing.

Contemporary surface coating methods like physical vapor deposition, chemical vapor deposition, galvanising, carburizing, sherardising, boriding, nitriding and cementation.

Unit 4: Batteries (9 Hours)

Primary and secondary batteries, characteristics of an Ideal Battery, principle, working, applications and comparison of the following batteries: Pb- acid battery, Li-metal batteries, Li-ion batteries, Li-polymer batteries, solid state electrolyte batteries, fuel cells, solar cells and polymer cells.

Unit 5: Nano dimensional materials (6 Hours)

Introduction to zero, one and two-dimensional nanomaterial: Synthesis, properties and applications of fullerenes, carbon nanotubes, carbon fibres, semiconducting and superconducting oxides.

Practical component (30 Hours)

(Laboratory periods:15 classes of 2 hours each)

(At least four experiments to be performed)

1. Detection of constituents of Ammonium Sulphate fertilizer (Ammonium and Sulphate ions) by qualitative analysis and determine its free acidity.

2. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) fertilizer and estimation of Calcium content.

3. Detection of constituents of Superphosphate fertilizer (Calcium and Phosphate ions) and estimation of phosphoric acid content.

4. Analysis of (Cu, Ni) in alloy or synthetic samples (methods involving Gravimetry and Spectrophotometry).

5. Analysis of (Cu, Zn) in alloy or synthetic samples (Multiple methods involving Iodometry, and Potentiometry).

6. Synthesis of pure ZnO and Cu doped ZnO nanoparticles.

7. Synthesis of silver nanoparticles by green and chemical approach methods and its characterization using UV-visible spectrophotometer

Essential/recommended readings

Theory:

1. West, A. R. (2014),**Solid State Chemistry and Its Application**, Wiley
2. Smart, L. E.; Moore, E. A. (2012),**Solid State Chemistry An Introduction**, CRC Press Taylor & Francis.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010),**Shriver and Atkins Inorganic Chemistry**, W. H. Freeman and Company.
4. Kent, J. A. (ed) (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
5. Poole Jr.; Charles P.; Owens, Frank J.(2003), **Introduction to Nanotechnology**, John Wiley and Sons.

Practical:

1. Svehla, G.(1996),**Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
2. Banewicz, J. J.; Kenner, C.T. **Determination of Calcium and Magnesium in Limestones and Dolomites**, Anal. Chem., 1952, 24 (7), 1186–1187.
3. Ghorbani, H. R.; Mehr, F.P.; Pazoki, H.; Rahmani B. M. **Synthesis of ZnO Nanoparticles by Precipitation Method.** Orient J Chem 2015;31(2).
4. Orbaek, W.; McHale, M.M.; Barron, A.R. **Synthesis and characterization of silver nanoparticles for an undergraduate laboratory**, J. Chem. Educ. 2015, 92, 339−344.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 3 (DSE-3): Green Chemistry in Organic Synthesis

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Green Chemistry in Organic Synthesis (DSE-3)	04	03	0	01	Passed Class 12^{th} with Physics, Chemistry	Basic knowledge of organic reactions

Learning objectives

The objectives of this course are as follows:

- To create awareness about the chemistry that is not harmful for human health and the environment.
- To provide thorough knowledge of the green chemistry principles that can be used to develop chemistry in greener way.
- To familiarize students with new remediation technologies for the cleaning up of hazardous substances.
- To use green chemistry for boosting profits, increase productivity and ensure sustainability with absolute zero waste.
- To learn about innovations and applications of green chemistry in education that helps companies to gain environmental benefits as well as to achieve economic and societal goals also
- The objective of the practical component is to develop basic skills to be able to design, develop and run chemical processes in a sustainable way.

Learning outcomes

By studying this course, students will be able to:

- List the twelve principles of green chemistry and build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis
- State the uses of catalyst over stoichiometric reagents
- Debate and use green solvents, renewable feedstock, and renewable energy sources for carrying out safer chemistry
- Use green chemistry for problem solving, innovation and finding solutions to environmental problems.
- Design safer processes, chemicals, and products through understanding of inherently safer design (ISD)

- Discuss the success stories and use real-world cases to practice green chemistry

SYLLABUS OF DSE-3

UNIT – 1: Introduction **(3 Hours)**

Introduction to Green Chemistry, some important environmental laws, pollution prevention Act of 1990, emergence of green chemistry, need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. Green chemistry in sustainable development.

UNIT – 2: Application of Green Chemistry Principles **(36 Hours)**

Principles of Green Chemistry and designing a chemical synthesis
Concept familiarization and application of green chemistry principles using specific examples

1. Prevention of waste/ by products; waste or pollution prevention hierarchy
2. Green metrics to assess greenness of a reaction: Calculation of atom economy of the rearrangement, addition, substitution, and elimination reactions; calculation of E-factor for industrial processes
3. Prevention/ minimization of hazardous/ toxic products
4. Safer Solvent and Auxiliaries: Problems associated with conventional reaction media Some Common Green solvents: Introduction, application, advantages, and disadvantages of green solvents in organic synthesis (taking suitable examples). Special emphasis on the following:
   i. Super Critical Fluids (with special reference to carbon dioxide)
   ii. Water: Concept of In-water, and on-water reactions (with special reference to synthesis of terpinol and linalool in water, Benzoin condensation, Heck reaction)
   iii. Ionic Liquids: Physical properties and classification of Ionic Liquids (with special reference to Diels Alder reaction and Coumarin synthesis in ionic liquids)
   iv. Biomass derived Solvents: Physicochemical properties, Use of glycerol and its derivatives (Mizoroki–Heck reaction) and 2-methyltetrahydrofuran (Suzuki–Miyaura reaction).
5. Design for energy efficiency: Phenomenon of accelerating organic reactions by using the following Green Chemistry tools (taking suitable examples) and its advantages:
   i. Mechanochemistry
   ii. Ultrasound assisted reactions: Taking examples like Simmons Smith reaction, Diels–Alder reaction,
   iii. Microwave assisted reactions: Special emphasis on solvent-free synthesis- copper phthalocyanine and aspirin, In-water reactions-Hofmann Elimination, methyl benzoate to benzoic acid and Decarboxylation reaction;
   iv. Electrocatalysis: Taking examples like adiponitrile synthesis, synthesis of 3-bromothiophene.
   v. Visible light induced Reactions: with examples such as, syntheses of caprolactam and vitamin D_3, cis-trans isomerization of alkenes
6. Use of renewable starting materials: Illustrate with few examples such as biodiesel, bioethanol, polymers from renewable resources (PLA from corn), Synthesis and properties of 2-Methyltetrahydrofuran, furfural and 5-Aminolevulinic acid (DALA) from levulinic acid

7. Avoidance of unnecessary derivatization – careful use of blocking/protecting groups (taking specific examples like selective oxidation of aldehydic group and synthesis of 6-Aminopenicillanic Acid (6-APA) from penicillin G
8. Catalysis and green chemistry
   Introduction to Catalysis (including concept of selectivity, turnover frequency and turnover number), Types of Catalysts: Heterogeneous catalysis and homogeneous catalysis (H-beta and zeolites in organic synthesis), General catalytic cycle for heterogeneous catalysis; Asymmetric catalysis (Monsanto route to L-dopa via asymmetric hydrogenation, synthesis of carbapenhem via Asymmetric reduction); Photocatalysis (with special reference to TiO2); Biocatalysis (Synthesis of adipic acid/catechol using biocatalyst) and Nanocatalysis (oxazole synthesis using nanocatalyst)
9. Design for degradation: (Illustrate with the help of examples: soaps and detergents, pesticides, polymers)
10. Real Time monitoring of chemical processes using inline, offline, and online techniques
11. Inherently safer design/chemistry:
    Principle and subdivision of ISD, Bhopal Gas Tragedy (safer route to carbaryl) and Flixiborough accident (safer route to cyclohexanol, Asahi Process)

UNIT – 3: Industrial Applications and Success Stories (6 Hours)

- Vitamin C Synthesis using enzymes (Hoffman La Roche)
- Zoloft -Presidential Chemistry Award Winning Innovation (Pfizer)
- Methyl Methacrylate syngas process (Eastman Chemicals)
- Synthesis of herbicide disodium iminodiacetate
- Rightfit pigments azo dyes synthesis and their applications
- Healthier Fats and oils by Green Chemistry: Enzymatic Interesterification for production of No Trans-Fats and Oils.
- Synthesis of anti-tuberculosis drug Paramycin from waste water stream

Practical component (30 Hours) (Laboratory periods:15 classes of 2 hours each)

Note: Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.
2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
3. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
4. Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice.
5. Mechanochemical solvent free, solid-solid synthesis of azomethine using p-toluidine and o-vanillin/p-vanillin.
6. Microwave-assisted Knoevenagel reaction using anisaldehyde, ethylcyanoacetate and ammonium formate.
7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (cis-trans isomerisation)

9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.
10. Preparation of dibenzalacetone by cross aldol condensation reaction using base catalysed green method.

Essential/recommended readings

Theory:

1. Anastas, P.T., Warner, J.C. (2014), **Green Chemistry, Theory and Practice**, Oxford University Press.
2. Lancaster, M. (2016), **Green Chemistry: An Introductory Text**, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), **Real-World cases in Green Chemistry, American Chemical Society**, Washington.
4. Matlack, A.S. (2010), **Introduction to Green Chemistry**, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia,V.K., Kidwai, M.R. (2005), **New Trends in Green chemistry**, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

Practicals:

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
4. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. **DU Journal of Undergraduate Research and Innovation**, 1(1),131-151. ISSN: 2395-2334.
5. Sidhwani, I.T; Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.
6. **Monograph on Green Chemistry Laboratory Experiments**, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.
7. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi
8. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–II**, I K International Publishing house Pvt. Ltd, New Delhi

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 4 (DSE-4): Reactions, Reagents and Chemical Process

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Reactions, Reagents and Chemical Process (DSE-4)	04	03	0	01	Passed Class 12th with Physics, Chemistry	Basic knowledge of organic reactions

Learning objectives

The objectives of this course are as follows:

- To study the important organic name and rearrangement reactions that are crucial for the synthesis of valuable organic compounds.
- To give the knowledge belonging to the role of reagents in organic reactions for the synthesis of chemo-, diastereo- and enantio-selective products.
- To impart the knowledge of process chemistry that is a key part of the large-scale synthesis of chemical products essential for day-to-day life

Learning outcomes

By studying this course, students will be able to:

- Explain the reaction mechanism of various name and rearrangement reactions
- Discuss the role of the reagents in organic synthesis and apply these reagents for the bulk chemical synthesis
- Debate and use oxidizing and reducing reagents for selective synthesis organic products
- Apply the learnt techniques to chemical processes
- Acquire skills for human resource building especially in the chemical industry.

SYLLABUS OF DSE-4

UNIT – 1: Name Reactions (15 Hours)

Application, scope and mechanism of following reactions: Prevost Reaction, Chugaev Reaction, Maukaiyama Aldol Reaction, Mozingo Reaction, Ramberg Backlund Reaction, Shapiro Reaction, Barbier Reaction, Clark- Eschweiler Reaction, Darzen's Reaction, Julia-Olifination Reaction, Tiffeneaus Damjanov Reaction, Darkin West Reaction, Bischler-Napieralaski Reaction, Birch reduction of aromatic compounds, Appel Reaction, Mitsunobu Reaction, Corey Kim Oxidation, Azide-alkyne 1,3-dipolar cycloaddition reaction, Olefin metathesis: Grubbs reaction, Heck Reaction, Suzuki coupling and Wittig reaction.

UNIT – 2: **Reducing Reagents** **(9 Hours)**

Reactions, mechanism and applications of following reducing agents: Sodium borohydride, Lithium aluminium hydride, $NaBH_3CN$, DIBALH, lithium-tri-*tert*-butoxyaluminum hydride, Red-Al $Na[AlH_2(OCH_2OCH_2OCH_3)_2]$, Zinc borohydride, L and K selectrides, $LiBHEt_3$ and $KBHEt_3$, Luche Reagent $NaBH_4$-$CeCl_3$, $K[BH(OAc)_3]$, *bis*-Boric Acid (BBA), Catecholborane, DEMS (Diethoxymethylsilane), 3-Mercapto propionic acid, Polymethylhydrosiloxane (PMHS), Schwartz's Reagent (Zirconocene chloride hydride).

UNIT – 3: Oxidizing Reagents **(9 Hours)**

Reactions, mechanism and applications of following oxidizing agents: Jones Reagent (CrO_3, H_2SO_4, H_2O), Swern Reagent (DMSO, oxalyl chloride), Dess Martin, TEMPO, TPAP (Tetrapropyl ammonium perruthenate), Fetizon's Reagent, Fenton's Reagent [H_2O_2 + Fe(II) ion], Sodium perborate NaH_2BO_4, Sodium Bismuthate $NaBiO_3$, ABNO (9-Azabicyclo[3.3.1]nonane N-oxyl), DEAP (Diethyl allyl phosphate, 

), AZADO (2-Azaadamantane N-oxyl], Wacker oxidation.

UNIT – 4: Process Chemistry **(12 Hours)**

1. Process chemistry a) Introduction, stages of scale up process: Bench, pilot, and large-scale process with at least two examples of scale up process of API. b) In-process control and validation of large-scale process.
2. Unit Processes: The following unit processes should be studied with mechanism and one example of each process Nitration: Nitrating agents, process equipment for technical nitration. Halogenation: Types of halogenations, catalytic halogenations. Reduction: Catalytic hydrogenation, hydrogen transfer reactions, metal hydrides. Oxidation: Types of oxidative reactions, and non-metallic oxidizing agents such as H, sodium hypochlorite, oxygen gas, ozonolysis.

Practical component (30 Hours)

(Laboratory periods:15 classes of 2 hours each)

1. Oxidation of alcohols to acid using Jones reagent.
2. Reduction of acetophenone and its derivatives to 1-phenyl ethanol derivatives by $NaBH_4$.
3. Reduction of 4-tert-butyl-cyclohexanone to cis and trans 4-tert-butyl-cyclohexanol.
4. Synthesis of 2,5-dimethyl-2,5-hexanediol from tert-butanol using Fenton's reagents.
5. Wittig reaction of benzyltriphenylphosphonium chloride and 4-bromobenzaldehyde using potassium phosphate (tribasic).
6. Substitution (S_N2) reaction of 1-iodobutane and 2-naphthol.
7. Aldol condensation reaction: solventless synthesis of chalcones.
9. Borohydride reduction of a ketone: hydrobenzoin from benzil.
10. Visit to chemical industry for the demonstration of pilot scale.

Essential/recommended readings

Theory:

1. Clayden, J. Greeves, N., Warren, S. **Organic Chemistry**, South Asian Edition, Oxford University Press, USA
2. Gadamasetti K., **Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever- Changing Climate-An Overview**, Vol-2, CRC Press, London.
3. Murphy R.M., **Introduction to Chemical Processes: Principles, Analysis, Synthesis**, McGraw-Hill Education, New York.
4. Harrington P. J., **Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale up**, John Wiley and Sons, Inc, New Jersey.
5. Parashar, R.K.; Ahluwalia, V.K. (2018), **Organic Reaction Mechanism,** 4th Edition, Narosa Publishing House.
6. Singh J., S. K. Awasthi, Singh Jaya (2023) Fundamental of Organic Chemistry, Paper III, Pragati Prakashan.

Practical:

1. Mann F.G, Saunders, B.C., **Practical Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), Singapore.
2. Vogel A.I., **Elementary Practical Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), Singapore.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -5(DSE-5): Solutions, Colligative properties, Phase Equilibria and adsorption

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Solutions, Colligative properties, Phase Equilibria and adsorption (DSE-5)	**04**	**03**	**0**	**01**	Class 12th with Physics, Chemistry	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To make the students understand the various properties of dilute solutions.

- To make the students understand the thermodynamic basis of colligative properties.
- To explain the concept of phase, co-existence of phases, phase diagram for various types of system, CST and distribution law.
- To introduce the concept of adsorption, its dependence on various conditions and applications

Learning outcomes

By studying this course, students will be able to:

- Explain different types of phase equilibrium, draw a well labelled phase diagram.
- Predict the existence of a substance in a given phase under different conditions of temperature and pressure
- Apply the concepts of phase, solutions and distribution law while studying other chemistry courses and every-day life processes.
- Explain the type of adsorption that can take place in different systems and predict the conditions to get maximum adsorption.

SYLLABUS OF DSE-5

UNIT-1: Solutions and Colligative Properties (12 Hours)

Dilute solutions; lowering of vapour pressure, Raoult's law, Henry's law. Thermodynamic basis of the colligative properties - lowering of vapour pressure, elevation of Boiling Point, Depression of Freezing point and Osmotic pressure and derivation of expressions for these using chemical potential. Application of colligative properties in calculating molar masses of normal, dissociated and associated solutes in solutions, van't Hoff factor and its applications. Concept of activity and activity coefficients.

UNIT-2: Phase Equilibria (24 Hours)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H_2O and S), with applications. A comparison between the phase diagram of CO_2 and H_2O. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions (excluding partial miscibility). Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), Konovalov's laws, azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.
Three component systems, water-chloroform-acetic acid system, triangular plots.

UNIT-3: Surface chemistry (9 Hours)

Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Multilayer adsorption, BET equation derivation, thermodynamic treatment of adsorption-Gibbs equation.

Practical component (30 Hours)
(Laboratory periods: 15 classes of 2 hours each)

Practical

Phase Equilibrium

1. Determination of critical solution temperature and composition at CST of the phenol water system
2. To study the effect of impurities of sodium chloride and succinic acid on the CST of phenol-water system.
3. To study the cooling curves for the following systems:
   (i) simple eutectic
   (ii) congruently melting systems.

Adsorption

Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Essential/recommended readings

Theory:

1. Peter, A.; Paula, J. de. (2011), **Physical Chemistry**, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
3. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 3, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**, Vol 5, 6th Edition, McGraw Hill Education.
5. Ball, D. W. (2017), **Physical Chemistry,** 2nd Edition, Cengage Learning, India.

Practical:

4. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
5. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Suggestive readings

1. Levine, I.N. (2010), **Physical Chemistry**, Tata Mc Graw Hill.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE- 6 (DSE-6): Applications of computers in Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Applications of computers in Chemistry (DSE 6)	**04**	**03**	**0**	**01**	Class 12th with Physics, Chemistry	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:
To make the students learn the working of computer and its applications in chemistry *via* programming language, C language and use of software as a tool to understand chemistry and solve chemistry-based problems.

Learning outcomes

By studying this course, students will be able to:

- Use commands and library functions in programming in C language.
- Develop algorithm to solve problems and write corresponding programs in C language for performing calculations involved in laboratory experiments.
- Use various spreadsheet software to perform theoretical calculations and plot graphs

SYLLABUS OF DSE-6

UNIT 1: Introduction to Basic Computer System (6 Hours)

Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII); Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Software languages: Low level and High-Level languages (Machine language, Assembly language; QBASIC, C, C++, FORTRAN 90&95); Compiled versus interpreted languages. Debugging Software Products (Office, chemsketch, scilab, matlab, and hyperchem), internet application

UNIT 2: Commands and Library functions in C language (18 Hours)

C language for solving some of the basic and complicated chemistry problems). QB4 version of C language can be used.

Numeric constants, variables & its declaration, Arithmetic expressions, hierarchy of operations, inbuilt functions and header files. Syntax and use of the following commands in C language: scanf, printf, fscanf and fprintf; goto, relational operators, *if-else* statement; *while*, *for* and *do while* loops, *switch-break* statements; header files (<stdio.h>, <stdlib.h>, <math.h>, <ctype.h>, <malloc.h>, <string.h>), arrays & pointers, library functions (abs & fabs, int, float, double, ceil, char, exp, log, rand, sqrt, \t, \v, \n and trigonometric Functions), defining and accessing functions, gnuplot- syntax and commands

Simple programs using C commands, Matrix addition and multiplication

UNIT 3: Use of C language for solving problems in Chemistry (21 Hours)

Solution of quadratic equation, polynomial equations (formula, iteration, Newton – Raphson methods and binary bisection) with examples of polynomial equations used in chemistry; Numerical differential, Numerical integration (Trapezoidal and Simpson's rule), Calculation of area under the curves for chemistry problems, e.g., entropy calculations, Simultaneous equations, Statistical analysis-mean, variance, standard deviation, error, least square method.

Plotting linear graphs using experimental data, plotting (i)trigonometric functions-particle in a one-dimensional box(ii) exponential function (iii) Ideal gas isotherms. Plotting van der Waals Isotherms, and observe whether van der Waal gas equation is valid at temperatures lower than critical temperature where we require to solve a cubic equation.

Practical Component (30 Hours)
(Laboratory periods: 15 classes of 2 hours each)

Computer programs using C language based on numerical methods

1. Simple programs to calculate numerical values of chemistry problems.
2. Roots of equations: (e.g. volume of gas using Van der Waals equation and comparison with ideal gas, pH of a weak acid).
3. Solving polynomial equation using iterative method. (Van der Waal's equation of state, pH of a weak acid using exact expression)
4. Solving polynomial equation using Newton-Raphson's method. (Van der Waal's equation of state, pH of a weak acid using exact expression)
5. Matrix operations: addition, multiplication and transpose
6. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
7. Numerical integration using trapezoidal method. (e.g. entropy/ enthalpy change from heat capacity data).

8. Numerical integration using Simpson's rule
9. Mean, standard deviation
10. Least square curve fitting method for linear equation.
11. Calculate the relative intensities of peaks of a proton obtained after spin-spin coupling with 4 equivalent neighbouring protons in a high-resolution NMR spectrum using GOSUB RETURN.

Computer programs using C language for plotting graphs

1. Van der Waals isotherm
2. Compressibility versus pressure curves
3. Maxwell distribution curves
4. Concentration-time graph using kinetics data
5. pH metric titration curve
6. Conductometric titration curves for strong acid-strong base titrations.
7. Calibration curve using Lambert Beer's law
8. Particle in a one-dimensional box.

Note: Minimum 12 exercises is to be performed relating to C language

Plotting graphs using spreadsheet

1. Particle in a one-dimensional box.
2. van der Waals isotherms below critical temperature, at critical temperature and above critical temperature.
3. Radial plots and radial distribution functions for orbitals of hydrogen atom.
4. Plotting characteristics graphs of zero, first and second order reactions using concentration time data and determine the order of the reaction.

Essential/recommended readings

Theory:

1. McQuarrie, D. A. (2008), **Mathematics for Physical Chemistry,** University Science Books.
2. Mortimer, R. (2005), **Mathematics for Physical Chemistry**,3rd Edition, Elsevier.
3. Steiner, E. (1996), **The Chemical Maths Book,** Oxford University Press.
4. Yates, P. (2007), **Chemical Calculations**, CRC Press.
5. Harris, D. C. (2007), **Quantitative Chemical Analysis**,6th Edition, Freeman, Chapters 3-5.
6. Rajaraman, V., **Computer Programming in C**, PHI Learning Private Limited.
7. Gottfried, B., **Programming with C,** Tata McGraw Hills Education Pvt. Ltd., 3rd Edition.

Practical:

1. Levie, R.D. (2001), **How to use Excel in analytical chemistry and in general scientific data analysis**, Cambridge University Press.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Bachelor of Sciences in Industrial Chemistry

Category II

Industrial Chemistry Course for Undergraduate Programme of study with Industrial Chemistry as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – 7: (DSC-7) Industrially important Inorganic Materials

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Industrially important Inorganic Materials (DSC-7: Industrial Chemistry -III)	04	02	0	02	Class XII Pass with Physics, Chemistry, Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To imparts basic knowledge of chemistry of inorganic materials such as silicates, non-silicates, ceramics, and cement.
- To enrich students with the knowledge of various types of batteries like Pb acid Battery, Li-ion Battery, Fuel Cells and Solar cell.
- To impart the theoretical and practical knowledge of estimation and determination of various industrially important chemicals.

Learning outcomes

By the end of this course, students will be able to:

- Establish an appreciation of the role of inorganic chemistry in the chemical sciences.
- Analyse inorganic materials like silicates, ceramics and cement.

- Familiarized with scientific method of planning, developing, conducting, reviewing and reporting experiments.
- Draw various concepts of industrial metallurgy which will help them to explore new innovative areas of research.
- Explain scientific methods employed in inorganic chemistry.

SYLLABUS OF DSC-7

Unit 1: Silicate Industries **14 Hours**

(a) *Glass*: Glassy state and its properties, Classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, and photosensitive glass.
(b) *Ceramics*: Ceramic, their types and manufacture. High technology ceramics and their applications, super conducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fiber, clays and feldspar.
(c) *Cement*: Classification of cement, ingredients and their role. Manufacture of cement and the setting process, quick setting cements.

Unit 2: Batteries **8 Hours**
Primary and secondary batteries, battery components and their role and characteristics of battery. Working of following batteries: Pb acid Battery, Li-ion Battery, Fuel Cells, and Solar cell

Unit 3: Fertilizers **8 Hours**
Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime, potassium chloride and potassium nitrate.

Practical components **(Laboratory periods: 60)**

1. Detection of constituents of Dolomite (Calcium, Magnesium and carbonate ions) by qualitative analysis.
2. Determination of composition of Dolomite using complexometric titration.
3. Detection of constituents of Ammonium Sulphate fertilizer (Ammonium and Sulphate ions) by qualitative analysis.
4. Determine its free acidity in Ammonium Sulphate fertilizer.
5. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) by qualitative analysis.
6. Estimation of Calcium content in CAN fertilizer.

7. Detection of constituents of Superphosphate fertilizer (Calcium and Phosphate ions) by qualitative analysis.
8. Estimation of phosphoric acid content in Superphosphate fertilizer.
9. To determine the total insoluble residue in the cement sample.
10. To determine the amount of lime (CaO) in the given sample of cement.
11. To determine the silica content in the given sample of cement.
12. To determine the Oxides (Sesquioxides Fe_2O_3 + Al_2O_3) in the given sample of cement.

Essential/recommended readings

Theory:

1. Felder, R. M.; Rousseau, R. W. (2015), **Elementary Principles of Chemical Processes**, Wiley Publishers, New Delhi.
2. Stocchi, E. (1990), **Industrial Chemistry**, Vol -I, Ellis Horwood Ltd. UK.
3. Kingery, W. D.;Bowen, H. K.;Uhlmann, D. R. (1976), **Introduction to Ceramics**, Wiley Publishers, New Delhi.
4. Kent, J. A. (ed**)** (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
5. Jain, P. C.; Jain, M. (2013), **Engineering Chemistry**, Dhanpat Rai & Sons, Delhi.
6. Sharma, B. K. (2014), **Engineering Chemistry**, Goel Publishing House, Meerut

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis,** John Wiley and Sons.
2. Svehla, G.(1996),**Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
3. Banewicz, J. J.; Kenner, C.T. **Determination of Calcium and Magnesium in Limestones and Dolomites**, Anal. Chem., 1952, 24 (7), 1186–1187.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –DSC 8: Chemical Energetics and Equilibria

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Energetics and Equilibria (DSC-8: Chemistry -III)	04	02	0	02	Class XII Pass with Physics, Chemistry, Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic understanding of the chemical energetics, laws of thermodynamics and ionic equilibrium.
- To provide basic understanding of the behaviour of electrolytes and their solutions.
- To give an overview of the properties of ideal and real gases and deviation from ideal behaviour.

Learning outcomes

By the end of the course, the students will be able to:

- Explain the laws of thermodynamics, thermochemistry and equilibria.
- Illustrate the concept of pH and its effect on the various physical and chemical properties of the compounds.
- Explain and draw the concepts to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium.

SYLLABUS OF DSC-8

Unit 1: Chemical Energetics **16 Hours**

Recapitulation of Intensive and extensive variables; state and path functions; isolated, closed and open systems, concept of heat, Q, work, W, internal energy, U, and enthalpy, H.

First law

Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities for ideal gas, Joule's experiment, calculations of Q, W, ΔU and ΔH for reversible expansion of ideal gases under isothermal conditions.

Thermochemistry

Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of ionization enthalpy of hydration, enthalpy of formation and enthalpy of combustion, Integral enthalpy of solution, bond dissociation energy and bond enthalpy; Hess's law, Born Haber's cycle (NaCl/ KCl).

Second Law

Concept of entropy; statements of the second law of thermodynamics (Kelvin and Clausius). Calculation of entropy change for reversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy (Non-PV work and the work function); Free energy change and concept of spontaneity (for ideal gases).

Third Law

Statement of third law, qualitative treatment of absolute entropy of molecules (examples of NO, CO), concept of residual entropy

Unit 2: Chemical Equilibrium 4 Hours

Criteria of thermodynamic equilibrium. Free energy change in a chemical reaction and equilibrium constant, exergonic and endergonic reactions with examples such conversion of ATP to ADP or vice versa,, Le Chatelier's principle, relationship between Kp, Kc and Kx for reactions involving ideal gases.

Unit 3: Ionic Equilibria 10 Hours

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, Degree of ionization, pH scale, common ion effect, Buffer solutions, Henderson-Hasselbach equation. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

Practicals components (Laboratory periods: 60)

Chemical Energetics:

1. Determination of heat capacity of calorimeter.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of the enthalpy of ionization of acetic acid.
4. Determination of enthalpy of neutralization of acetic acid and ammonium hydroxide using Hess's law.
5. Determination of integral enthalpy of solution (both endothermic and exothermic)

of salts.

6. Determination of enthalpy of hydration of Copper sulphate.

Ionic equilibria:

7. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammonium chloride-ammonium acetate. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

8. Study the effect of addition of HCl/NaOH on pH of the buffer solutions (acetic acid, and sodium acetate).

9. Titration of strong acid with strong base using pH meter.

Essential/recommended readings

Theory:

1. Castellan, G. W. (2004), **Physical Chemistry**, Narosa.

2. Kapoor, K. L. (2015), **A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGraw Hill Education.

3. Kapoor, K. L. (2015), **A Textbook of Physical Chemistry**, Vol 2, 6thEdition, McGraw Hill Education.

4. Puri, B. R., Sharma, L. R. and Pathania M. S. (2020), **Principles of Physical Chemistry**, Vishal Publishing Co.

Practical:

1. Khosla, B. D.; Garg, V. C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co.

2. Kapoor, K. L. (2019), **A Textbook of Physical Chemistry**, Vol 7, 1st Edition, McGraw Hill Education.

3. Batra, S. K., Kapoor, V and Gulati, S. (2017) 1st Edition, **Experiments in Physical Chemistry,** Book Age series.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC 9: Elementary Linear Algebra

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elementary Linear Algebra	4	3	1	0	Class XII pass with Mathematics	NIL

Learning Objectives: The objective of the course is:
- To introduce the concept of vectors in R^n.
- Understanding the nature of solution of system of linear equations.
- To view the $m \times n$ matrices as a linear function from R^n to R^m and vice versa.
- To introduce the concepts of linear independence and dependence, rank and linear transformations has been explained through matrices.

Learning Outcomes: This course will enable the students to:

- Visualize the space R^n in terms of vectors and the interrelation of vectors with matrices.
- Familiarize with concepts of bases, dimension and minimal spanning sets in vector spaces.
- Learn about linear transformation and its corresponding matrix.

SYLLABUS OF DSC-2

UNIT – I: Euclidean Space R^n and Matrices (18 hours)
Fundamental operations with vectors in Euclidean space R^n, Linear combinations of vectors, Dot product and their properties, Cauchy-Schwarz inequality, Triangle inequality, Solving system of linear equations using Gaussian elimination, Application: Curve Fitting, Gauss-Jordan row reduction, Reduced row echelon form, Application: Solving several systems simultaneously, Equivalent systems, Rank and row space of a matrix, Eigenvalues, Eigenvectors, Eigenspace, Diagonalization, Characteristic polynomial of a matrix.

UNIT – II: Introduction to Vector Spaces (12 hours)
Definition, Examples and some elementary properties of vector spaces, Subspaces, Span, Linear independence and linear dependence of vectors, Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets.

UNIT – II: Linear Transformations (15 hours)
Linear transformations**:** Definition, Examples and elementary properties, The matrix of a linear transformation, Kernel and range of a linear transformation, The dimension theorem, one-to-one and onto linear transformations, Invertible linear transformations, Isomorphic vector spaces.

Essential Reading

1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Elsevier India.

Suggestive Readings

- Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). *Linear Algebra and its Applications* (5th ed.). Pearson Education.
- Kolman, Bernard, & Hill, David R. (2001). *Introductory Linear Algebra with Applications* (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 1: GREEN CHEMISTRY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/ Practice		
Green Chemistry (DSE-1)	04	02	--	02	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Huge rise in environmental pollution, depleting resources, climate change, ozone depletion, heaps and heaps of landfills piling up has forced the society to become more and more environmentally conscious.
- It is not a new branch of chemistry but helps to improve the creative and innovative thinking in undergraduate students. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Innovations and applications of green chemistry in education have helped companies to gain environmental benefits as well as to achieve economic and societal goals also. Undergraduate students are the ultimate scientific community of tomorrow.
- Training them to practice chemistry in the safest way possible is key towards safe working conditions in the laboratories as well as the chemical industry and extends to society in a sustainable future for the planet.
- To develop basic understanding of the chemical energetics, laws of thermodynamics and ionic equilibrium.

Learning outcomes

By the end of the course, the students will be able to:

- Understand the twelve principles of green chemistry and also build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis
- Appreciate the use of catalyst over stoichiometric reagents
- Learn to use green solvents, renewable feedstock and renewable energy sources for carrying out safer chemistry
- Appreciate the use of green chemistry in problem solving skills and critical thinking to innovate and find solutions to environmental problems.

- Learn to design safer processes, chemicals and products through understanding of inherently safer design (ISD)
- Appreciate the success stories and real-world cases as motivation for them to practice green chemistry

SYLLABUS OF DSE-1

Unit :1 Introduction 08 Hours

Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry.

• Need of green chemistry

• Importance of green chemistry in- daily life, Industries and solving human health problems (four examples each).

• A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards).

Unit 2: Twelve Principles of Green Chemistry 12 Hours

The twelve principles of the Green Chemistry with their explanations, Special emphasis on the following:

• Prevention of waste / byproducts, pollution prevention hierarchy.

• Green metrics to assess greenness of a reaction: environmental impact factor, atom economy and calculation of atom economy.

• Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources.

• Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysts, asymmetric catalysis and photocatalysis.

• Green energy and sustainability.

• Real-time analysis for pollution prevention.

• Prevention of chemical accidents, designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation

Unit 3: 10 Hours

The following Real-world Cases in green chemistry should be discussed: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. Designing of environmentally safe marine antifoulant. Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

Practical components: Credit:02, Laboratory periods: 60)

Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.
2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
4. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
5. Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice.
6. Mechanochemical solvent free, solid-solid synthesis of azomethine using p-toluidine and o-vanillin/p-vanillin.
9. 6 Microwave-assisted Knoevenagel reaction using anisaldehyde, ethylcyanoacetate and ammonium formate.
7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (cis-trans isomerisation)
9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.

Essential/recommended readings

Theory:

7. Anastas, P.T., Warner, J.C. (2014), **Green Chemistry, Theory and Practice**, Oxford University Press.
8. Lancaster, M. (2016), **Green Chemistry: An Introductory Text**, 3rd Edition, RSC Publishing.
9. Cann, M. C., Connely, M.E. (2000), **Real-World cases in Green Chemistry, American Chemical Society**, Washington.
10. Matlack, A.S. (2010), **Introduction to Green Chemistry**, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
11. Alhuwalia, V.K., Kidwai, M.R. (2005), **New Trends in Green chemistry**, Anamalaya Publishers.
12. Sidhwani, I.T, Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

Practical:

11. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.
12. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
13. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
14. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. **DU Journal of Undergraduate Research and Innovation**, 1(1),131-151. ISSN: 2395-2334.
15. Sidhwani, I.T; Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.
16. **Monograph on Green Chemistry Laboratory Experiments**, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.

Category II

B.SC. (H) ANALYTICAL CHEMISTRY

DISCIPLINE SPECIFIC CORE COURSE – 7: DSC-7:AC-3

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Course Title: Quantitative Methods of Analysis **Course Code:** Analytical Chemistry-3 (DSC7:AC-3)	04	02	00	02	Class XII Pass with Physics, Chemistry and Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquire knowledge about the basic principles underlying gravimetric and volumetric analysis, different types of titration curves, equilibria principles and environmental analysis

Learning outcomes

By the end of this course, students will be able to:

- By the end of this course, students will be able to:
- Know the concept of volumetric and gravimetric analysis and deducing the conversion factor for determination
- Understand the various titration curves
- Stability of complexes
- Know and analyse various pollutants present in the environment.

SYLLABUS OF Analytical Chemistry-2 (DSC-7: AC-3)

Theory Component

UNIT – I: Gravimetric Analysis (08 Hours)

Requisites of precipitation, Nucleation, precipitation, and growth of precipitates; Particle size and filterability of precipitates; Factors influencing precipitation, Co-precipitation, post-precipitation. Super saturation, digestion, precipitation from homogeneous solution, washing of precipitate and ignition of precipitate, Brief idea about method of filtration and drying of precipitate, Use of reagents used in gravimetry (8-hydroxy quinoline (oxine) and dimethyl glyoxime (DMG).

UNIT – II: Basic principles underlying titrimetric analysis (12 Hours)

- **Acid-base:** pH of strong and weak acid solutions. Buffer solutions. Henderson equations. Preparation of acidic and basic buffers. Relative strength of acids and bases from Ka and Kb values. Neutralisation-titration curve, theory of indicators, choice of indicators.
- **Theory of redox indicator**s: Principle and detection of equivalence point by visual & potentiometric methods
- **Precipitation titrations** Argentometric titrations, indicators for precipitation titrations involving silver nitrate- Volhard's method., Mohr's method, Adsorption indicators.
- **Complexometric titrations:** Stability of complexes, titration involving EDTA: . direct, back, displacement and indirect determinations, Metal ion indicators and characteristics. Application-determination of hardness of water

UNIT – III: Introduction to Environmental Analysis (10 Hours)

- Environmental analysis of water: colour, odour, taste, conductivity, dissolved solids, hardness, DO, COD, BOD, chlorides, sulphates, nitrates and phosphates
- Environmental analysis of air: Sampling, particulate matter, gaseous pollutants-SOx, NOx, COx, and organic pollutants
- Environmental analysis of industrial effluents-estimation of toxic metals Hg, Cd, Pb, As, radiochemical wastes

Practical component - 60 Hours

1. Determination of the pK_a of a weak acid by potentiometric and pH metric titrations.
2. Determination of the strength of the given ferric chloride solution by titrating it against EDTA.
3. Estimation of chloride in water by precipitation method.
4. Estimation of amount of nickel present in given solution as *bis*(dimethylglyoximato)nickel (II) /Aluminium as oxinate.
5. Draw the absorbance curve of bromophenol blue using a colorimeter.
6. Determination of the composition of the Fe^{3+}-salicylic acid complex in solution by Job's method (*Plot curve using excel also*).
7. Determination of the formula of the chelate formed between iron (III) and Tiron.
8. Determination of dissolved oxygen (DO) /biological oxygen demand (BOD),/chemical oxygen demand (COD) (*Use at least two water samples from different sources*)

Essential/recommended readings

- Willard, Merritt, Dean, Settle (2004), Instrumental Methods of Analysis, CBS Publishers & Distributors.
- Skoog, D.A.; West, D.M.; Holler, F.J.; Crouch, S.R. (2014), Fundamentals of Analytical Chemistry, Cengage Learning.
- Harris, D.C. (2015),Quantitative Chemical Analysis, W.H. Freeman & Company.
- Mendham, J., Denney, R.C., Barnes, J.D.; Thomas, M.J.K. (2000); Vogel's Quantitative Chemical Analysis, Prentice Hall.
- Manahan, S.E. (2017)Environmental Chemistry, CRC Press
- De, A.K. (2012)Environmental Chemistry, New Age International Pvt. Lt

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 8: DSC8:C3

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Course Title: CHEMICAL ENERGETICS AND EQUILIBRIA **Course Code:** CHEMISTRY-3 (DSC8-C3)	04	02	00	02	Class XII pass with Physics, Chemistry and Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The objective of this paper is to develop basic understanding of the chemical energetics, laws of thermodynamics and ionic equilibrium. It provides basic understanding of the behaviour of electrolytes and their solutions.
- The students will also learn about the properties of ideal and real gases and deviation from ideal behaviour.

Learning outcomes

By the end of this course, students will be able to:

- Understand the laws of thermodynamics, thermochemistry and equilibria.
- Understand concept of pH and its effect on the various physical and chemical properties of the compounds.
- Use the concepts learnt to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium.

SYLLABUS OF Chemistry-3 (DSC-8:C3)

Theory Component

UNIT – I: Chemical Energetics (14 Hours)

Review of Intensive and extensive variables; state and path functions; isolated, closed and open systems, concept of heat, Q, work, W, internal energy, U, and enthalpy, H.

First law

Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, Joule Thompson Porous Plug experiment, Nature of Joule Thompson coefficient, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of ideal gases under isothermal conditions.

Thermochemistry

Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications, bond dissociation energy and bond enthalpy; effect of temperature (Kirchhoff's equations) on enthalpy of reactions.

Second Law

Concept of entropy; statement of the second law of thermodynamics. Calculation of entropy change for reversible processes and irreversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity (for ideal gases), Gibbs-Helmholtz equation.

Third Law

Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.

UNIT – II: Chemical Equilibrium (4 Hours)

Criteria of thermodynamic equilibrium, chemical equilibrium in ideal gases. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their qualitative dependence on T, P and concentration (Le Chatelier's principle). Free energy of mixing and spontaneity.

UNIT – III: Ionic Equilibria (12 Hours)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions, Henderson-Hasselbach equation. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Practical component – 60 Hours

Chemical Energetics:

1. Determination of heat capacity of calorimeter.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of the enthalpy of ionization of ethanoic acid.

4. Determination of basicity of a dibasic acid by thermochemical method.
5. Determination of integral enthalpy of solution of salts (KNO_3 or NH_4Cl).
6. Determination of enthalpy of hydration of copper sulphate.

Ionic equilibria:

7. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammonium chloride-ammonium acetate. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.
8. Study the effect of addition of HCl/NaOH on pH of the buffer solutions (acetic acid, and sodium acetate).
9. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base

Essential/recommended readings

- Castellan, G. W. (2004), Physical Chemistry, Narosa.
- Kapoor, K. L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.
- Kapoor, K. L. (2015), A Textbook of Physical Chemistry, Vol 2, 6thEdition, McGraw Hill Education.
- Puri, B. R., Sharma, L. R. and Pathania M. S. (2020), Principles of Physical Chemistry, Vishal Publishing Co.
- Khosla, B. D.; Garg, V. C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co.
- Kapoor, K. L. (2019), A Textbook of Physical Chemistry, Vol 7, 1st Edition, McGraw Hill Education.
- Batra, S. K., Kapoor, V and Gulati, S. (2017) 1st Edition, Experiments in Physical Chemistry, Book Age series.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVES (DSE)

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE-1

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Course Title: ANALYTICAL BIOCHEMISTRY **Course Code:** (DSE-1)	04	02	00	02	Class XII Pass with Physics, Chemistry and Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Students will learn about proteins, enzymes, nucleic acids and lipids, using suitable examples, drug-receptor interaction and Structure-Activity Relation (SAR) relationship.
- Students will also learn about the genetic code and concept of heredity.

Learning outcomes

By the end of this course, students will be able to:

- Learn about the structures of carbohydrates and Proteins
- Learn about the molecules, macromolecules, polymers and their formations
- Learn about the metabolism of a few biomolecules.
- Know basic principles of drug-receptor interaction and strucstructure-activitytionship (SAR).
- Know the biochemistry of diseases.

SYLLABUS OF DSE-1

Theory Component

UNIT – I: Carbohydrates and Proteins **(16 Hours)**

Basic understanding of the structures and properties of carbohydrates, biological importance of Carbohydrates.
Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, Haworth projections and conformational structures; Structure elucidation of glucose and fructose (Fischer's proof), Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;
Disaccharides – Structure elucidation of maltose, lactose and sucrose.
Polysaccharides – Elementary treatment of starch, cellulose and glycogen.
Amino Acids, Peptides and Proteins:
α-Amino Acids - Classification and characterization, Zwitterions, pKa values, isoelectric point and electrophoresis;
Proteins: Classification, Primary, secondary and tertiary structures of proteins, test for proteins, isolation, characterization, biological importance; denaturation of proteins.
Enzymes: Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as an example), factors affecting enzyme action, coenzymes and cofactors (ATP, NAD, FAD), specificity of enzyme action (including stereospecificity).

UNIT – II: Lipids (6 Hours)

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Liposomes and their biological functions and underlying applications. Lipoproteins. Properties, functions and biochemical functions of steroid hormones and peptide hormones.

UNIT – III: Biochemistry of Diseases (8 Hours)

A diagnostic approach by blood/ urine analysis. **Blood:** Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Causes and symptoms of Anemia.
Urine: Collection and preservation of samples. Formation of urine. Composition and estimation of constituents of normal and pathological urine. Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Practical component - 60 Hours

1. Carbohydrate- qualitative and quantitative both.
2. Proteins-qualitative tests
4. Determination of the iodine number of oil.
5. Determination of the saponification value of an oil.
6. Determination of acid value of fats and oils.
7. Determination of cholesterol using Liebermann- Burchard reaction.
8. Estimation of DNA by diphenylamine reaction
9. Isolation and characterization of DNA from Onion/cauliflower.
10. Determination of amount of protein using Lowry's method/ Biuret method.
11. To study the activity of ⟨-amylase.
12. To study the effect of temperature and pH on the activity of ⟨-amylase.

Essential/recommended readings

- Devlin, T. M. (2010), Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons.
- Berg, J.M., Tymoczko, J.L.; Stryer, L. (2010), Loose-leaf Version for Biochemistry, W.H.Freeman.
- Lehninger, A.L., Nelson, D.L.;Cox, M. (2004), Principle of Biochemistry, W.H.Freeman.
- Morrison, R. N.; Boyd, R. N. (2016) Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. (2015) Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Swahney, S.K.; Singh, R. (2001), Introductory Practical Biochemistry, Narosa Publishing House.
- Cooper, T.G. (2011),The Tools of Biochemistry, Wiley India Pvt Ltd.
- Wilson, K.; Walker, J. (2000), Principles and Techniques of Practical Biochemistry, Cambridge University Press.

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DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE-2

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Course Title: Green Chemistry **Course Code:** (DSE-2)	04	02	00	02	Class XII Pass with Physics, Chemistry and Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Huge rise in environmental pollution, depleting resources, climate change, ozone depletion, heaps and heaps of landfills piling up has forced the society to become more and more environmentally conscious. Future chemists and innovators are compelled to work towards sustainable practices. Green chemistry has arisen from these concerns. It is not a new branch of chemistry but helps to improve the creative and innovative thinking in undergraduate students. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Innovations and applications of green chemistry in education have helped companies to gain environmental benefits as well as to achieve economic and societal goals also.
- Undergraduate students are the ultimate scientific community of tomorrow. Training them to practice chemistry in the safest way possible is key towards safe working conditions in the laboratories as well as the chemical industry and extends to society in a sustainable future for the planet.

Learning Outcomes:

By the end of this course, students will be able to:

- Understand the twelve principles of green chemistry and also build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis.
- Appreciate the use of catalyst over stoichiometric reagents.
- Learn to use green solvents, renewable feedstock and renewable energy sources for carrying out safer chemistry.
- Appreciate the use of green chemistry in problem solving skills and critical thinking to innovate and find solutions to environmental problems.

- Learn to design safer processes, chemicals and products through understanding of inherently safer design (ISD).
- Appreciate the success stories and real-world cases as motivation for them to practice green chemistry.

SYLLABUS OF DSE-2

Theory Component

Unit-I: Introduction (8 Hours)

Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry.

• Need of green chemistry

• Importance of green chemistry in- daily life, Industries and solving human health problems (four examples each).

• A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards).

Unit-II: Twelve Principles of Green Chemistry (12 Hours)

The twelve principles of the Green Chemistry with their explanation's. Special emphasis on the following:

• Prevention of waste / byproducts, pollution prevention hierarchy.

• Green metrics to assess greenness of a reaction: environmental impact factor, atom economy and calculation of atom economy.

• Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources.

• Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

• Green energy and sustainability.

• Real-time analysis for pollution prevention.

• Prevention of chemical accidents, designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation

Unit-III: Real-World Cases (10 Hours)

The following Real-world Cases in green chemistry should be discussed: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. Designing of environmentally safe marine antifoulant. Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

Practical Component – 60 Hours

Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.
2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
3. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
4. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice.
5. Mechanochemical solvent free, solid-solid synthesis of azomethine using *p*-toluidine and *o*-vanillin/*p*-vanillin.

6 Microwave-assisted Knoevenagel reaction using anisaldehyde, ethylcyanoacetate and ammonium formate.

7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (*cis-trans* isomerisation)
9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.

Essential/recommended readings

1. Anastas, P.T., Warner, J.C. (2014), Green Chemistry, Theory and Practice, Oxford University Press.
2. Lancaster, M. (2016), Green Chemistry: An Introductory Text, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), Real-World cases in Green Chemistry, American Chemical Society, Washington.
4. Matlack, A.S. (2010), Introduction to Green Chemistry, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia, V.K., Kidwai, M.R. (2005), New Trends in Green chemistry, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), An Introductory Text on Green Chemistry, Wiley India Pvt Ltd.
7. Kirchoff, M.; Ryan, M.A. (2002), Greener approaches to undergraduate chemistry experiment, American Chemical Society, Washington DC.
8. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.
9. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), Introduction to organic Laboratory Technique- A Microscale approach, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
10. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated.

DU Journal of Undergraduate Research and Innovation, 1(1),131-151. ISSN: 2395-2334.

11. Sidhwani, I.T; Sharma, R.K. (2020), An Introductory Text on Green Chemistry, Wiley India Pvt Ltd.
12. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Bachelor of Sciences (Life Sciences)

Category II

BSc (Life Sciences) with Chemistry as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE -7: Chemistry -III Chemical Energetics and Equilibria

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Energetics and Equilibria (DSC-7: Chemistry 03:	04	02	00	02	Passed Class 12th with Physics, Chemistry, Mathematics	NIL

Learning objectives

The objectives of this course are as follows:

- To develop basic understanding of the chemical energetics, laws of thermodynamics and ionic equilibrium.
- to provides basic understanding of the behaviour of electrolytes and their solutions.
- To make students learn about the properties of ideal and real gases and deviation from ideal behavior

Learning outcomes

By studying this course, students will be able to:

- Explain the laws of thermodynamics, thermochemistry and equilibria.
- Use the concept of pH and its effect on the various physical and chemical properties of the compounds.
- Use the concepts learnt to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium

SYLLABUS

UNIT-1: Chemical Energetics (16 Hours)

Recapitulation of Intensive and extensive variables; state and path functions; Isolated, closed and open systems

First law

Concept of heat (Q), work (W), internal energy (U), and statement of first law; enthalpy (H), relation between heat capacities for ideal gas, Joule's experiment, calculations of Q, W, ΔU and ΔH for reversible expansion of ideal gases under isothermal conditions.

Thermochemistry

Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of ionization enthalpy of hydration, enthalpy of formation and enthalpy of combustion, Integral enthalpy of solution, bond dissociation energy and bond enthalpy; Hess's law, Born Haber's cycle (NaCl/ KCl).

Second Law

Concept of entropy; statements of the second law of thermodynamics (Kelvin and Clausius). Calculation of entropy change for reversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy (Non-PV work and the work function); Free energy change and concept of spontaneity (for ideal gases).

Third Law

Statement of third law, qualitative treatment of absolute entropy of molecules (examples of NO, CO), concept of residual entropy

UNIT-2: Chemical Equilibrium (4 Hours)

Criteria of thermodynamic equilibrium. Free energy change in a chemical reaction and equilibrium constant, exergenic and endergenic reactions with examples such conversion of ATP to ADP or vice verca,, Le Chatelier's principle, relationship between Kp, Kc and Kx for reactions involving ideal gases.

UNIT-3: Ionic Equilibria (10 Hours)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, Degree of ionization, pH scale, common ion effect, Buffer solutions, Henderson-Hasselbach equation. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

Practical Component: 60 Hours

(Laboratory periods: 15 classes of 4 hours each)

Chemical Energetics:

1. Determination of heat capacity of calorimeter.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodiumhydroxide.
3. Determination of the enthalpy of ionization of acetic acid.
4. Determination of enthalpy of neutralization of acetic acid and ammonium hydroxide using Hess's law.

5. Determination of integral enthalpy of solution (both endothermic and exothermic) of salts.

6. Determination of enthalpy of hydration of Copper sulphate.

Ionic equilibria:

7. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammonium chloride-ammonium acetate. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

8. Study the effect of addition of HCl/NaOH on pH of the buffer solutions (acetic acid, and sodium acetate).

9. pH metric titration of strong acid with strong base,

10. pH metric titration of weak acid with strong base

References:

Theory:

1. Castellan, G. W. (2004),**Physical Chemistry**,Narosa.

2. Kapoor, K. L. (2015),**A Textbook of Physical Chemistry**,Vol 1, 6th Edition, McGraw Hill Education.

3. Kapoor, K. L. (2015), **A Textbook of Physical Chemistry**, Vol 2, 6thEdition, McGraw Hill Education.

4. Puri, B. R., Sharma, L. R. and Pathania M. S. (2020), **Principles of Physical Chemistry**, Vishal PublishingCo.

Practical:

1. Khosla,B. D.;Garg,V. C.; Gulati,A.(2015), **SeniorPracticalPhysicalChemistry**,R.Chand&Co.

2. Kapoor, K. L. (2019), **A Textbook of Physical Chemistry**, Vol 7, 1st Edition, McGraw Hill Education.

3. Batra, S. K., Kapoor, V and Gulati, S. (2017) 1st Edition, **Experiments in Physical Chemistry,** Book Age series.

Additional Resources:

1. Mahan, B. H.(2013), **University Chemistry**,Narosa.

2. Barrow, G. M. (2006), **Physical Chemistry**, 5thEdition, McGrawHill.

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Pool of DISCIPLINE SPECIFIC ELECTIVES (DSEs) for BSc. Life Science

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -1:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-1: Chemistry of Major and Minor Biogenic Elements	04	02	00	02	Passed Class XII with Science	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To review periodic properties of main group elements and their role in the biological systems.
- To discuss the patterns and trends exhibited by main group elements and their compounds with emphasis on synthesis, structure, bonding and their diverse applications in the environment, industry and in the biological system.
- To get an insight into how these compounds such as oxides of N and S affect our day-to-day life.
- To learn about inorganic polymeric compounds borazine, silicates, silicones, phosphonitrilic compounds and their applications.
- To develop the interest of students in the frontier areas of inorganic and material chemistry.

Learning outcomes

By studying this course, students will be able to:

- Explain the periodicity in atomic and ionic radii, electronegativity, ionization enthalpy, electron gain enthalpy of elements of the periodic table.
- Explain oxidation states with reference to the existence of elements in unusual and rare oxidation states in alkalides, carbides and nitrides.
- Explain vital role of sodium, potassium, calcium and magnesium ions etc. in biological systems and the role of oxides of N and S in our environment.
- Predict distribution of major and minor biogenic elements in human beings

SYLLABUS OF CHEM-DSE 1

UNIT-1: Periodic Properties (6 Hours)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, the concept of exchange energy, inert pair effect.
General group trends of main group elements with special reference to size (atomic and ionic), Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, oxidation states (including rare oxidation states of alkali metals, carbides and nitrides), melting and boiling points, flame colour, metallic character and complex formation tendency (crown ethers and cryptates), Alkali metal solutions in liquid ammonia
Distribution of major and minor biogenic elements in human beings

UNIT 2: Structure, Bonding and Properties (16 Hours)

Structure, bonding and properties: Acidic/Basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, thermal stability of the following:
Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.
Oxides: Oxides of nitrogen, phosphorus and sulphur
Oxoacids: oxoacids of phosphorus, sulphur and chlorine
Halides of phosphorus

Relevance of above compounds in industrial/environmental/biological systems wherever applicable

UNIT 3: Preparation, Properties, Structure and Uses (8 Hours)

Preparation, properties, structure and uses of the following compounds: Borazine, Silicates, silicones, Phosphonitrilic halides {$(PNCl_2)_n$ where n = 3 and 4}

Practical component 60 Hours
(Laboratory periods: 15 classes of 4 hours each)

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations (preferably 7-8 mixtures). Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested: CO_3^{2-}, NO_2^- , S^{2-}, SO_3^{2-}, SO_4^{2-} , $S_2O_3^{2-}$, CH_3COO^-, F, Cl^- , Br^- , I- ,
NO_3^- , BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+} , Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}.
The mixtures may contain combination of anions/one interfering anion.
Spot tests should be preferred wherever applicable.

References:

Theory:

1. Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry,** John Wiley & Sons.

4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins, Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Housecraft, E. H.; Sharpe, A.G. (2018), **Inorganic Chemistry**, 5th Edition, Pearson.

Practicals:

1. Vogel, A.I. (1972), **Qualitative Inorganic Analysis**, Longman.
2. Svehla, G. (1996), **Vogel's Qualitative Inorganic Analysis**, Prentice Hall

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -2:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-2: Polynuclear Hydrocarbons, Pharmaceutical Compounds, UV- Visible & IR Spectroscopy	**04**	**02**	**00**	**02**	**Passed Class XII with Science**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the chemistry and applications of polynuclear hydrocarbons and heterocyclic compounds.
- Introduction to spectroscopy, an important analytical tool which allows identification of organic compounds by correlating their spectra to structure.

Learning outcomes

By studying this course, students will be able to:

- Understand the fundamentals of polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
- Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.
- Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules.

SYLLABUS OF CHEM-DSE-2

UNIT-1: Polynuclear Hydrocarbons (6 Hours)

Introduction, classification, uses, aromaticity of polynuclear compounds, Structure elucidation of naphthalene, preparation and properties of naphthalene and anthracene.

UNIT-2: Pharmaceutical Compounds (12 Hours)

Introduction, classification, general mode of action of antipyretics and analgesics, aspirin; Synthesis, uses and side effects of the following drugs:
Antipyretics - Paracetamol (with synthesis and mode of action); Analgesics- Ibuprofen (with synthesis and overview of the mode of action); Antimalarials - Chloroquine (synthesis and mode of action).
An elementary treatment of Antibiotics and detailed study of chloramphenicol including mode of action. Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

UNIT-3: UV-Visible and IR Spectroscopy (12 Hours)

UV-Visible and IR Spectroscopy and their application to simple organic molecules. Electromagnetic radiations and their properties; double bond equivalence and hydrogen deficiency. UV-Visible spectroscopy (electronic spectroscopy): General electronic transitions, λ_{max} & ε_{max}, chromophores &auxochromes, bathochromic & hypsochromic shifts. Application of Woodward rules for the calculation of λ_{max} for the following systems: conjugated dienes - alicyclic, homoannular and heteroannular; α, β-unsaturated aldehydes and ketones, charge transfer complex.

Infrared (IR) Spectroscopy: Infrared radiation and types of molecular vibrations, the significance of functional group & fingerprint region. IR spectra of alkanes, alkenes, aromatic hydrocarbons (effect of conjugation and resonance on IR absorptions), simple alcohols (inter and intramolecular hydrogen bonding and IR absorptions), phenol, carbonyl compounds, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Practical component 60 Hours
(Laboratory periods: 15 classes of 4 hours each)

1. Isolation and estimation of the amount of aspirin in a commercial tablet.
2. Preparation of Aspirin.
3. Synthesis of ibuprofen.
4. Systematic qualitative identification and derivative preparation of organic compounds (Aromatic hydrocarbons, Aryl halides)
5. Detection of simple functional groups through examination of IR spectra (spectra to be provided). IR spectra of simple compounds like phenols, aldehydes, ketones, carboxylic acids may be given.
6. Differentiation between of o-/p-hydroxybenzaldehyde by IR spectroscopy (Spectra to be provided).
7. Differentiation between benzoic acid and cinnamic acid by UV spectroscopy.
8. Diel's Alder reaction using Anthracene and Maleic anhydride.

9. Partial Reduction of m-dinitrobenzene to m-nitroaniline and then analysing the IR spectra of reactant and Product.
10. Laboratory preparation of Paraacetamol.

References:

Theory:

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N. **Organic Chemistry,** Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Bahl, A; Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.
4. Pavia, D.L. **Introduction to Spectroscopy**, Cengage learning (India) Pvt. Ltd.
2. Kemp, W. (1991), **Organic Spectroscopy**, Palgrave Macmillan.

Practicals:

1. Ahluwalia, V.K.; Dhingra, S.; Gulati, A. (2005), **College Practical Chemistry,** University Press (India) Ltd.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Vogel, A.I. (1972), **Textbook of Practical Organic Chemistry**, Prentice-Hall.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 3:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 3: Computer Applications in Chemistry	**04**	**02**	**0**	**02**	**Passed Class XII with Science**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to basic computer skills that will help them in solving chemistry problems using spreadsheets and BASIC language.
- To acquaint the students with different software for data tabulation, calculation, graph plotting, data analysis and document preparation.
- To expose the students to the concept of molecular modelling, its applications to various molecular systems, energy minimization techniques, analysis of Mulliken Charge and ESP Plots.

Learning outcomes

By studying this course, students will be able to:

- Have knowledge of most commonly used commands and library functions used in programming in C language.
- Develop algorithm to solve problems and write corresponding programs in C language for performing calculations involved in laboratory experiments.
- Use various spreadsheet software to perform theoretical calculations and plot graphs

SYLLABUS OF CHEM-DSE-3

UNIT-1: Programming using BASIC **(20 Hours)**

Programming Language – Elements of BASIC language, Numeric and string Constants and Variables, arithmetic expressions, hierarchy of operations, inbuilt functions. Syntax and use of the various QBASIC commands: REM, CLS, INPUT, PRINT, GOTO, IF, IF…THEN, IF..THEN..ELSE, IF and END IF, FOR and NEXT etc., DIM, READ, DATA, GOSUB, RETURN, RESTORE, DEF FNR and Library Functions, Simple programs based on usage of the commands mentioned above.

Statistical analysis using BASIC: Mean, Least square fit - Linear regression, variance, standard deviation.

UNIT-2: Handling of Numerical Data **(4 Hours)**

Spreadsheet software: MS Excel. Creating a spreadsheet, entering and formatting information, applying basic functions and formulae to the data, drawing charts, tables and graphs, displaying the equation of graph along with the R^2 value, incorporating tables and graphs in Word files, graphical solution of equations, plotting pressure-volume curves of van der Waals gases, Maxwell-Boltzmann distribution, concentration versus time graphs, spectral data, titration curves, etc.

UNIT-3: Molecular Modelling **(6 Hours)**

Introduction to molecular modelling, overview of classical and quantum mechanical methods (molecular mechanics, semi empirical, ab initio and DFT), general considerations and comparison of these methods.

Practical component 60 Hours

(Laboratory periods: 15 classes of 4 hours each)

Exercises of Programing

1. Calculate pressure of a real gas using Van der Waal's Equation.
2. Calculate the most probable speed, average speed and root men square velocity of an ideal gas.
3. Roots of quadratic equations
4. Binomial coefficient using GOSUB statement.
5. Mean, standard deviation
6. Least square curve fitting method for linear equation.

Plotting graphs using a spreadsheet

1. van der Waals isotherms
2. Maxwell-Boltzmann distribution curves as function of temperature and molecular weight
3. Plot the conductometric titration curve for

   a) strong acid vs strong base and b) weak acid vs strong base

0. Plot the pH metric titration curve for

   a) strong acid vs strong base and b) weak acid vs strong base and determine the pK_a of the weak acid

0. Plot the graphs for the kinetics of first order reaction and determine the rate constant
1. Plot the UV-vis absorbance spectra and determine the molar absorption coefficient.

Molecular Modelling

1. Optimize and compare the geometry parameters of H_2O and H_2S using Argus Lab.
2. Compare the basicities of N atom in ammonia, methylamine, dimethylamine and trimethylamine using Argus Lab by comparing Mulliken charges and ESP map in Argus Lab.
3. Compare C-C bond lengths and bond order in ethane, ethene and ethyne using Argus Lab.
4. Determine enthalpy of isomerization of cis and trans-2-butene in Argus Lab.
5. Compare the HAH bond angles for the second row hydrides (BeH_2, CH_4, NH_3, H_2O) and compare with the results from qualitative MO theory.

References:

Theory:

1. Levie, R. de. (2001), **How to use Excel in analytical chemistry and in general scientific data analysis**, Cambridge Univ. Press.
2. Venit, S.M. (1996),**Programming in BASIC: Problem solving with structure and style**. Jaico Publishing House.
3. Lewars, E. (2003), **Computational Chemistry,** Kluwer academic Publisher.
4. Cramer, C.J.(2004), **Essentials of Computational Chemistry,** John Wiley & Sons.
5. Hinchcliffe, A. (1996), **Modelling Molecular Structures,** John Wiley & Sons.
6. Leach, A.R.(2001), **Molecular Modelling,** Prentice-Hall.

Practicals:

1. Lewars, E. **(2003), Computational Chemistry,** Kluwer academic Publisher.
2. Cramer, C.J. **(2004), Essentials of Computational Chemistry,** John Wiley & Sons.
3. Hinchcliffe, A. **(1996), Modelling Molecular Structures,** John Wiley & Sons.

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Bachelor of Sciences (Physical Sciences)

Category II

BSc (Physical Sciences) with Chemistry as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE -7: Chemistry -III Chemical Energetics and Equilibria

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Energetics and Equilibria (DSC-7: Chemistry 03:	04	02	0	02	Passed Class 12^{th} with Physics, Chemistry, Mathematics	NIL

Learning objectives

The objectives of this course are as follows:

- To develop basic understanding of the chemical energetics, laws of thermodynamics and ionic equilibrium.
- to provides basic understanding of the behaviour of electrolytes and their solutions.
- To make students learn about the properties of ideal and real gases and deviation from ideal behavior

Learning outcomes

By studying this course, students will be able to:

- Explain the laws of thermodynamics, thermochemistry and equilibria.
- Use the concept of pH and its effect on the various physical and chemical properties of the compounds.
- Use the concepts learnt to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium

SYLLABUS

UNIT-1: Chemical Energetics **(16 Hours)**

Recapitulation of Intensive and extensive variables; state and path functions; Isolated, closed and open systems

First law

Concept of heat (Q), work (W), internal energy (U), and statement of first law; enthalpy (H), relation between heat capacities for ideal gas, Joule's experiment, calculations of Q, W, ΔU and ΔH for reversible expansion of ideal gases under isothermal conditions.

Thermochemistry

Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of ionization enthalpy of hydration, enthalpy of formation and enthalpy of combustion, Integral enthalpy of solution, bond dissociation energy and bond enthalpy; Hess's law, Born Haber's cycle (NaCl/ KCl).

Second Law

Concept of entropy; statements of the second law of thermodynamics (Kelvin and Clausius). Calculation of entropy change for reversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy (Non-PV work and the work function); Free energy change and concept of spontaneity (for ideal gases).

Third Law

Statement of third law, qualitative treatment of absolute entropy of molecules (examples of NO, CO), concept of residual entropy

UNIT-2: Chemical Equilibrium (4 Hours)

Criteria of thermodynamic equilibrium. Free energy change in a chemical reaction and equilibrium constant, exergenic and endergenic reactions with examples such conversion of ATP to ADP or vice verca,, Le Chatelier's principle, relationship between Kp, Kc and Kx for reactions involving ideal gases.

UNIT-3: Ionic Equilibria (10 Hours)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, Degree of ionization, pH scale, common ion effect, Buffer solutions, Henderson-Hasselbach equation. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

Practical Component: 60 Hours

(Laboratory periods: 15 classes of 4 hours each)

Chemical Energetics:

1. Determination of heat capacity ofcalorimeter.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodiumhydroxide.
3. Determination of the enthalpy of ionization of acetic acid.

4. Determination of enthalpy of neutralization of acetic acid and ammonium hydroxide using Hess's law.

5. Determination of integral enthalpy of solution (both endothermic and exothermic) of salts.

6. Determination of enthalpy of hydration of Copper sulphate.

Ionic equilibria:

7. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammonium chloride-ammonium acetate. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

8. Study the effect of addition of HCl/NaOH on pH of the buffer solutions (acetic acid, and sodium acetate).

9. pH metric titration of strong acid with strong base,

10. pH metric titration of weak acid with strong base

References:

Theory:

1. Castellan, G. W. (2004),**Physical Chemistry**,Narosa.
2. Kapoor, K. L. (2015),**A Textbook of Physical Chemistry**,Vol 1, 6th Edition, McGraw Hill Education.
3. Kapoor, K. L. (2015), **A Textbook of Physical Chemistry**, Vol 2, 6thEdition, McGraw Hill Education.
4. Puri, B. R., Sharma, L. R. and Pathania M. S. (2020), **Principles of Physical Chemistry**, Vishal PublishingCo.

Practical:

1. Khosla,B. D.;Garg,V. C.; Gulati,A.(2015), **SeniorPracticalPhysicalChemistry**,R.Chand&Co.
2. Kapoor, K. L. (2019), **A Textbook of Physical Chemistry**, Vol 7, 1st Edition, McGraw Hill Education.
3. Batra, S. K., Kapoor, V and Gulati, S. (2017) 1st Edition, **Experiments in Physical Chemistry,** Book Age series.

Additional Resources:

1. Mahan, B. H.(2013), **University Chemistry**,Narosa.
2. Barrow, G. M. (2006), **Physical Chemistry**, 5thEdition, McGrawHill.

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Pool of DISCIPLINE SPECIFIC ELECTIVES (DSEs) for BSC (Physical Science)

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -1:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-1: Main Group Chemistry	**04**	**02**	**0**	**02**	**Passed Class XII with Science**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide basic understanding of the fundamental principles of metallurgy through study of the different methods of extraction and refining of metals.
- To illustrate the diversity and fascination of inorganic chemistry through the study of structure, properties and utilities of s- and p-block elements and their compounds.

Learning outcomes

By studying this course, students will be able to:

- Understand the basis of occurrence of metals in nature and the methods that can be applied on minerals to extract the metals from them.
- Explain the importance of free energy of formation of oxides with the choice of reducing agent for extracting the metals.
- Understand and explain the importance of refining of metals and the choice of a refining procedure
- Explain the group trends observed for different properties of s and p block elements
- Explain the structures and the bonding basis of compounds of s- and p- block elements
- Explain the uniqueness observed in alkali metals and some other main group elements
- Understand and explain the polymerization of inorganic ions to generate inorganic polymers and the difference between organic and inorganic polymers.

Syllabus

Unit 1: General Principles of Metallurgy **(6 Hours)**

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, Van Arkel-De Boer process, Zone refining.

Unit 2: General Properties **(4 Hours)**

General group trends of s- and p-block elements with special reference to melting and boiling points, flame colour, metallic character and complex formation tendency, diagonal relationship and anomalous behaviour of first member of each group, Alkali metal solutions in liquid ammonia

Unit 3: Structure, Bonding, Properties and Applications **(16 Hours)**

Structure, bonding, properties (Acidic/Basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, thermal stability) and applications of the following:

Crown Ethers and cryptates of Alkali metals

Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.

Oxides: Oxides of nitrogen, phosphorus and sulphur.

Oxoacids: oxoacids of phosphorus, sulphur and chlorine

Halides of phosphorus

Unit 4: Inorganic Polymers **(4 Hours)**

Preparation, properties, structure and uses of the following:

Borazine, Silicates and Silicones

Practicals **(60 Hours)**

(Laboratory periods:60)

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations (preferably 7-8 mixtures). Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-}, NO_2^- , S^{2-}, SO_3^{2-}, SO_4^{2-} , $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^- , NO_3^- , BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-},

NH_4^+, K^+, Pb^{2+} , Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

The mixtures may contain combination of anions/one interfering anion.

Spot tests should be preferred wherever applicable.

References:

Theory:

1. Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
5. Housecraft, E. H.; Sharpe, A.G. (2018), Inorganic Chemistry, 5th Edition, Pearson.
6. F.A. Cotton & G. Wilkinson (1999), Advanced Inorganic Chemistry, 6th Edition, John Wiley & Sons.

Practicals:

1. Vogel, A.I. (1972), Qualitative Inorganic Analysis, Longman.
2. Svehla, G. (1996), Vogel's Qualitative Inorganic Analysis, Prentice Hall.

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DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE -2:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE-2: Polynuclear Hydrocarbons, Pharmaceutical Compounds, UV- Visible & IR Spectroscopy	**04**	**02**	**0**	**02**	**Passed Class XII with Science**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the chemistry and applications of polynuclear hydrocarbons and heterocyclic compounds.
- Introduction to spectroscopy, an important analytical tool which allows identification of organic compounds by correlating their spectra to structure.

Learning outcomes

By studying this course, students will be able to:

- Understand the fundamentals of polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
- Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.
- Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules.

SYLLABUS OF CHEM-DSE-2

UNIT-1: Polynuclear Hydrocarbons (6 Hours)

Introduction, classification, uses, aromaticity of polynuclear compounds, Structure elucidation of naphthalene, preparation and properties of naphthalene and anthracene.

UNIT-2: Pharmaceutical Compounds **(12 Hours)**

Introduction, classification, general mode of action of antipyretics and analgesics, aspirin; Synthesis, uses and side effects of the following drugs:
Antipyretics - Paracetamol (with synthesis and mode of action); Analgesics- Ibuprofen (with synthesis and overview of the mode of action); Antimalarials - Chloroquine (synthesis and mode of action).
An elementary treatment of Antibiotics and detailed study of chloramphenicol including mode of action. Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine)**.**

UNIT-3: UV-Visible and IR Spectroscopy **(12 Hours)**

UV-Visible and IR Spectroscopy and their application to simple organic molecules. Electromagnetic radiations and their properties; double bond equivalence and hydrogen deficiency. UV-Visible spectroscopy (electronic spectroscopy): General electronic transitions, λ_{max} & ε_{max}, chromophores &auxochromes, bathochromic & hypsochromic shifts. Application of Woodward rules for the calculation of λ_{max} for the following systems: conjugated dienes - alicyclic, homoannular and heteroannular; α, β-unsaturated aldehydes and ketones, charge transfer complex.

Infrared (IR) Spectroscopy: Infrared radiation and types of molecular vibrations, the significance of functional group & fingerprint region. IR spectra of alkanes, alkenes, aromatic hydrocarbons (effect of conjugation and resonance on IR absorptions), simple alcohols (inter and intramolecular hydrogen bonding and IR absorptions), phenol, carbonyl compounds, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Practical component 60 Hours

(Laboratory periods: 15 classes of 4 hours each)

1. Isolation and estimation of the amount of aspirin in a commercial tablet.
2. Preparation of Aspirin.
3. Synthesis of ibuprofen.
4. Systematic qualitative identification and derivative preparation of organic compounds (Aromatic hydrocarbons, Aryl halides)
5. Detection of simple functional groups through examination of IR spectra (spectra to be provided). IR spectra of simple compounds like phenols, aldehydes, ketones, carboxylic acids may be given.
6. Differentiation between of o-/p-hydroxybenzaldehyde by IR spectroscopy (Spectra to be provided).
7. Differentiation between benzoic acid and cinnamic acid by UV spectroscopy.
8. Diel's Alder reaction using Anthracene and Maleic anhydride.
9. Partial Reduction of m-dinitrobenzene to m-nitroaniline and then analysing the IR spectra of reactant and Product.
10. Laboratory preparation of Paraacetamol.

References:

Theory:

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd.

(Pearson Education).
2. Morrison, R. N.; Boyd, R. N. **Organic Chemistry,** Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Bahl, A; Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.
4. Pavia, D.L. **Introduction to Spectroscopy**, Cengage learning (India) Pvt. Ltd.
3. Kemp, W. (1991), **Organic Spectroscopy**, Palgrave Macmillan.

Practicals:

1. Ahluwalia, V.K.; Dhingra, S.; Gulati, A. (2005), **College Practical Chemistry,** University Press (India) Ltd.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Vogel, A.I. (1972), **Textbook of Practical Organic Chemistry**, Prentice-Hall.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE CHEM-DSE 3:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chem-DSE 3: Computer Applications in Chemistry	**04**	**02**	**0**	**02**	**Passed Class XII with Science**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to basic computer skills that will help them in solving chemistry problems using spreadsheets and BASIC language.
- To acquaint the students with different software for data tabulation, calculation, graph plotting, data analysis and document preparation.
- To expose the students to the concept of molecular modelling, its applications to various molecular systems, energy minimization techniques, analysis of Mulliken Charge and ESP Plots.

Learning outcomes

By studying this course, students will be able to:

- Have knowledge of most commonly used commands and library functions used in programming in C language.
- Develop algorithm to solve problems and write corresponding programs in C language for performing calculations involved in laboratory experiments.
- Use various spreadsheet software to perform theoretical calculations and plot graphs

SYLLABUS OF CHEM-DSE-3

UNIT-1: Programming using BASIC (20 Hours)

Programming Language – Elements of BASIC language, Numeric and string Constants and Variables, arithmetic expressions, hierarchy of operations, inbuilt functions. Syntax and use of the various QBASIC commands: REM, CLS, INPUT, PRINT, GOTO, IF, IF…THEN, IF..THEN..ELSE, IF and END IF, FOR and NEXT etc., DIM, READ, DATA, GOSUB, RETURN, RESTORE, DEF FNR and Library Functions, Simple programs based on usage of the commands mentioned above.

Statistical analysis using BASIC: Mean, Least square fit - Linear regression, variance, standard deviation.

UNIT-2: Handling of Numerical Data **(4 Hours)**

Spreadsheet software: MS Excel. Creating a spreadsheet, entering and formatting information, applying basic functions and formulae to the data, drawing charts, tables and graphs, displaying the equation of graph along with the R^2 value, incorporating tables and graphs in Word files, graphical solution of equations, plotting pressure-volume curves of van der Waals gases, Maxwell-Boltzmann distribution, concentration versus time graphs, spectral data, titration curves, etc.

UNIT-3: Molecular Modelling **(6 Hours)**

Introduction to molecular modelling, overview of classical and quantum mechanical methods (molecular mechanics, semi empirical, ab initio and DFT), general considerations and comparison of these methods.

Practical component 60 Hours

(Laboratory periods: 15 classes of 4 hours each)

Exercises of Programing

1. Calculate pressure of a real gas using Van der Waal's Equation.
2. Calculate the most probable speed, average speed and root men square velocity of an ideal gas.
3. Roots of quadratic equations
4. Binomial coefficient using GOSUB statement.
5. Mean, standard deviation
6. Least square curve fitting method for linear equation.

Plotting graphs using a spreadsheet

1. van der Waals isotherms
2. Maxwell-Boltzmann distribution curves as function of temperature and molecular weight
3. Plot the conductometric titration curve for

   a) strong acid vs strong base and b) weak acid vs strong base
4. Plot the pH metric titration curve for

   a) strong acid vs strong base and b) weak acid vs strong base and determine the pK_a of the weak acid
5. Plot the graphs for the kinetics of first order reaction and determine the rate constant
6. Plot the UV-vis absorbance spectra and determine the molar absorption coefficient.

Molecular Modelling

1. Optimize and compare the geometry parameters of H_2O and H_2S using Argus Lab.
2. Compare the basicities of N atom in ammonia, methylamine, dimethylamine and trimethylamine using Argus Lab by comparing Mulliken charges and ESP map in Argus Lab.
3. Compare C-C bond lengths and bond order in ethane, ethene and ethyne using Argus Lab.
4. Determine enthalpy of isomerization of cis and trans-2-butene in Argus Lab.
5. Compare the HAH bond angles for the second row hydrides (BeH_2, CH_4, NH_3, H_2O) and compare with the results from qualitative MO theory.

References:

Theory:

1. Levie, R. de. (2001), **How to use Excel in analytical chemistry and in general scientific data analysis**, Cambridge Univ. Press.
2. Venit, S.M. (1996),**Programming in BASIC: Problem solving with structure and style**. Jaico Publishing House.
3. Lewars, E. (2003), **Computational Chemistry,** Kluwer academic Publisher.
4. Cramer, C.J.(2004), **Essentials of Computational Chemistry,** John Wiley & Sons.
5. Hinchcliffe, A. (1996), **Modelling Molecular Structures,** John Wiley & Sons.
6. Leach, A.R.(2001), **Molecular Modelling,** Prentice-Hall.

Practicals:

1. Lewars, E. **(2003), Computational Chemistry,** Kluwer academic Publisher.
2. Cramer, C.J. **(2004), Essentials of Computational Chemistry,** John Wiley & Sons.
3. Hinchcliffe, A. **(1996), Modelling Molecular Structures,** John Wiley & Sons.

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Bhaskaracharya College of Applied Science

B.Sc. (Honours) Polymer Science
Category I

DISCIPLINE SPECIFIC CORE COURSE – 7:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
RUBBER ADDITIVES (DSC-7-RA)	4	3	0	1	Passed Class XII with Physics, Chemistry, Maths	NIL

LEARNING OBJECTIVES
The Learning Objectives of this course are as follows:
- To enable the students to know about need for additives in compounding of rubber
- To understand the different types of ingredients in compounding.
- To know about property modification by vulcanization
- To enrich knowledge on testing of compounded rubber

LEARNING OUTCOMES
The Learning Outcomes of this course are as follows:

After completing the course, the students
- Will understand concept of rubber compounding.
- Will modify the properties of rubber by incorporation of additives.
- Will develop rubber compound for required end use application.
- Will modify the strength by varying vulcanizing agents.
- Will do testing of rubber and asses quality of rubber compound.

SYLLABUS OF DSC-7

THEORY COMPONENT-

UNIT – I **(09 Hours)**

FILLERS AND PROCESSING AIDS

Fillers: Carbon black, Non carbon black, Colors and Pigments,Plasticizers, Process aids, Softeners and Extenders.

UNIT – II (9 Hours)

OTHER ADDITIVES FOR RUBBERS

Vulcanizing agents (sulphur, peroxide and metal oxide, phenolic curatives, benzoquinone derivatives, bismaleimides), accelerators (benzothiazoles, benzothiazolesulfenamide, dithiocarbamates, amines), lubricants, retarders (pre-vulcanized inhibitor), activators,

UNIT – III (06 Hours)

ANTIDEGRADATION AND MISCELLEOUS ADDITIVES

Uv stabilizers, Heat stablizers, Antioxidants, Antiozonants- Mechanism of degradation – Mechanism of ozone attack. Special purpose additives: Chemical blowing agents – Flame retardants – Antistatic agent – Abrasives -Integral bonding additives – stiffening agents. antioxidants, thermal), softners, tackifying agents, blowing agents, surface property modifiers etc.

UNIT – IV (06 Hours)

INDIVIDUAL RUBBER FORMULATIONS

Formulating for natural and synthetic rubbers and typical recipes for a few rubber products, Implications of FDA Regulations - Toxicity and environmental issues.

UNIT – V (12 Hours)

FORMULATION FOR PERFORMANCE REQUIREMENTS

Compounding to meet different Hardness requirements – Iow compression set – For damping application – Compounding to meet bonding requirements with metals and textiles– Compounding to meet processing – Economics of compounding – Cost estimation.

PRACTICAL COMPONENT- 60 Hours

- Mastication of NR on two roll mill
- Mixing of rubber compounds
- Compression moulding of rubber compounds
- Preparation of dry rubber products – play ball
- Preparation of dry rubber products – Hawaii sheet
- Preparation of dry rubber products – M.C Sheet
- Preparation of dispersions for compounding of latex
- Preparation of latex products: i. Hand Gloves ii. Balloon iii. Rubber band iv. Thread
- Compression moulding of fabric/rubber composite
- Preparation of rubber blends

ESSENTIAL/RECOMMENDED READINGS

- John S Dick, Rubber Technology- Compounding and Testing for Performance Hanser Publishers, 2001.
- C. Hepburn, Rubber Technology and Manufacturing, Butterworth-Heinemann, 2009
- Brendon Rodgers, Rubber Compounding- Chemistry and Applications, Taylor and Francies, 2016.

SUGGESTIVE READINGS

- Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
- Roger Brown, Physical Testing of Rubber, Chapman and Hall, 3rd Edition, 1996.

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DISCIPLINE SPECIFIC CORE COURSE – 8

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PLASTIC ADDITIVES (DSC-8-PA)	4	3	0	1	Passed Class XII with Physics, Chemistry and Mathematics	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- **To introduce the basics of polymer additives and their significance**
- **To study different additives and their representative formulations**

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:

After studying this paper, students will be able to

- Understand the role of various compounding additives used for plastics and rubbers
- Describe various steps & variables for mixing and blending of additives
- Utilize understanding of compounding additives and methods for modification of polymer properties

SYLLABUS OF DSC- 8

THEORY COMPONENT-

UNIT – I (12 Hours)

INTRODUCTION TO ADDITIVES AND COMPOUNDING

Importance of additives and their selection criteria for commercial polymers and technical requirements of additives, limitation of polymer additives, physical behavior of polymer additives (solubility etc.), limitation of polymer compounding, two roll mill, high speed mixer, internal batch mixer, single screw & twin screw extruders

UNIT – II (15 Hours)

ADDITIVES FOR PLASTICS

Plasticizers, theories of plasticization, types of plasticizer (phthalate, polymeric, hydrocarbon oil, vegetable oil, phosphates trimellitic etc.), methods of incorporation, fillers, introduction, classification, selection criteria (particle size, shape & geometry, packing fraction, hardness and abrasiveness, optical properties), impact of fillers on properties (mechanical properties, thermal properties, moisture content and electrical properties), Foaming agents, blowing agents, stabilizers (UV, heat, antioxidants and light), metal deactivators, Colorants (Dyes and pigments, coloring properties, classification of pigments, inorganic and organic pigments, method of incorporation (dispersion, pre mixing, agglomerate breakdown, compaction and wetting)

UNIT – III (09 Hours)

ADDITIVES FOR SPECIAL NEEDS

Flame retardants (halogen based, metal oxides, hydrated salts etc.), impact modifiers, lubricants & flow promoters, dry bonding agent and antistatic agents, conductive additives, biodegradation additives

UNIT – IV (09 Hours)

CASE STUDY

Compounding techniques with illustration of few formulations like:

- Rigid PVC pipes
- Clear bags and flexible films
- Acrylic sheet and display board
- Rubber sole
- Air water hose
- Conveyor belt

PRACTICAL COMPONENT- 30 Hours

- Determination of bulk density of fillers.
- Determination of pore size and net size of fillers.
- Determination of thermal stability of polymer stabilized by heat stabilizer.
- Measurement of flash point of a plasticizer.
- Identification of additives using chromatography.
- Determination of the plasticizer and filler content in plastic materials.
- Evaluate the bleeding and blooming properties of an additive.
- Evaluate the effect of fillers/plasticizers on the properties of a plastic/rubber.
- To prepare a PVC masterbatch.
- Identification of a pigment by spot test.
- Estimation of Iodine value of Castor oil
- Determination of DBP value and sieve analysis of Carbon black.

ESSENTIAL/RECOMMENDED READINGS

- Lutz J.T., (2001), Polymer Modifiers and Additives, Marcel Dekker.
- Zweifel H., Amos S.E., (2001) Plastics Additives Handbook, Hanser.
- Gachter R., Muller H., (1987) Plastics Additive Handbook, Hanser Publishers.

SUGGESTIVE READINGS

- Mascia L., (1974) The Role of Additives in Plastics, Edward Arnold Publishers Ltd., U.K.
- Murphy J., (2001) Additives for Plastics Handbook, Second Edition, Elsevier Advanced Technology, Oxford.
- Gerard J. F., (2001) Fillers and Filled Polymers, Wiley-VCH verlag GmbH

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DISCIPLINE SPECIFIC CORE COURSE – 9:

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
POLYMER DEGRADATION (DSC-09-PD)	4	3	0	1	Passed Class XII with Physics, Chemistry and Mathematics	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- To familiarize with the utility and importance of polymer degradation
- To learn about the conditions and the reactions of degradation of polymers

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:

After studying this paper, students will be able to

- Explain the factors responsible for degradation
- Understand the handling of various polymers without affecting the properties
- Evaluate degradation of polymers by various methods

SYLLABUS OF DSC-9

THEORY COMPONENT-

UNIT – I (12 Hours)

CONCEPT OF DEGRADATION

Introduction to degradation, classification of degradation based on

a. Pattern of degradation:
    i. Random degradation
    ii. Side chain degradation
    iii. Chain end degradation
b. Cause of degradation (mechanism, factors affecting thermal degradation, example)

i. Thermal degradation
ii. Oxidative degradation
iii. Degradation by radiation
iv. Mechanical degradation
v. Chemical degradation
vi. Biological degradation

UNIT – II (21 Hours)

DEGRADATION OF A FEW THERMOPLASTICS

Different types of degradation patterns with mechanism of the polymers:

- Polyolefins (PE and PP)
- PVC
- Polyamides
- PMMA
- Cellulose
- Polyacrylonitrile (PAN)
- Polystyrene (PS)
- PET

UNIT – III (6 Hours)

DEGRADATION OF ELASTOMERS

i. PU **ii.** Natural rubber **iii.** SBR

UNIT – IV (6 Hours)

QUANTITATIVE AND QUALITATIVE EVALUATION OF DEGRADATION

Degradation studies using DSC, TGA

PRACTICAL COMPONENT- 30 Hours

- To study biodegradation of polymers.
- To study mechanical degradation of polymers and its effect on properties.
- To study thermal degradation of polymers under various conditions.
- To study thermal analysis of a given polymer by DSC/ TGA.
- To study photo-degradation of PVC.
- To evaluate chemical degradation of PET.
- To determine environmental stress cracking resistance of polymers.
- To evaluate chemical degradation of Nylon 66.
- To study epoxidation of Natural Rubber Latex.
- To study the effect of degradation on properties like: Mechanical strength, hardness, solubility, viscosity etc.

ESSENTIAL/RECOMMENDED READINGS

- Pesce W.J., (2007) Encyclopaedia of Polymer Science and Technology, Wiley.
- Turi E.A., (1997) Thermal Characterization of Polymeric Materials, Academic Press.
- Glaser, J. A. (2019). Biological degradation of polymers in the environment (Vol. 1, p. 13). London, UK: IntechOpen.
- Gilbert, M. (2017). Cellulose plastics. In Brydson's Plastics Materials (pp. 617-630). Butterworth-Heinemann.

- Krasowska, K., Heimowska, A., & Rutkowska, M. (2015). Environmental degradability of polyurethanes. Thermoplastic Elastomers—Synthesis and Applications; IntechOpen: London, UK, 75-94.

SUGGESTIVE READINGS

- Hamid S.H., Amin M.B., (1992) Handbook of Polymer Degradation, Marcel Dekker.
- Ehrenstein G.W., Riedel G., Trawiel P., (2004) Thermal analysis of plastics, Hanser.

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DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-1)

Credit distribution, Eligibility and Pre-requisites of the Course

COMMON POOL OF DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE) COURSES OFFERED IN ODD SEMESTERS BY THE DEPARTMENTS

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
ADVANCED ANALYTICAL TECHNIQUES (DSE-01-AAT)	4	2	0	2	Passed 12Th with Science	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- **To acquaint the students with the modern instrumental techniques and their applications in characterization of polymeric materials**
- **Students will be able to determine a chemical property and identify a chemical substance in a polymer.**

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:

After studying this paper, students will be able to

- Interpret NMR, raman, mass and IR–spectra for characterization of molecular structure of polymeric materials

- Elucidate the morphology of various polymers
- Acquire the knowledge about separation of components from polymer mixture

SYLLABUS OF DSE-1

THEORY COMPONENT-

UNIT 1 (14 Hours)

SPECTROSCOPIC TECHNIQUES

Principles and applications of structural determination of polymers (functional group, tacticity, molecular structure, purity, unsaturation etc.) using FT-IR, electron spin resonance, raman, nuclear magnetic resonance (^{1}H NMR, ^{13}C NMR).

Mass Spectroscopy: introduction, basic principles, instrumentation, fragmentation patterns, nitrogen rule, McLafferty rearrangement, interpretation of mass spectra and applications, MALDI-TOF, ESI-MS and methods for determination of molecular mass (principles and applications in polymer characterization).

UNIT 2 (08 Hours)

CHROMATOGRAPHY TECHNIQUES

Introduction to chromatographic methods: TLC, column and gas chromatography, principles, instrumentation, GC column, detectors and stationary phases and applications, hyphenated techniques (GC-MS). Liquid chromatography LC/HPLC, gel permeation chromatography (GPC)

UNIT 3 (08 Hours)

MICROSCOPIC AND MISCELLANEOUS TECHNIQUES

Optical microscopy, electron microscopy (SEM, TEM, AFM) and XRD: basics and applications (size, morphology, crystallinity etc.) for polymers characterization. Particle size analyzer, zeta potential, etc.

PRACTICAL COMPONENT- (60 Hours)

- To identify the functional groups in various polymers using FTIR.
- To analyze the NMR spectra of a given polymer.
- To analyze the raman spectra of given polymers.
- Evaluate percentage crystallinity of polymeric samples by XRD.
- To separate additives in a given polymeric sample by chromatography.
- To separate a polymeric mixture by TLC.
- To analyze film morphology by compound/electron/Atomic Force microscope.
- To determine the size of polymer/additives particles by particle size analyzer.
- To study the polymers tacticity using NMR.
- Visit to an analytical laboratory.

ESSENTIAL/RECOMMENDED READINGS

- Willard H.H., Merritt L.L., Dean J.A. (1988) Instrumental method of analysis, Wads worth Publishing Company.
- Skoog D.A, (1997) Principle of Instrumental Analysis, Harcourt College Pub.
- Shah V., (2007) Handbook of Plastic Testing, Technology, Wiley-Inter science.

- Banwell C.N., McCash E.M., (2008) Fundamentals of Molecular Spectroscopy, Fourth Edition, Tata McGraw-Hill.

SUGGESTIVE READINGS

- Tanaka T., (1999) Experimental Methods in Polymer Sciences, Academic Press.
- Silverstein R.M., (1991) Spectrometric identification of organic compounds, John Wiley.
- Macomber R.S., (2008) A complete introduction to NMR spectroscopy, Wiley-inter science.

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DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
FIBRE MANUFACTURING TECHNOLOGY (DSE-02-FMT)	4	2	0	2	Passed 12Th with Science	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- To learn about the basic concepts of spinning including melt and solution spinning.
- To understand various parameters affecting spinning, drawing and heat setting of fibre structure and properties

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:
After studying this paper, students will be able to

- Manufacture fibre with desired properties.
- Understand the various spinning variables.

SYLLABUS OF DSE-2

THEORY COMPONENT-

UNIT 1(06 Hours)
INTRODUCTION TO FIBRES

Manmade fibres: definition of man-made fibres, brief history of manmade fibres, relative merits and demerits of manmade and natural fibres

UNIT 2: (12 Hours)
MELT SPINNING

Melt spinning process: Crystallization in spin line, stress induced crystallization, melt spinning of PP, polyester and nylon-6 and nylon -66, effect of process parameters on structure and properties of melt spun filament.

UNIT 3 (12 Hours)
SOLUTION DRY & WET SPINNING

Dry spinning of cellulose acetate, acetylation of cellulose, dope preparation and spinning of cellulose diacetate and triacetate, dry spinning of acrylic, significance and types of co-monomers used during polymerization of acrylonitrile (PAN)

Wet spinning of acrylic fibre and viscose rayon, formation of structure in viscose, influence of various additives and temperature of the regeneration bath on the process and properties of viscose rayon

PRACTICAL COMPONENT- 60 Hours

- To prepare polypropylene fibre by melt spinning.
- Melt spinning of Nylon 6/66.
- To prepare polyester fibre by melt spinning
- Solution spinning of acrylic fibre.
- Dry spinning of PAN fibre.
- To characterize a woven fabric with respect to its dimensional properties: thread density , yarn number, yarn crimp, weave, cover factor, areal density, skewness, thickness
- Identification of dyestuff on different substrates
- To determine the crease recovery of fabric and observe the effect of loading time and recovery time on crease recovery.
- Drawing and heat setting of fibres.
- Chemical modification of fibres.

ESSENTIAL/RECOMMENDED READINGS

- Gupta V.B., Kothari V.K., (1997) Manufactured Fibre Technology, 1st Ed Chapman and Hall.
- NPTEL course material on Manufactured fibre Technology.
- Macintyre J.E., (2005) Synthetic Fibres: Nylon, Polyester, Acrylic, Polyolefin, Elsevier Science.

SUGGESTIVE READINGS

- Vaidya A.A., (1988) Production of Synthetic Fibres, First Edition, Prentice Hall of India.
- Kothari V.K., (2000), Textile Fibres: Developments and Innovations, IAFL Publications.

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DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
TYRE TECHNOLOGY (DSE-03-TT)	4	2	0	2	Passed 12Th with science	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- Familiarizing various types of tyres and their components
- Developing the knowledge of manufacturing techniques of various tyres

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:

After studying this paper, students will be able to

- Apply knowledge of basic concept of manufacturing technology of tyre
- Understand designing and compounding of various tyre components
- Evaluate testing and quality assessment of tyre

SYLLABUS OF DSE-3

THEORY COMPONENT-

UNIT 1 (08 Hours)

INTRODUCTION AND TYRE MANUFACTURING

Classification: based on construction (pneumatic, radial, bias, cross ply, tube, tubeless, solid), Mixing (Mixing instruments: two roll mill, kneader, internal mixers), processing (extrusion, calendaring, bead winding), building drum, curing (molding machines etc.), mold

UNIT 2 (12 Hours)

TYRE DESIGN

Compound design (selection of chemical ingredients); process design (process parameters correlating with properties); product design (constructions), latest advances in materials and technologies

UNIT 3 (10 Hours)

TYRE TESTING

Endurance, groove crack test, plunger test, traction: dry, wet and snow, air permeation, noise test, rolling resistance, drivability, road test, wet braking test, fuel economy test, tread to ply pull out, bead seating test

PRACTICAL COMPONENT- 60 Hours

- To identify the type of rubber by reverse engineering.
- To prepare fabric- rubber coated ply.
- To test mechanical and physical properties of vulcanized rubber.
- To perform air aging properties of rubber and rubber to fabric ply.
- To determine bonding strength of rubber to fabric.
- To calculate abrasion losses of tyre tread.
- To calculate rebound resilience of a rubber.
- Tyre indexing and cut section analysis.
- To evaluate the compression set of a rubber.
- To determine rolling resistance test
- Industrial Visit of Tyre Industry/ R&D

ESSENTIAL/RECOMMENDED READINGS

- Clark S.K., (1971) Mechanics of Pneumatic Tires, National Bureau of Standards, Monograph, US Govt. printing office.
- French T., (1989) Tyre Technology, Adam Hilger, New York.

SUGGESTIVE READINGS

- Ford T.L., Charles F.S., (1988) Heavy Duty Truck TIRE Engineering SAE's 34th L. Ray Buckingdale Lecture, SP729.
- Gent A.N., Walter J.D., (2006) The Pneumatic TIRE, U.S. Department of Transportation, National Highway Traffic Safety Administration.
- Mark J.E., Erman B., Eirich F.R., (2005) The Science and Technology of Rubber, Elsevier.
- Koutny F., Zling, (2007) Geometry and Mechanics of Pneumatic TIRE, CZE.

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DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-4)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
POLYMER PRODUCT DESIGN (DSE-04-PPD)	4	2	0	2	Passed 12Th with science	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- To learn physical properties of polymers required for product design

- To design plastic parts such as static and dynamic loaded parts for electrical, optical and mechanical applications (gears, bearings, pipes, seals, couplings and vibration dampers)

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:

After studying this paper, students will be able to

- Demonstrate the response of polymers for various loads.
- Apply the knowledge to develop plastic products.
- Develop the design for polymer products in engineering applications.

SYLLABUS OF DSE-4

THEORY COMPONENT-

UNIT-1 (5 Weeks)

INTRODUCTION

Introduction to structure and physical properties of polymers, stress – strain behaviour of polymers, effect of fillers on properties of polymers, stress analysis of polymers, structural design of beams, plates and other structural members.

UNIT 2 (10 Hours)

CHARACTERISTICS OF PRODUCT DESIGN

Dynamic load response of polymers, effects of cyclic loading, other forms of stress applied to polymer parts, design for stiffness, processing limitations on polymers product design. Material and process interaction and the effects on the performance of plastic parts and the resulting design limitations, performance in service and environmental exposure.

UNIT 3 (10 Hours)

PRODUCT DESIGN TECHNIQUES

Design procedure for plastic parts- basic principles-shrinkage-flash lines-undercuts-suggested wall thickness-draft-tolerance-moulded holes-threads radius- moulded hinges-integral hinge-snap fits – product design thumb rules – case studies and product design. design of plastic structural parts for static loads, design of dynamically loaded plastic parts, design of plastic parts for electrical applications, design of plastic parts for optical applications.

PRACTICAL COMPONENT- (60 Hours)

- To prepare a poly styrene sheet with in-situ polymerization.
- To prepare open and closed cell foam.
- To prepare laminates such as epoxy, polyester and epoxy-polyester.
- To prepare a PMMA sheet using bulk polymerizations.
- To join polymer products by molding.
- Preparation of polymer products by different processing techniques.
- To study the post curing of rubber
- To prepare a composite mouse pad
- To prepare rubber - metal composite products
- To determine mechanical properties of designed products

ESSENTIAL/RECOMMENDED READINGS

- Levy S. & Dubois J.H., (1977) Plastic Product Design Engineering Hand Book, Van Nostrand Reinhold Co., New York.
- Miller E., Plastics Products Design Hand Book, Marcel Dekker,

SUGGESTIVE READINGS

- Malloy R. A., (1994) Plastic Part Design for Injection Moulding, Hanser Pub., Munich Vienna NY.
- Belofsky H., (1995) Plastics Product Design and Process Engineering, SPE, Hanser Publication, Munich Vienna NY.
- Freekly P.K. & Payne A. R., Theory and Practice of Engineering with Rubber.
- Hepburn B. and Raynolds R.J.W. , Elastomers, Criteria for Engineering Design.
- Beck R.D., Plastic Product Design, Van Nostrand Reinhold Co.

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DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
POLYMERS IN BIOMEDICAL APPLICATIONS (DSE-05-PBA)	4	2	0	2	Passed 12Th with science	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- To acquire knowledge of biocompatibility and biodegradation
- To learn about applications and testing of bio-compatible polymer in tissue engineering

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:

After studying this paper, students will be able to

- Understand the basic concepts and requirement of biomedical applications and biocompatibility
- Apply the knowledge of various polymers in biomedical application

SYLLABUS OF DSE-5

THEORY COMPONENT-

UNIT 1 (8 Hours)
BASICS OF BIOMATERIALS

Concept of biocompatibility and biodegradability, responsiveness, estimations of degradation and biocompatibility. Importance of biomaterials: hydrogel, fibres, bio-ceramics, bio-elastomers and membrane

UNIT 2 (10 Hours)
POLYMERS AS BIOMATERIALS
Sources, properties and applications: polyamides, polyesters, carbohydrates, natural gums, polyurethanes, polylactic acid, alginates, silicone.

UNIT 3 (12 Hours)
BIOMATERIALS FOR ORGAN TRANSPLANTS & DRUG DELIVERY
Properties and uses of polymers for organ transplant e.g. dental cement, orthopedic, skin, artificial kidney etc., basic concept of tissue engineering, uses of cellulose, chitosan and alginate

Introduction to drug delivery, polymers in controlled drug delivery, dressing strips, polymer drug vessels, core shell and nanogels

PRACTICAL COMPONENT- (60 Hours)

- Evaluate the biocompatibility of polymeric samples.
- Determination of the degradation behavior of polymers such as thermal, hydrolytic etc.
- Preparation of membranes and measurement of their absorption behavior.
- Preparation and characterization of dental cement.
- Prepare a hydrogel and characterization.
- Prepare jaw by powdered silicone rubber
- To find out biocompatibility of polymer products by enigmatic test
- Determination of mechanical strength of polymers.
- To find out hydro degradation of artificial bone.
- To prepare porous membranes.

ESSENTIAL/RECOMMENDED READINGS

- Tiwari A., Tiwari A., (2013) Nanomaterials in drug delivery, Imaging and Tissue Engineering, Wiley.
- Pilla S., (2011) Handbook of Bioplastics and Biocomposites Engineering Applications, Wiley.

SUGGESTIVE READINGS

- Ratner B.D., Hoffman A.S., (1996) An Introduction to Materials in Medicine, Academic Press.
- Saltzman W.M., (2001) Drug delivery: Engineering principles for drug therapy, Oxford University Press.
- Kalia S., Averous L., (2011) Biopolymers: Biomedical and Environmental Applications, John Wiley & Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-6)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
CONDUCTING POLYMERS (DSE-06-CP)	4	2	0	2	Passed 12Th with science	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- **To impart knowledge of structure and electrical properties of conducting polymers.**
- **To learn about applications of conducting polymers.**

LEARNING OUTCOMES

The Learning Outcomes of this course are as follows:

After studying this paper, students will be able to

- Understand synthesis and requirement of doping in polymers.
- Analyze properties of conducting polymers

SYLLABUS OF DSE-6

THEORY COMPONENT-

UNIT 1(8 Hours)

BASIC ASPECTS OF CONDUCTING POLYMERS

Historical background, band structure, band alignment, conduction mechanism, theory of electrical conduction in conducting polymers

UNIT 2 (10 Hours)

SYNTHESIS OF CONDUCTING POLYMERS

Chemical and electrochemical polymerizations: polyaniline, polypyrrole, polythiophene etc.; doping and its effects on properties of conducting polymers

UNIT 3(12 Hours)

PROPERTIES & APPLICATIONS OF CONDUCTING POLYMERS

Electrical properties, resistance, impedance, capacitance, magnetic properties and optical properties

Electronic devices, sensors, rechargeable batteries, solar cells, light emitting devices, biomedical devices, bio-system, organ transplant, artificial mussels and EMI shielding etc.

PRACTICAL COMPONENT- (60 Hours)

- Synthesis of polyaniline, polypyrrole and polythiophene by chemical polymerizations.
- Synthesis of conducting polymers by electro chemical polymerizations.

- To improve electrical conductivity of PANI by doping
- Evaluation of mechanical properties of conducting polymer films/sheets.
- Determination of the thermal properties of conducting polymers.
- To prepare a molded sheet of conducting polymers.
- To Manufacture molded conducting device
- To study the effect of doping of Polypyrrole
- To measure the electrical conductivity and resistivity of conducting polymer films/sheets.
- To design light emitting devices for conducting applications.

ESSENTIAL/RECOMMENDED READINGS

- Chandrasekhar P., (1999) Conducting Polymers, fundamentals and applications: A practical approach, Springer.
- Nalwa H.S., (1997) Handbook of Organic Conductive Molecules and Polymers: Conductive polymers: synthesis and electrical properties, Vol. 2, Wiley.
- Skotheim T.A., Elsenbaumer R.L., Reynolds J.R., (2007) Handbook of Conducting Polymers, CRC Press.
- Batrinescu, G., Constantin, L. A., Cuciureanu, A., & Constantin, M. A. (2016). Conductive polymer-based membranes. Conducting Polymers.
- Fernandez O.T., (2015) Conducting Polymers, Royal Society of Chemistry.
- Almeida L.C., (2013) Conducting Polymers: Synthesis, Properties & Applications, Nova Publishers.

SUGGESTIVE READINGS

- Dyson, R. W., (1982) Speciality polymers Chapman and Hall publications.
- Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
- Sołoducho, J., & Cabaj, J. (2016). Conducting polymers in sensor design. Conducting Polymers. Rijeka: Intech, 27-48.
- Otero, T. F. (2016). Conducting Polymers: Bioinspired Intelligent Materials and Devices. Royal Society of Chemistry.
- Gupta, R. K. (Ed.). (2022). Conducting Polymers: Chemistries, Properties and Biomedical Applications. CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-7)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
BIO-BASED AND BIODEGRADABLE POLYMERS (DSE-07-BBP)	4	2	0	2	Passed 12Th with science	NIL

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- To gain knowledge of biopolymers and their isolations
- To acquire knowledge on structure and properties of biopolymers
- To understand the basic applications of various biopolymers

COURSE LEARNING OUTCOMES:

After studying this paper, students will be able to

- Gain knowledge of biopolymers applications
- Characterize and analyze biopolymers

SYLLABUS OF DSE-7

THEORY COMPONENT-

UNIT 1 (12 Hours)

BASICS TO BIOPOLYMERS & NATURAL MACROMOLECULES

Significance, classifications, properties and applications of biopolymers and natural polymers such as Starch, cellulose, chitosan, gelatine, protein, fatty acids, lipids, aliphatic polyesters (PLA, PHB), cellulose

UNIT 2

PROCESSING (8 Hours)

Isolation, processing of biopolymers: composite formation, blending and solvent casting

UNIT 3 (10 Hours)

APPLICATIONS

Applications of biopolymers in packaging, biomedical testing and devices, agriculture: soil conditioning and micro-nutrient delivery

PRACTICAL COMPONENT- (60 Hours

- To determine the molecular weight of biopolymers.
- Isolation of starch from wheat/rice/potato
- Isolation of gelatin from natural resources
- To prepare Poly lactic acid
- To prepare a chitosan based composite for biomedical applications.
- To prepare blends of natural polymers and find out miscibility
- Develop a biodegradable film by solution casting of biopolymers.
- Estimate the biodegradability by soil burial test.
- Evaluate swelling index, porosity, hardness of a film.
- Estimate the water vapor transmission rate of a biopolymeric film.

ESSENTIAL/RECOMMENDED READINGS

- Byrom D., (1991) Biomaterials: Novel Materials from Biological Sources, First Edition, Macmillan Publishers Ltd.
- Bastioli C., (1987) HandBook of Biodegradable polymers, Rapra Technology.
- Niaounakis M., (2015) Biopolymers: Processing and Products, First Edition, Elsevier Inc.

SUGGESTIVE READINGS

- Johnson R.M., Mwaikambo L.Y., Tucker N., (2003) Biopolymers, Rapra Technology.
- Pilla S., (2011) Hand Book of Bioplastics & Biocomposites for Engineering Applications, Wiley.
- Alexander S., (2003) Biopolymers, Vol. 1, Wiley.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SEMESTER -III
BSc. (Life Science) – Zoology Component

DISCIPLINE SPECIFIC CORE COURSE-9 (Zoo-LS-DSC-9):– Biochemistry: Basic concepts of

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical		
Biochemistry: Basic concepts of metabolism Zoo-LS-DSC-09	**04**	**02**	**00**	**02**	**Passed Class XII**	**NIL**

Learning Objectives

The learning objectives of this course are as follows:

- to learn and develop an understanding of the various metabolic pathways in humans.
- to acquire knowledge of the tissue specific metabolism and its regulation.
- to get acquainted with the concept of enzyme specificity for important metabolic pathways and how the body adjusts to variations in the demand for energy.

Learning Outcomes

By studying this course, students will be able to:

- better understand the properties of carbohydrates, proteins, lipids, and their importance in biological systems.
- explain the biological mechanisms, such as the processes and control of bioenergetics and metabolism, as chemical reactions
- comprehend the concept of enzyme, its mechanism of action and regulation.
- appreciate the importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and anaerobic conditions.
- acquire knowledge related to the role of TCA cycle in central carbon metabolism, importance of anaplerotic reactions and redox balance.

SYLLABUS OF DSC- 09

UNIT-1: Metabolism of Carbohydrates **8 hrs**

Basic structure and physiological significance of mono-saccharides, disaccharides, homo and hetero-polysaccharides. Glycolysis: Preparatory and Payoff phases, regulation, fates of pyruvate, Pentose phosphate pathway: oxidative and non-oxidative Phases; Gluconeogenesis: Bypass reactions, regulation and reciprocal coordination of glycolysis and gluconeogenesis; Glycogen Metabolism: Glycogenolysis, Glycogenesis and its coordinated regulation, Kreb's Cycle (formation of Acetyl CoA, reactions of cycle, regulation),

UNIT- 2: Lipid Metabolism **6 hrs**

Basic structure and physiological significance of fatty acids, structure and significance of storage and structural lipids; Biosynthesis: FAS and synthesis reactions, regulation; β oxidation of palmitic acid: activation of fatty acids and oxidation with bioenergetics, regulation.

UNIT- 3: Protein metabolism **6 hrs**

Structure, classification and properties of amino acids, basics of protein structure; Transamination, Deamination, Glutamine formation, Glucose alanine cycle and Urea Cycle

UNIT- 4: Enzyme **6 hrs**

Enzymes and their classification, Introduction (basics of classification, properties and functions), Mechanism of action (understanding of basic concepts, Induced Fit Theory).

UNIT- 5: Oxidative Phosphorylation **4 hrs**

Review of Electron Transport Chain: Basics of electron transfer reactions, Universal Electron Acceptors without detailed structures, electron flow through complexes, Chemiosmotic theory, basics of ATP synthesis.

Practical **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. Qualitative tests to identify functional groups of carbohydrates, amino acids and lipids.
2. Estimation of total protein in given solutions by Lowry's method.
3. Study effect of temperature, pH, and inhibitor on enzymatic activity of salivary amylase.
4. Biological oxidation of goat liver.
5. Identification of normal and abnormal constituents of urine.
6. To study the enzymatic activity of Lipase.
7. Dry Lab: To trace the labelled 'C' atoms of Acetyl-CoA till they evolve as CO_2 in the TCA cycle through models.

Essential/recommended readings

1. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman Company.
2. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well,, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

Suggestive readings

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9 th ed.). New York, WH: Freeman.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd.

SEMESTER -III
DEPARTMENT OF ZOOLOGY
Category I

(B.Sc. Honours in Zoology in three years)

DISCIPLINE SPECIFIC CORE COURSE -7 –:
Diversity of Chordates
Zoo-DSC-7

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Diversity of Chordates Zoo-DSC-7	04	02	Nil	02	Passed Class XII	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course aims to impart in-depth knowledge about the diverse life forms from the taxonomic positions of Protochordates and Agnatha to Mammalia.
- It will help the students to identify the body plan types of complex chordates and their systematic organization based on evolutionary relationships, structural and functional affinities.
- The course will help the students to understand the characteristic morphological, adaptive and anatomical features of diverse animals.
- The course will help students to understand the economic and ecological significance of various animals in human life.
- The course will create interest among them to explore and appreciate the animal diversity in nature.

Learning Outcomes

By studying this course, students will be able to

- Correlate the importance of systematics, taxonomy, and structural organization of chordates.
- Recognize the diversity of chordates living in varied ecological habitats.
- critically analyse the organization, complexity and characteristic features of chordates.
- comprehend the economic importance of chordates, their interaction with the

environment and their role in the ecosystem.

- enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.

SYLLABUS OF DSC-7

UNIT-I: Introduction to Chordates **2 hrs**

General characteristics and outline classification.

UNIT-2: Protochordata **3hrs**

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of Tornaria and Ascidian larval forms in protochordates.

UNIT-3: Origin of Chordates **2 hrs**

Theories of Origin of chordates with detailed concept of Dipleurula and the Echinoderm theory.

UNIT-4: Agnatha **2 hrs**

General characteristics and classification of cyclostomes up to Class.

UNIT- 5: Pisces

3 hrs

General characteristics of Chondrichthyes and Osteichthyes; Classification up to order; Osmoregulation; Swimbladder in fishes

UNIT- 6: Amphibia

4 hrs

General characteristics and classification up to order; Origin of Tetrapods (Evolution of terrestrial ectotherms); Parental care in Amphibians.

UNIT-7: Reptilia

4 hrs

General characteristics and classification up to order; Affinities and evolutionary significance of *Sphenodon*; Poison apparatus and biting mechanism in snakes.

UNIT- 8: Aves

4 hrs

General characteristics and classification up to order; Flight adaptations; Migration in birds.

UNIT- 9: Mammalia **4 hrs**

General characteristics and classification up to order; Adaptive radiation with reference to locomotory appendages.

UNIT- 10: Zoogeography **2 hrs**

Zoogeographical realms, Platetectonics and Continental drift theory.

Practical **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. **Protochordata**: *Balanoglossus, Herdmania, Branchiostoma,* Colonial Urochordata, Sections of *Balanoglossus* through proboscis and branchio-genital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania* spicules.
2. **Agnatha**: *Petromyzon, Myxine.*
3. **Pisces**: *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/Diodon, Anabas*, Flatfish. Permanent slides of Placoid and Cycloid Scales.
4. **Amphibia**: *Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra.*
5. **Reptilia**: *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus*; Key for Identification of poisonous and non-poisonous snakes.
6. **Aves**: Study of six common birds from different orders. Types of beaks and claws.
7. **Mammalia**: *Sorex,* Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes*, *Erinaceous.*
8. **Student Presentation**: Power point presentation on any two animals from two different classes.

**__Note__: Refer Young, J.Z. (2004) for the classification of Protochordates and Tetrapods, and Parker T.J. and Haswell W.A. (1972) for the classification of Agnatha and Pisces.*

Essential/recommended readings

1. Young, J.Z. (2004). **The Life of Vertebrates**. III Edition, Oxford University Press.

2. Parker T.J. and Haswell W.A. (1972).**Text book of Zoology Vertebrates**.VII Edition, Volume II.

Suggestive readings

1. Pough H. (2018). **Vertebrate Life**. X Edition, Pearson International.
2. Darlington P.J. (1966).**The Geographical Distribution of Animals**. R.E. Krieger Pub. Co.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE -8 – :
Biochemistry: Metabolic Processes
Zoo-DSC-8

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemistry: Metabolic Processes Zoo-DSC-8	04	02	Nil	02	Passed 12th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To provide fundamental and precise knowledge of the metabolic processes that play a crucial role in all processes of life and the development of diseases.
- To apprise the students of the various functions of the molecules like providing structural integrity to the tissue-engineered constructs.
- Through this course, the students would be able to understand myriads of health, potential treatments of diseases and solve several industrial problems
- The enzymatic study would enable them to understand the various metabolic pathways and physiological reactions.

Learning Outcomes

By studying this course, students will be able to

- Interpret the structure-functional relationships of carbohydrates, proteins, lipids and nucleic acids.
- Understand the clinical knowledge and importance of antioxidants.
- Understand the process of biological oxidation crucial to generation of energy for a living cell.
- Appreciate the action of various types of enzymes under variety of conditions.

Syllabus of DSC-8

UNIT- 1: Carbohydrate Metabolism **9 hrs**

Glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.

UNIT- 2: Lipid Metabolism **7 hrs**

β-oxidation and omega-oxidation of saturated fatty acids with even number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis.

UNIT- 3: Protein Metabolism 4 hrs

Catabolism of amino acids: Transamination, Deamination, Urea cycle.

UNIT- 4: Oxidative Phosphorylation 7 hrs

Redox systems; review of mitochondrial respiratory chain: electron carriers, sites of ATP production, Oxidative phosphorylation; Chemiosmotic hypothesis, mitochondrial shuttle system.

UNIT- 5: Liver as a Major Metabolic Hub 3 hrs

Inter-connection of glucose-6-phosphate, pyruvate and acetyl-CoA; fates of amino acids, fatty acids and glucose in liver cells; cascade of metabolic events in fasting and starvation.

Practical 60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT in serum/ tissue.
3. Estimation of GST and GSH in serum/ tissue.
4. To study the enzymatic activity of Lipase.
5. Study of biological oxidation (SDH) [goat liver].
6. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
7. Dry Lab: To trace the labelled 'C' atoms of Acetyl-CoA till they evolve as CO_2in the TCA cycle through models.

Essential/recommended readings

3. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman Company.
4. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

Suggestive readings

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.), NewYork,WH: Freeman.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd.

DISCIPLINE SPECIFIC CORE COURSE– 9:
Human Physiology- Life Sustaining Systems
Zoo-DSC-9

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Physiology- Life Sustaining Systems Zoo-DSC-9	04	02	Nil	02	Passed 12th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course will provide a thorough understanding of the normal body function and helps to determine the cause of disease.
- It will enable the development of new and more effective treatments and guidelines for maintaining good health.
- It will equip the students with an ability to pursue career in medical and healthcare sector, pharmaceuticals and other related areas.
- It will help in understanding how these systems interact among themselves to maintain stability or homeostasis.

Learning Outcomes

By studying this course, students will be able to:

- Appreciate human physiology and have its enhanced knowledge.
- Recognize and identify principal and physiology of digestion.
- Understand the functions of important physiological systems including the digestive, circulatory, renal and respiratory system.
- Learn an integrative approach to understand how these separate systems interact to yield integrated physiological responses to maintain homeostasis in the body along with feedback mechanisms.
- Amalgamate ideas to make the connection between knowledge of physiology and real-world situations, including healthy lifestyle decisions and problems faced due to homeostatic imbalances.
- Perform, analyze and report on experiments and observations in physiology.
- Know the fundamentals and understand advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue an advanced degree.

SYLLABUS OF DSC-9

UNIT- I Physiology of Digestion 7 hrs

Overview of gastrointestinal tract and its associated glands; digestion; Absorption of carbohydrates, lipids, proteins; Hormonal control of secretion of enzymes in gastrointestinal tract.

UNIT- 2 Blood 4 hrs

Structure and functions of haemoglobin; Blood clotting system, Fibrinolytic system.

UNIT- 3: Physiology of Heart 7 hrs

Structure of heart; Coronary circulation; Origin and conduction of cardiac impulses; Cardiac cycle; Cardiac output and its regulation; nervous and chemical regulation of heart rate.

UNIT- 4: Physiology of Respiration 6 hrs

Overview of respiratory system; Mechanism of respiration, Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Dissociation curves and the factors influencing it; regulation of respiration.

UNIT- 5: Renal Physiology 6 hrs

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance.

Practical 60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. To understand the components of blood, their functions and Hematopoiesis.
2. To study whole blood hemolysis with ammonium chloride solution.
3. Preparation of haemin and haemochromogen crystals.
4. Measurement and statistical analysis of variations observed in the student population in the class for the following parameters:
   a) White blood cells using haemocytometer
   b) Red blood cells using haemocytometer
   c) Hemoglobin
   d) Blood pressure
5. Examination of histological sections of mammalian oesophagus, stomach, duodenum, ileum, rectum, liver, trachea, lung, kidney.
6. Study of Electrocardiogram; Analysis of ECG records and calculation of heart rate.
7. Detection of abnormal constituents in urine and their physiological significance.

Essential/recommended readings

1. Tortora, G.J. and Derrickson, B.H. (2017). Principles of Anatomy and Physiology. XV Edition, John Wiley and Sons, Inc.
2. Ganong W.F. (2019). Review of Medical Physiology 26th ed. Mc Graw-Hill.
3. Widmaier E, Raff H and Strang K. (2013) Vander’s Human Physiology: The Mechanism of Body Functions. XIII Edition, McGraw-Hill Education.
4. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
5. Eroschenko, Victor P. (2012) Di Fiore's Atlas of Histology with Functional Correlations; 12th edition, CBS Publishers and Distributors Pvt. Ltd.

Suggestive readings

1. Chatterjee, C.C. (2021) Human Physiology, 14th Edition, Volume 1 & Volume II, CBS Publishers and Distributors Pvt. Ltd.
2. Vander A, Sherman J, and Luciano D (2014). Vander's Human Physiology

POOL OF DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES

DISCIPLINE SPECIFIC ELECTIVES (DSE-1): Aquatic Biology
Zoo-DSE-1

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Aquatic Biology Zoo-DSE-1	04	03	00	01	Passed 12th Class	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- This course offers a comprehensive knowledge on life in freshwater and marine environments; lakes; stream and their characteristics, adaptations of organisms, water resource management; nutrient cycling; major threats to aquatic systems, pollution and eutrophication.
- To impart knowledge and understanding of basic laboratory equipment and practice of water quality analysis, to study of aquatic plants.
- To introduce various freshwater and marine ecosystems and its components.
- To understand the biodiversity and productivity of freshwater and marine environments.
- To impart knowledge on various threats and conservation strategies.

Learning Outcomes

By studying this course, students will be able to

- Be acquainted with the physico-chemical environment, and its role in aquatic ecosystem.
- Learn about adaptations unveiled by organisms to survive in these distinctive conditions.
- well-versed with the laws governing the use of freshwater systems, as well as the local, state, federal, and international agencies that enforce these laws to protect endangered and vulnerable species.
- Understand and apply relevant scientific principles in the area of aquatic biology and educate others or work to conserve our natural resources.
- Realize impact of human activities on aquatic organisms.

SYLLABUS OF DSE-1

UNIT-I: Aquatic Biomes **6 hrs**

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), Estuaries, Intertidal zones, Oceanic pelagic zone, Marine benthic zone and Coral reefs.

UNIT-2: Lakes **9 hrs**

Lakes: Origin and classification (Glacial, Tectonic, Volcanic and Fluvial Lakes), Lake as an Ecosystem, Lake morphometry, Physico–Chemical Characteristics: Thermal stratification, Vertical distribution of oxygen in lakes, Dissolved Nitrates and Phosphates, Turbidity.

UNIT- 3: Streams and Rivers **9 hrs**

Streams: Different stages of stream development, Physico-chemical environment, Stream flora and fauna. Adaptations of hill stream fishes. Rivers: Origin and characteristics of river. Functions. Concept of watershed management. Ramsar Convention.

UNIT-4: Marine Biology **12 hrs**

Continental shelf, Salinity and density of sea water, Light attenuation in water: Photic, dysphotic and aphotic zones. Adaptations of deep-sea organisms. Marine mammals and their adaptations. Coral reefs: Formation, distribution, fauna and effect of climate change. Physico-chemical characteristics of estuaries, estuarine ecosystem.

UNIT-5: Management of Aquatic Resources **9 hrs**

Major threats to freshwater systems, including pollution and sand mining. Impact of large dams and fragmentation on river ecology and fishery. Thermal pollution and oil spills; Sewage treatment, Water quality assessment- BOD and COD.

Practical **30 hrs**

(Laboratory periods: 15 classes of 2 hours each)

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identification of following present in a lake ecosystem (3-5 each):
   a) Macrophytes
   b) Phytoplankton
   c) Zooplankton

3. Estimation of pH, dissolved oxygen, alkalinity, free carbondioxide, carbonates and bicarbonates in water collected from a nearby lake/ water body.

4. Estimation of Biochemical oxygen demand of water sample.
5. To demonstrate the following instruments used in limnology and discuss its significance:
   a) Secchi disc
   b) Van Dorn Bottle
   c) Conductivity meter
   d) Turbidity meter
   e) PONAR grab sampler
6. Project Report on a visit to a Sewage treatment plant/Freshwater ecosystem (wetland, lake, river side etc.)/Marine bio-reserve/Fisheries Institutes.

Essential/recommended readings

1. Sullivan O.P. and Reynolds C.S. (2004) The lakes hand book, Limnology and limnetic ecology. Wiley Blockwell.
2. Brian R. Moss (2018) Ecology of Freshwaters: Earth's Blood stream (5thedition). Wiley.
3. Dodds W.K. and Whiles M.R. (2019). Freshwater Ecology: Concepts and Environmental Applications of Limnology (3rd edition). Academic Press.
4. Barrick, M., Odum, E.P., Barrett, G.W., (2005). Fundamentals of Ecology. 5thEdition. Cengage Learning.

Suggested readings:

1. Robert G. Wetzel. (2001)Limnology: Lake and River Ecosystems. 3rdedition.
2. Castro and Huber. MarineBiology.11th Edition, Mc Graw and Hill.

DISCIPLINE SPECIFIC ELECTIVES (DSE-2): Agrochemicals & Pest Management
Zoo-DSE-2

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Agrochemicals & Pest Management Zoo-DSE-2	04	03	00	01	Passed 12^{th} Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- This course offers an insight about the role of insects as powerful competitors of man as they cause enormous injury to crops and animals and also act as vectors of many diseases.
- To impart knowledge about various types of pests, their distinguishing features, life cycle, symptoms of infestation and/or damage to crops and human health.
- This course will help the students to understand the concept of insect pests and their population dynamics in relation to changing environmental conditions.
- The students will learn about the various methods used in pest management with *pros* and *cons* of each, and how they could be integrated for effective, economical and eco-friendly pest management programs (IPM).
- To enthuse the students to become entomologists.

Learning Outcomes

By studying this course, students will be able to:

- create awareness about adverse effects of insecticides on the environment and the need for an environment-friendly approach to the management of insect pests.
- gain knowledge about the concepts and tools of pest management.
- Understand the planning of agricultural ecosystem, tolerance of pest damage, and timing of different pest control tactics to effectively manage the pest population.
- learn about the use of different pest control techniques in a harmonious manner.
- understand the role of IPM in sustainable agriculture as the future of modern plant protection and pest control strategy.

SYLLABUS OF DSE-2

UNIT- I: Diversity of insects **6 hrs**

Salient features of insects and reasons for their diversity; Outlines of insect classification up to orders. Significance of insects in the ecosystem.

UNIT-2: Insect morphology and development **9 hrs**

Overview of insect morphology: Distinction between prognathous, hypognathous and opisthognathous head, types of antennae, mouth parts and legs. Insect development and types of metamorphosis.

UNIT-3: Insect crop pests and their management **12 hrs**

Introduction to different types of pests and their status, Factors responsible for emergence of pest, Pest population dynamics.

Bionomics and Control of Crop pests: *Leptocorisa acuta*, *Sesamia inferens*, *Helicoverpa armigera*, *Pyrilla perpusilla*, *Earias vitella*, *Raphidopalpa faveicollis, Papilio demoleus.*

Bionomics and strategies for the management of stored grain pests: *Sitophilus oryzae, Callosobruchus chinensis, Trogoderma granarium* and *Corcyra cephalonica*.

UNIT-4: Medically Important and Household Pests **6 hrs**

Bionomics and management of cockroach, rat flea, mosquitoes, house fly, sand fly, human louse and termites.

UNIT-5: Insect Pest Management **12 hrs**

Overview of pest management tactics: physical, mechanical, cultural, biological, microbial, botanical and genetic control (SIT/SIRM).

Chemical control: Chlorinated hydrocarbons (BHC, Aldrin) organophosphates (Malathion Parathion), carbamates (Carbaryl, Propoxur) and synthetic pyrethroids (Allethrin and Cypermethrin).

Integrated pest management (IPM): Definition, principle, components of IPM and advantages.

Practical **30 hrs**

(Laboratory periods: 15 classes of 2 hours each)

1. Study of the morphology of insects with the help of museum specimens/ slides/ photographs: types of antennae, mouthparts, and legs of insects.
2. Study of two economically important insects representing different orders: Dictyoptera, Hemiptera, Orthoptera, Isoptera, Anoplura (Siphunculata), Diptera, Coleoptera, Hymenoptera and Lepidoptera.
3. Elementary knowledge of collection, preservation and rearing techniques of

insects: Submission of life cycle stages of any two insect pests.

4. Determination of LD_{50}/ LC_{50} of insecticides based on the data provided.
5. Study of Instruments used for chemical control through specimens/videos/photographs.
6. Submission of report based on field trips to entomological institutes, museums, laboratories.

Essential/recommended readings

1. Borror, D.J., Triplehorn, C.A., and Johnson, N.F. (2005) Introduction to the Study of Insects. M Saunders College Publication, USA.
2. Chapman, R.F. (1998) The Insects: Structure and Function. Cambridge University Press, UK.
3. Imms, A. D. (1923) A General Text Book of Entomology. Chapman &Hall, UK.
4. Snodgrass, R. E. (1935) Principles of Insect Morphology. Cornell Univ. Press, USA.
5. Dennis, S. Hill. (2005) Agricultural Insect Pests of the Tropics and Their Management. Cambridge University Press.
6. David, B. V. and Ananthakrishnan, T.N. (2004) General and Applied Entomology. Tata-McGraw Hill, New Delhi.

Suggested readings

1. Duntson, P.A. (2004) The Insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.
2. Atwal, A.S. (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, New Delhi.
3. Wigglesworth, V.B. (1984) Insect Physiology. VIII Edition, Chapman & Hall, New York.

DISCIPLINE SPECIFIC ELECTIVES (DSE-3): Medical Zoology
Zoo-DSE-3

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Medical Zoology Zoo-DSE-3	04	03	00	01	Passed 12th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- This course offers an insight about the various types of human diseases.
- The students will understand the concepts of pathogenic and pathological basis of diseases including infectious diseases caused by viruses, prokaryotes, protozoans, helminthes, vector borne and zoonotic diseases.
- Learn about nutritional deficiencies and lifestyle diseases, endocrine diseases and cancer.

Learning Outcomes

By studying this course, students will be able to:

- understand various types of human diseases.
- clarify the concepts of pathogenic and pathological basis of diseases.
- Recognize deficiencies and lifestyle diseases, endocrine diseases and cancer.
- broaden the understanding of medical importance of studying Zoology.

SYLLABUS OF DSE-3

UNIT-1: Introduction to Infectious diseases **6 hrs**

Concept of Epidemiology, Incidence, Prevalence, Virulence, Pathogenicity, Transmission, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis.

UNIT- 2: Transmission, prevention and control of Viral infection **6 hrs**

Dengue, Polio, Measles, Mumps, influenza, SARS, HIV.

UNIT-3: Bacterial infections **6 hrs**

Tetanus, Diphtheria, Tuberculosis, Typhoid, Cholera; brief account of *Rickettsia, Borellia, Treponema* and *Leptospira*.

UNIT- 4 Protozoan and Helminthic infection **6 hrs**

Life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax, Trypanosoma gambiense; Wuchereria bancrofti, Faciolopsis buski, Ancylostoma duodenale.*

UNIT-5: Nutritional deficiency and lifestyle-based diseases. 6 hrs

Kwashiorkar, Marasmus, Beri-beri, Scurvy, Pellagra, Anaemia, Night blindness, Rickets, Osteoporosis, Obesity, Cardiovascular diseases (CVD), Atherosclerosis, Diabetes mellitus, Inflammatory Bowel Disease (IBD).

UNIT-6: Endocrine Diseases 9 hrs

Hormonal imbalances leading to diseases: Diabetes insipidus, Acromegaly, Gigantism, Dwarfism, Goitre, Cretinism, Cushing and Crohn’s syndrome, Addison’s disease.

UNIT-7: Cancer 6 hrs

Definitions, Nomenclature, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, invasion and metastasis, carcinogens and cancer.

Practical 30 hrs

(Laboratory periods: 15 classes of 2 hours each)

1. Study of Disease specific bacteria and viruses through pictures/micrographs/Videos.
2. Performing of gram staining and study of Acid Fast staining through permanent slides.
3. Urine analysis for abnormal constituents: protein, blood, bile salts and glucose.
4. Study of arthropod vectors associated with human diseases: *Anopheles, Aedes, Culex, Phlebotomus, Xenopsylla*.
5. Study of permanent slides and specimens of *Plasmodium sp, Entamoeba histolytica, Trypanosoma gambiense, Schistosoma haematobium* and *Wuchereria bancrofti.*
6. Study of endocrine diseases through case studies (any 2).
7. Identification and study of cancer cells- Slides/Photomicrographs/Videos.
8. Project work/report: field visit to a research institute/laboratory to study some of the pathological and diagnostic techniques.

Essential/recommended readings

1. Park, K. (2017) Textbook of Preventive and social medicine. 23rd Edition. B.B Publisher.
2. Robbins, Basic Pathology, 9th edition (2012), Kumar, Abbas, Fausto and Mitchell; Saunders Publication, ISBN-13: 978-1437717815
3. Ramnik. Sood (2009) Medical Laboratory Technology Methods and Interpretations, 6th edition; Jaypee Brothers Medical Publishers, ISBN-13: 978-8184484496.

Suggested readings

1. Robbins and Cotran. Pathologic Basis of Disease, 8th edition (2009), Vinay Kumar, Abul. K. Abbas, Jon C. Aster, Nelson Fausto; Saunders Publishers, ISBN-13: 978-1416031215
2. Arora, D.R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications

DISCIPLINE SPECIFIC ELECTIVES (DSE-4): Wildlife Conservation & Management
Zoo-DSE-4

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITESOF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Wildlife Conservation &Management Zoo-DSE-4	04	03	00	01	Passed 12th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To acquaint the students with varied aspects of wildlife conservation, including its importance, major threats, and management of their habitats and populations.
- The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation.
- The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals.
- To motivate students to pursue a career in the field of wildlife conservation and management.

Learning Outcomes

By studying this course, students will be able to:

- Appreciate wildlife in general and realize its conservation and management in particular.
- Better understand the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their habitats.
- Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration.
- comprehend the key factors for loss of wildlife and important strategies for their in situ and ex situ conservation.
- recognize the techniques for estimation, remote sensing and Global Position Tracking for wildlife.
- gain knowledge about the wildlife diseases and the quarantine policies.
- know about the Protected Area Networks and Ecotourism in India.
- Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife.

SYLLABUS OF DSE-4

UNIT-1: Introduction to Wildlife **3 hrs**

Values of wildlife - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion.

UNIT-2: Evaluation and Management of Wildlife **9 hrs**

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage; Standard evaluation procedures: Bio-telemetry, Remotesensing and GIS.

UNIT- 3: Management of Habitats **9 hrs**

Setting back succession: Grazing, prescribed fire, mechanical treatment and selective herbicide application; Advancing the successional process and cover construction; Preservation of genetic diversity; Restoration of degraded habitats.

UNIT- 4: Population Estimation **6 hrs**

Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation and hair identification; Pug marks and census methods.

UNIT- 5: Wildlife Health and Rehabilitation **9 hrs**

Care of injured and diseased animal; Quarantine; Common diseases of wild animals: Zoonosis (*Ebola* and S*almonella*), Rabies, Foot and Mouth Disease, *Mycobacterium* TB, Bovine and Avian Flu (Any 3 in detail).

UNIT- 6: Protected Areas and their management **9 hrs**

National parks and Sanctuaries; Biosphere reserves; Conservation and Community reserve; Important features of Protected Areas in India; Project Tiger- conservation and management challenges in Tiger reserves; Human-wildlife conflict; Eco-tourism.

Practical **30 hrs**

(Laboratory periods: 15 classes of 2 hours each)

1. Demonstration of basic equipment needed in wildlife studies- use, care and maintenance (Compass, Binoculars, Spottings cope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
2. Familiarization and study of animal evidences in the field: Identification of animals through pugmarks, hoof marks and scats.
3. Trail/ transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
4. Identification of Big cats: Lion, Tiger, Cheetah, Leopard and Jaguar.
5. Project Report: Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a National Park/Wildlife

Sanctuary/Biodiversity Park or any other wildlife conservation site.

Essential/recommended readings:

1. Hudson, P.J., Rizzoli, A., Grenfell, B.T. Heestrbeek, H. and Dobson, A.P. (2002) The Ecology of Wildlife Diseases. Oxford University Press, Oxford.
2. Banerjee, K. (2002) Biodiversity Conservation in Managed and Protected Areas. Agrobios, India.
3. Kenneth Anderson (2000) The Kenneth Anderson Omnibus Vol I. Rupa Publications.
4. Jim Corbett. (2017) Man Eaters of Kumaon. Om Books International.
5. Saha, G.K. and Mazumdar, S. (2017) Wildlife Biology: An Indian Perspective. PH Ilearning Pvt. Ltd. ISBN: 8120353137, 978-812035313.
6. Sinclair, A.R.E., Fryxell, J.M. and Caughley, G. (2006) Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
7. Singh, S.K. (2005) Text Book of Wildlife Management. IBDC, Lucknow.

Suggested readings:

1. Primack, R.B. (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
2. Hossetti, B.B. (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.
3. Sharma, B.D. (1999) Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVES (GE-5): Food, Nutrition & Health
Zoo-GE-5

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Food Nutrition & Health Zoo-GE-5	04	02	00	02	Passed 12^{th} Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- This course offers an overview of the concepts of normal food and nutrition required by the human body to maintain good health.
- To understand physiology, biochemistry, pathology, immunology, medicine, food science, and other fields with context to nutrition.
- Learn the concept of malnutrition, lifestyle-related disorders, addiction-related social health problems and eating disorders will be introduced.
- Appreciate knowledge that can be applied in everyday life.
- Learn the role of macronutrients and micronutrients, their nutritional requirements for different age groups during various health conditions.
- The students will be encouraged to pursue further studies in nutrition and health.

Learning Outcomes

By studying this course, students will be able to

- have an in-depth understanding of the dietary sources and role of nutrients in forming a balanced diet.
- appreciate the concept of nutritional requirements for different age groups and in pregnancy and lactation.
- know about the various food allergens and the body's hypersensitivity towards it.
- understand the concept of health and role of various nutrients in mitigating several deficiency disorders.
- identify and analyse the causes of malnutrition, lifestyle-related disorders, addiction-related social health problems and eating disorders.

- appreciate the various techniques from identification of adulterants, estimation of essential nutrients in food products, to measurement of vital anthropometric indicators of health, as widely used by practitioners.

SYLLABUS OF GE-5

UNIT-1: Basic concept of food and nutrition **2 hrs**

Components of nutrients (Macronutrients and Micronutrients).

UNIT-2: Dietary sources and physiological functions **6 hrs**

Carbohydrates, Proteins, Lipids Vitamins and Minerals (Iron, Iodine, Calcium, Selenium, Zinc); beneficial effects of dietary fibres; elementary idea of Probiotics, Prebiotics, Organic Food.

UNIT-3: Nutritional requirements **4 hrs**

Study of different age groups (infants, preschool children, school children, adolescents, adults, elderly) and in pregnant women and lactating mother.

UNIT-4: Concept of a balanced diet **4 hrs**

Food groups, Food Pyramid, Food and Culture; Food Hypersensitivity: Food allergy (nuts and seafood) and Food intolerance (lactose and gluten).

UNIT-5: Health **2 hrs**

Definition and concept of health. Indicators of metabolic health.

UNIT-6: Nutritional deficiencies and disorders **9 hrs**

Symptoms and prevention of the following: Protein Energy Malnutrition (Kwashiorkor and Marasmus), Vitamin deficiency (A, D, B1, B3 B12, C) Mineral deficiency (Iron, Iodine, Calcium, Selenium, Zinc).

Lifestyle-related diseases: Causes, Symptoms and Complications of Hypertension, Diabetes mellitus and Obesity. Role of dietary and lifestyle modifications for the prevention of these diseases.

Eating Disorders: Complications and Management of Anorexia nervosa and Bulimia nervosa.

UNIT-7: Social health problems **3 hrs**

Deleterious effects of addiction-related social health problems: Smoking, alcoholism, and drug dependence.

Practical **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. To detect adulteration in (a) Ghee (b) Sugar (c) Tea Leaves (d) Turmeric.
2. Study of nutrition labelling of any 5 popular packaged foods.
3. Study and comparison of food pyramids of any 3 popular diet trends with focus on their pros and cons.
4. Ascorbic acid estimation in food by titrimetry.
5. Estimation of calcium in food by titrimetry.
6. Measurement of anthropometric indicators of health (BMI, Waist to hip ratio, Skin fold test).
7. Plan the diet chart of any three different age groups using RDA values (infants, preschool children, school children, adolescents, adults and elderly).
8. An exercise based on 24-hour food recall of students for quantification and analysis of the macronutrients' and micronutrients' uptake based on the current RDA values (with focus on nutritional status and risk factors).
9. Project Work on the Indian government initiatives focused on nourishment of school children/ expectant mothers.

   OR

   A small-scale questionnaire-based survey on the knowledge and usage of available resources for quitting smoking and its success/relapse rates.

Essential/recommended readings

1. Gibney MJ et al (2009) Introduction to Human Nutrition, 2nd edition, Wiley-Blackwell, Hoboken
2. ICMR-NIN (2020) Expert Group on Nutrient Requirement for Indians, Recommended Dietary Allowances (RDA) and Estimated Average Requirement (EAR)
3. Elia M et al (2013) Clinical Nutrition, 2nd edition, Wiley-Blackwell, Hoboken

Suggested readings:

1. Mann J and Truswell AS (2017) Essentials of Human Nutrition, 5th edition, Oxford University Press. Oxford
2. Kaveri Chakrabarty and A.S. Chakrabarty (2020) Textbook of Nutrition in Health and Disease, 1st edition, Springer Nature Singapore Pte Ltd

GENERIC ELECTIVES (GE-6): Introduction to Biology
Zoo-GE-6

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Introduction to Biology Zoo-GE-6	04	02	00	02	Passed 12th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course is designed to acquaint students with the basic concepts of modern biology including processes in cell biology, genetics and variation, process of evolution and also the physic chemical aspects of life.
- It emphasizes on exploring different techniques, perspectives in the fields of biology from microscopy to computational biology.
- The course has been designed keeping in mind the fact that biology helps to understand ourselves and our place and role in the living world.
- It will motivate the students to pursue careers in the field of technology.

Learning Outcomes

By studying this course, students will be able to

- learn the importance of Biology in everyday life, understand the conditions and processes that led to biochemical origin of life on earth.
- compare and contrast evolutionary theory and their application to populations.
- appreciate the different cell types and cellular processes.
- know the basic structure and functioning of cell such as division, processes of information transfer from DNA to proteins.
- have an in-depth understanding of the role and importance various biomolecules like nucleic acids, proteins, lipids and carbohydrates.
- demonstrate practical knowledge of using basic laboratory instrumentation such as microscopes, micropipettes and their applications.
- learn the diverse techniques taught in practical like chromatography, biochemical test, spectrophotometric analysis and also computational biology will hone their analytical skills.

SYLLABUS OF GE-6

UNIT-1: Introduction to concepts of biology **2 hrs**

Themes in the study of biology; a closer look at ecosystem; a closer look at cell; process of science, biology and everyday life.

UNIT-2: Evolutionary history of biological diversity **4 hrs**

Early earth and the origin of life; major events in the history of life; classifying the diversity of various Kingdoms of Life.

UNIT-3: Darwinian view of life and origin of species **9 hrs**

Darwin's theory of evolution; evolution of populations (Hardy-Weinberg principle); Concepts of species; mechanism of speciation.

UNIT-4: Genetic approach to Biology **7 hrs**

Cell and organelles; cell cycle: Mitosis and meiosis; Mendel's laws and variations; model organisms for the genetic analysis.

UNIT-5: Chemical context of living systems **8 hrs**

Structure and function of biomolecules: carbohydrate, protein, lipid, and nucleic acid.

Practical **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. To learn use of microscope and other common instruments used in laboratory.
2. Preparation of normal, molar, and standard solutions, phosphate buffers.
3. Separation of amino acids (*any three*) by paper chromatography.
4. To perform gram staining of bacteria.
5. To prepare temporary mount of human cheek epithelial cells and to study its characteristics.
6. To perform quantitative estimation of protein using the Lowry's method.
7. To perform biochemical test and identify two functional groups of carbohydrates.
8. To retrieve sequence from database and perform Multiple Sequence Alignment.
9. Visit to a cell culture and tissue culture facility and submission of project report.

Essential/recommended readings

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P. Hetal (2006) Biology 7th edition Tata McGraw Hill Publications, New Delhi

3. Karp, G. (2010). Cell & Molecular Biology: Concepts & Experiments. VI edition, John Wiley& Sons Inc.

4. De Roberties, E.D.P. & De Roberties. E.M.F. (2009). The cell & Molecular Biology, Lippincott Williams, Wilkins, Philadelphia.
5. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition, John Wiley & Sons Inc.

Suggestive readings

1. Sheeler, P and Bianchi, D.E. (2006). Cell and Molecular Biology, 3rd edition, John Wiley & sons NY.
2. Rideley, M. (2004). Evolution. III Edition, Blackwell publishing.

GENERIC ELECTIVES (GE-7): Water-borne Diseases: Understanding and Management
Zoo-GE-7

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Water-borne Diseases: Understanding and Management Zoo-GE-7	04	02	00	02	Passed 12th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- It deals with interactions between microbial water quality and human health.
- It includes appreciating how the quality of water can be affected by natural, seasonal, accidental, intentional, and man-made activities,
- It will help the students learn how the contaminated water increases the burden of human diseases with particular emphasis on infectious diseases,
- It will help understand the environmental pressures caused by contaminated water and how it drives the emergence and re-emergence of infectious diseases with increased/altered virulence, antibiotic resistance.
- It will motivate students to pursue a career in Health Management

Learning Outcomes

By studying this course, students will be able to

- know the sources of microbial water contamination and its impact on human health.
- understand the relationship between human behaviour and water quality.
- learn remediation strategies for several types of microbial water quality contamination.
- understand epidemiological studies related to water quality and public health.
- be able to grasp the concepts of various water sources and transmission mechanisms of infectious agents from those sources to humans.
- organize and present well-synthesized scientific discussions on topics relevant to waterborne disease and public health.
- develop a critical understanding of the contribution of organisms tothe welfare of society.

- examine the multiple water-borne pathogens, their modes of transport and transmission, their public health effects, and existing methods for disease prevention and remediation.

SYLLABUS OF GE-7

UNIT-1: Introduction to Public Health **4 hrs**

Definition, scope, concept, and importance of public health microbiology; Roles of microbiologists in public health; Concept of health and disease; Indicators of health; Basic concept of water pollution and public health hazard in the community.

UNIT- 2: Introduction to Water Quality **8 hrs**

Common terms and definitions in water quality, aquatic resources of the world and sources of drinking water; Water, sanitation, and hygiene (WASH) – fact sheets, WHO guidelines and resolutions; common contaminants of drinking water and linkages to disease; Water pollution (water quality properties, types of water pollution, point and non-point sources of water pollution); Types of contaminants influencing water quality; Water Treatment, Control of Water Borne Diseases.

UNIT- 3: Microbiology of Water **3 hrs**

Microbiological quality of drinking; water as a causing factor of infectious diseases; water-borne pathogens (types, sources, and transmission); microbial testing of Water; monitoring and surveillance of water quality.

UNIT- 4: Water-Borne Diseases **10 hrs**

Source of infection, transmission, symptoms, mitigation, prevention and treatment (with reference to the role of agencies/NGO).

-Bacterial infections- Cholera, Typhoid fever, Botulism, *E. coli* infection, Campylobacteriosis, Dysentery, Typhoid fever.

-Viral infections: Rotavirus, Hepatitis A and E, Poliomyelitis, Polyomavirus infection.

-Protozoal infections: Acanthamoeba keratitis, Amoebiasis, Cryptosporidiosis, Cyclosporiasis, Giardiasis.

- Parasitic worms: Schistosomiasis, Fascioliasis, Strongyloidiasis, Hookworm infections, Giardiasis.

-Vector-borne infections: Malaria, Dengue, Chikungunya, Onchocerciasis, Leishmaniasis, Japanese encephalitis, Dracunculiasis, Lymphatic filariasis,

UNIT- 5: Waterborne Pathogens: Detection Methods **5 hrs**

Polymerase chain reaction (PCR) -Multiplex PCR; Quantitative PCR (qPCR), Real-time PCR; Microarrays; Pyro-sequencing; Biosensors; Fluorescence *in situ* hybridization

(FISH); Immunology-based methods.

Practical (60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. To determine dissolved oxygen in water samples collected from different water bodies by Winkler's Method.
2. To determine temperature, pH, conductivity, total solids, and total dissolved solids in water samples from different locations.
3. To measure the COD of water samples from various sources.
4. Isolation and identification of microorganisms from different water samples.
5. Project report on water quality monitoring system.
6. Visit to WASH Institute (Water Sanitation and Hygiene Institute)/ Shri Ram Institute for Industrial Research.

Essential/recommended readings

1. Aquatic Pollution: An Introductory Text, 3rd Edition, Edward A. Laws, ISBN 9780471348757.
2. Waterborne Disease, 1st edition (January 15, 1997), Paul Hunter, ISBN 0125515707.

Suggestive readings

1. Microbiology of Waterborne Diseases, Steven Percival, Rachel Chalmers, Martha Embrey, Paul Hunter, Jane Sellwood and Peter Wyn-Jones, ISBN 978012551570-2.

DEPARTMENT OF BOTANY
B.Sc. (H) Botany
Category-I

DISCIPLINE SPECIFIC CORE COURSE - 7: Phycology - The World of Algae

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Phycology - The World of Algae DSC-7	4	**2**	**0**	**2**	Class XII pass	Nil

Learning Objective:
To provide students with in-depth knowledge of the unique group of algae that are the primary photosynthetic organisms.

Learning Outcomes:

By studying this course students will gain basic knowledge on algae, with reference to:
- the diversity and general characteristics.
- distinguishing features of taxa belonging to different families.
- the various ecological and economic benefits.

Unit 1: Introduction to Algal World **6 hours**
Relevance of studying algae – Industrial (food, feed, fodder), Environmental (climate change, biofuel, acidification of oceans), Evolutionary (range of thallus organization); General characteristics; Ecology, diversity and distribution; Range of thallus organization; Cell structure; Criteria for classification (cell wall, pigment system, reserve food, flagella); Reproduction and life cycle patterns; Classification by Fritsch; Evolutionary classification of Lee (only up to groups); Significant contributions of eminent Phycologists.

Unit 2: Cyanophyceae (Blue-Green Algae) **3 hours**
General characteristics; Occurrence; Cell structure; Heterocyst (structure and function); Morphology, reproduction and life-cycle of *Nostoc*, economic importance.

Unit 3: Chlorophyceae (Green Algae) **6 hours**
General characteristics; Occurrence; Cell structure; Morphology, reproduction and life-cycle of *Chlamydomonas*, *Volvox*, *Chlorella, Ulva*, *Oedogonium*, *Coleochaete*; *Chara*; Structure and evolutionary significance of *Prochloron*, economic importance.

Unit 4: Xanthophyceae (Yellow-Green Algae) **2 hours**
General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Vaucheria*, economic importance.

Unit 5: Bacillariophyceae (Diatoms) and Dinophyceae (Dinoflagellates) **3 hours**

General characteristics, Occurrence, morphology, unique features, economic importance.

Unit 6: Phaeophyceae (Brown Algae) **4 hours**
General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Ectocarpus* and *Sargassum*, economic importance.

Unit 7: Rhodophyceae (Red Algae) **4 hours**
General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Gracilaria*, economic importance.

Unit 8: Recent advances in algal studies **2 hours**
Model systems and their applications in genetic, molecular and evolutionary studies.

Practicals **60 hours**

1. Study of algal diversity in different habitats through botanical excursion and submission of digital catalogue/report of various species observed.
2. ***Nostoc***: Study of vegetative, reproductive structures from temporary mounts and permanent slides; Ultrastructure of Heterocyst through Electron Micrographs.
3. ***Chlorella***: Study of vegetative, reproductive structures from temporary mounts. Study of ultrastructure through Electron Micrographs.
4. ***Volvox***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
5. ***Oedogonium***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
6. ***Coleochaete***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
7. ***Chara***: Study of vegetative, reproductive structures from temporary mounts, specimens and permanent slides.
8. ***Vaucheria***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
9. **Diatoms** and **Dinoflagellates**: Study vegetative, reproductive structures of at least two taxa from water bodies.
10. ***Ectocarpus***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
11. ***Sargassum***: Study of vegetative, reproductive structures from temporary mounts, specimens and permanent slides.
12. ***Polysiphonia/ Gracilaria***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.

Suggested Readings:

1. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae: Structure and Reproduction, 2nd edition. Prentice-Hall International INC.
2. Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Affiliated East-West Press, New Delhi.
3. Lee, R.E. (2018). Phycology, 4th edition: Cambridge University Press, Cambridge.
4. Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer, Dordrecht.
5. Sahoo, D. (2000).Farming the Ocean: Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.

Additional Resources:

1. Van den Hoek, C., Mann, D.G., Jahans H.M. (1995). Algae: An Introduction to Phycology. Cambridge University Press.
2. Sharma, O.P. (2011). Algae. Tata Mc Graw Hill Education Private Limited, New Delhi.
3. Smith, G.M. (1955). Cryptogamic Botany. Vol.1.Algae and Fungi. McGraw-Hill Book Company, New York.
4. Vashishta, B.R., Singh, V.P. and Sinha, A.K. (2012). Botany for Degree Students: Algae. S Chand Publishing, New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 8: Bryophytes, Pteridophytes and Gymnosperms

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Bryophytes, Pteridophytes and Gymnosperms DSC – 8	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:

- Provide a deep understanding of morphology, anatomy, reproduction and developmental biology of these unique groups of non-flowering plants.
- Enhance understanding of diversity, economic value, taxonomy in representative members of phylogenetically important groups.

Learning Outcomes:

At the end of this course students will be able to:

- identify and describe the group of plants that have given rise to land habit and the flowering plants.
- comprehend various phenological stages of the plants belonging to the sub-groups – bryophytes, pteridophytes and gymnosperms.

Unit 1: Bryophytes **9 hours**

Origin of bryophytes through green algal ancestor; Morphology and Reproduction of *Marchantia*, *Anthoceros* and *Funaria* with fertilization & spore dispersal mechanism (excluding developmental stages). Progressive sterilization of sporogenous tissue; Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit 2: Pteridophytes **9 hours**

Fossil pteridophytes (*Rhynia*). Morphology and Reproduction *of Selaginella*, *Equisetum* and *Pteris* (excluding developmental stages). Apogamy and apospory; Heterospory and seed habit; Stelar evolution. Economic importance.

Unit 3: Gymnosperms **9 hours**

Morphology, Sstem anatomy (significance of transfusion tissue) and Reproduction of *Cycas*, *Pinus* and *Gnetum*(excluding developmental stages and secondary growth). Economic importance.

Unit 4: Recent Advances **3 hours**

Model systems (*Physcomitrella*, *Ceratopteris*, *Ephedra*) and their applications in genetic, molecular and evolutionary studies.

Practicals: **60 hours**

1. *Riccia* – Morphology: Vegetative and reproductive structures (Specimen).

2. *Marchantia* - Morphology; V.S. of thallus through Gemma cup, whole mount of Gemmae (temporary slides); V.S. of Vegetative thallus, Antheridiophore, Archegoniophore, L.S. of Sporophyte (permanent slides).

3. *Pellia* - Morphological details through specimens/permanent slides; L.S. Sporophyte (permanent slide).

4. *Porella* - Vegetative Morphological details through specimens/permanent slides.

5. *Anthoceros* – Morphology; Dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), V.S. of thallus (permanent slide).

6. *Funaria* - Morphology; T.S. Stem (temporary and permanent slides both); Sporophyte: operculum, peristome, spores (temporary slides); Antheridial and archegonial heads, L.S. of capsule, W.M. of protonema (Permanent slides).

5. *Psilotum* – Morphology (specimen); T.S. of rhizome, stem and synangium (permanent slides).

6. *Selaginella* – Morphology (specimen); W.M. of leaf with ligule, T.S. of stem, L.S. of strobilus, W.M. of microsporophyll, megasporophyll (temporary slides); T.S. of rhizophore (permanent slide).

7. *Equisetum* – Morphology (specimen), T.S. of internode, L.S. of strobilus, T.S. of strobilus, W.M. of sporangiophore, W.M. of spores (wet and dry) (temporary slide).

8. *Pteris* - Morphology, T.S. of rachis, V.S. of sporophyll (temporary slides), T.S. of rhizome, W.M. of prothallus with sex organs and young sporophyte (permanent slide).

9. *Cycas* – Morphology, T.S. of coralloid root, T.S. of rachis, V.S. of leaflet, V.S. of microsporophyll, W.M. of spores (temporary slides); T.S. of stem, T.S. of root, L.S. of ovule (permanent slide).

10. *Pinus* - Morphology, T.S. of Needle, L.S. and T.S. of male cone, W.M. of microsporophyll (temporary slides); T.S. of stem, R.L.S. and T.L.S. of stem, L.S. of female cone (permanent slide).

11. *Gnetum* - Morphology (stem, male & female cones); T.S. of stem, L.S. of ovule (permanent slide).

12. Botanical Excursion and submission of digital catalogue/report of various species observed.

Suggested readings:

1. Bhatnagar, S.P., Moitra, A. (2023). Gymnosperms. 2nd edition, New Delhi, Delhi: New Age International (P) Ltd Publishers.
2. Kaur I.D., Uniyal P.L. (2019). Text Book of Gymnosperms. New Delhi, Delhi: Daya Publishing House.
3. Kaur I.D., Uniyal P.L. (2019). Text Book of Bryophytes. New Delhi, Delhi: Daya Publishing House.
4. Kaur I.D. (2023). Text Book of Pteridophytes. New Delhi, Delhi: Daya Publishing House.
5. Parihar, N.S. (2019). An Introduction to Embryophyta. Vol. II: Pteridophyta. Surjeet Publications.

Additional Resources:

1. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
2. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (latest edition). Biology. New Delhi, Delhi: Tata McGraw Hill.
3. Singh, H. (1978). Embryology of Gymnosperms. Berlin, Germany. GebruderBorntraeger.
4. Vashishta, P.C., Sinha, A.K., Kumar, A. (2022). Botany For Degree Students Pteridophyta, New Delhi, Delhi: S. Chand Publication. Delhi, India.
5. Vashistha, B.R., Sinha, A.K., Kumar, A. (2010). Botany For Degree Students, Bryophyta. New Delhi, Delhi: S Chand Publication.
6. Parihar, N.S. (1965). An Introduction to Embryophyta. Vol. I: Bryophyta. Allahabad, UP: Central Book Depot.
7. Puri, P. (1973). Bryophytes. New Delhi, Delhi, Atma Ram and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 9: Genetics and Plant Breeding

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Genetics & Plant Breeding DSC-9	4	2	0	2	Class XII pass	Nil

Learning Objectives:

- To apprise students with the basic principles of Genetics
- To enhance the applications of genetics in plant breeding and agriculture.

Learning Outcomes:

On completion of the course the students will be able to:

- understand the fundamentals of Mendelian inheritance and its deviation in gene interactions.
- describe the concepts of linkage and crossing over and their usage in constructing gene maps.
- become familiar with pedigree analysis.
- learn about principles of population genetics
- gain knowledge about gene mutations and inherited disorders
- learn about various plant breeding techniques / methods

Unit 1. Mendelian Genetics **6 hours**

Mendelism: History; Principles of inheritance, deviations (Incomplete dominance and co-dominance); Chromosome theory of inheritance; Multiple allelism; lethal alleles; Epistasis; Pleiotropy; Penetrance and expressivity; Polygenic inheritance; brief introduction to sex determination.

Unit 2. Extra-Nuclear Inheritance **4 hours**

Chloroplast and mitochondrial genomes; Chloroplast Inheritance: Variegation in Four O` clock plant; Mitochondrial inheritance in yeast; Maternal effect (Shell coiling in Snails).

Unit 3. Linkage, crossing over and chromosome mapping **5 hours**

Linkage and crossing over, Cytological basis of crossing over (Creighton and McClintock experiment in Maize); three factor crosses; interference and coincidence; Sex linkage (*Drosophila*)

Unit 4. Variation in Chromosome number and structure **4 hours**

Deletion; Duplication; Inversion; Translocation; Euploidy and aneuploidy (In Brief).

Unit 5. Mutations **4 hours**

Mutation types; Muller's CIB method, Molecular basis of mutations; Chemical mutagens (Base analogs, deaminating, hydroxylating, alkylating and intercalating agents) and Physical mutagens (Ionising and Non ionising radiations); Transposable genetic elements and their significance (Basic concept).

Unit 6. Population and evolutionary genetics **3 hours**

Hardy Weinberg law (Allele frequencies, genotype frequencies); speciation (modes of speciation and genetics of speciation).

Unit 7. Plant Breeding **4 hours**

Plant breeding- Principle and Practices, domestication and plant introduction (primary and secondary introduction), selection and its types: pure line selection, mass selection and clonal selection; hybridizations (inter-specific and intra-specific), heterosis and its significance.

Practicals: **60 hours**

1. To study meiosis in *Allium cepa* through squash preparation of anthers.
2. To study mitosis in *Allium cepa* through squash preparation of root tips.
3. To understand the deviations of Mendelian dihybrid ratios (12:3:1, 9:3:4, 9:7, 15:1, 13:3, 9:6:1) involved using the seed mixture given. Genetic ratio to be calculated using Chi square analysis.

4. Human Genetics:
   a) Study of autosomal & sex-linked dominant & recessive inheritance through pedigree analyses.
   b) ABO blood group testing using kits,
   c) To study the syndromes (Down's, Klinefelter's, Turner's, Edward's & Patau) through karyotypes
5. To calculate allelic and genotypic frequencies of human dominant and recessive traits using Hardy- Weinberg's principle.
6. To study Xeroderma pigmentosum, Sickle cell anaemia, albinism, haemophilia and colour blindness (Ishihara charts may be used to study colour blindness)
7. To study chromosomal aberrations:
   a) Quadrivalents, lagging chromosomes, dicentric/inversion bridge through photographs/permanent slides
   b) Reciprocal translocation through squash preparations of *Rhoeo* anthers.

8. Demonstration of basic methods of plant breeding (hybridizations): Emasculation, bagging and tagging using available plant material in pots/gardens/field.

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.
2. Griffiths, A.J.F., Doebley,J., Peichel, C, Wassarman D (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.
4. Pierce, B. A. (2020). Genetics: A Conceptual Approach, 7th Edition, Macmillan

5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
6. Singh, B.D., (2022). Plant Breeding: Principles and Methods. New Delhi, Medtech Publishers

Additional Resources:

1. Russell, P. J. (2010). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings
2. Snustad, D.P., Simmons, M.J. (2016). Principles of Genetics, 7th Edition. New Delhi, Delhi: John Wiley & sons
3. Hartl, D.L., Ruvolo, M. (2019). Genetics: Analysis of Genes and Genomes, 9th edition, Jones and Bartlett Learning.
4. Singh, B. D. (2023). Fundamentals of Genetics, 6th edition. MedTech.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF DISCIPLINE SPECIFIC ELECTIVES

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE -1): Evolutionary Biology of Plants

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Evolutionary Biology of Plants **DSE-1**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:

- This course builds on the fundamental points introduced in the core course on Plant Diversity and Evolution and presents a synthesis of various theories, concepts, evidence and methods to study evolution.

Learning Outcomes:

At the end of this course the students will be able to:

- understand the essential theories in evolution
- differentiate between micro and macroevolution and the forces shaping evolution
- construct phylogenetic trees based on morphological and molecular data
- understand evolution of life.

Unit 1: Historical Perspective of Eevolutionary Cconcepts **4 hours**

Pre-Darwinian ideas, Lamarckism, Darwinism, Post-Darwinian era – Modern synthetic theory, Neo-Darwinism

Unit 2: Origin of Life **3 hours**

Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Evolution of eukaryotes from pprokaryotes

Unit 3: Evidences of Evolution **4 hours**

Paleobiological– Concept of Stratigraphy and geological timescale; fossil study
Anatomical & Embryological – Vestigial organs; homologous and analogous organs (concept of parallelism and convergence in evolution)
Taxonomic –Transitional forms/evolutionary intermediates, living fossils
Phylogenetic – morphology, protein (Cytochrome C) and gene (Globin gene family) based

Unit 4: Microevolution and Macroevolution **8 hours**

Hardy Weinberg equilibrium; Founder effect, Natural and artificial selection. Levels of selection.

Inferring phylogenies- Gene trees, species trees; Patterns of evolutionary change; Adaptive radiation, Evolution and development (evo-devo); Biodiversity- Estimating changes in biodiversity; Taxonomic diversity through the Phanerozoic era.

Unit 5. Forces of Evolution **3 hours**

Mutation, Geneflow, Selection, Genetic Drift, Co-adaptation and co-evolution, Anthropogenic activities, Extinction (in brief)**-** Periodic and Mass-scale – Causes and events.

Unit 6. Speciation **4 hours**

Species concept, Modes of speciation – Allopatric; sympatric; peripatric; Patterns of speciation – Anagenesis and Cladogenesis; Phyletic gradualism and Punctuated eequilibrium (Quantum evolution); Basis of speciation – Isolating mechanisms.

Unit 7. Evolution of Land Plants **4 hours**

Origin of land plants – Terrestrial algae and Bryophytes; alternation of generations. Early vascular plants – Stelar evolution; Sporangium evolution; seed habit and evolution of seed. Angiosperms – Phylogeny of major groups.

Practicals **60 hours**

1. Study of different types of fossils, connecting links/transitional forms and Living fossils (Specimens/slides/photographs)
2. Sampling of quantitative characters (continuous and discontinuous) in a population(height, weight, number of nodes etc)
3. Study of adaptive strategies (colouration, co-adaptation and co-evolution); (Specimens/photographs)
4. Calculations of genotypic, phenotypic and allelic frequencies from the data provided
5. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies
6. To study and interpret Phylogenetic trees (reading and using trees) - minimum of three examples.

Suggested Readings:

1. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
2. Ridley, M. (2004). Evolution. III Edn. Blackwell Pub., Oxford.
3. Hall, B. K., Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett.
4. Zimmer, C., Emlen, D. J. (2013). Evolution: Making Sense of Life. Roberts & Co.
5. Futuyma, D. (1998). Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
6. Barton, Briggs, Eisen, Goldstein and Patel. (2007). Evolution. Cold Spring Harbor Laboratory Press.
7. Nei, M., Kumar S. (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York.
8. Futuyma, J. D., Kirkpatrick, M. (2017). Evolution, 4th Ed. Sinauer, Sunderland, MA: Sinauer Associates.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE -2): Biostatistics & Bioinformatics for Plant Sciences

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Biostatistics & Bioinformatics for Plant Sciences **DSE-2**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objective:

- To train students in using computational and mathematical tools to solve biological problems.

Learning Outcomes:

At the end of this course students will be able to:

- use the various online databases and resources for accessing biological data.
- use the different methods of alignment of DNA, RNA and protein sequences and interpret the significance of the same.
- understand the descriptive and inferential statistical tests for interpretation of experimental data.

Unit 1- Introduction to Bioinformatics **3 hours**

Historical background; Aims and scope; Bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics; Applications of bioinformatics in crop improvement

Unit 2- Biological databases **4 hours**

Introduction to biological databases - Primary, secondary and composite databases. Study of following databases: NCBI (GenBank, PubChem, PubMed and its tools (only BLAST)), introduction to UniProt, PDB, PlantPepDB.

Unit 3- Basic concepts of Sequence alignment **4 hours**

Similarity, identity and homology. Concepts of alignment (gaps and penalty); Alignment – pairwise and multiple sequence alignments

Unit 4- Molecular Phylogeny **4 hours**

Introduction, methods of construction of phylogenetic trees: maximum parsimony (MP), maximum likelihood (ML) and distance (Neighbour-joining) methods.

Unit 5- Introduction to Biostatistics **2 hours**

Definition, Basics of descriptive and inferential statistics; Limitations and applications.

Unit 6- Data and sampling methods **3 hours**
Primary and secondary data; Sampling methods (in brief); tabulation and presentation of data.

Unit 7- Measures and deviations of central tendencies **4 hours**
Dispersion - range, standard deviation, mean deviation, standard error, skewness and kurtosis, quartile deviation –merits and demerits; Coefficient of variation.

Unit 8-Correlation and Regression **3 hours**
Correlation - types and methods of correlation (I. E. Karl Pearson and Spearman Rank method), Introduction to simple regression equation; similarities and dissimilarities between correlation and regression.

Unit 9- Statistical tests **3 hours**
Statistical inference - hypothesis – (simple hypothesis), student's t test, chi-square test.

(Note: Numerical based questions of unit 7, 8 and 9 should be covered only in practical)

Practicals **60 hours**

1. Biological databases (NCBI, UniProt, PlantPepDB)
2. Literature retrieval from PubMed
3. Sequence retrieval (protein and gene) from NCBI (formats - FASTA, GenBank and GenPept formats)
4. Protein Structure retrieval from PDB (in pdb format) and visualization by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol)
5. Multiple sequence alignment (MEGA/Clustal omega)
6. Construction of phylogenetic tree (PHYLIP/ MEGA/ Clustal omega).
7. Calculation of standard deviation and coefficient of variation through manual calculation and using Microsoft Excel, using only ungrouped data)
8. Calculation of correlation coefficient values by Karl Pearson's /Spearman Rank methods (through manual calculation and using Microsoft Excel)
9. Student's t-test (using Microsoft Excel), chi square test (Manual and using Microsoft Excel)

Suggested Readings:

1. Ghosh, Z., Mallick, B. (2008). Bioinformatics – *Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2. Baxevanis, A.D., Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3. Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
4. Zar, J.H. (2012). Biostatistical Analysis, 4th edition. London, London: Pearson Publication.
5. Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

Additional Resources:

1. Pevsner J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
2. Xiong J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press.
3. Mount, D.W. (2004). Bioinformatics: Sequence and Genome analysis 2nd edition, Cold Spring Harbor Laboratory Press, USA.
4. Pandey, M. (2015). Biostatistics Basic and Advanced. New Delhi, Delhi: M V Learning.
5. Khan, I.A., Khanum, A., Khan S., (2020). Fundamentals of Biostatistics, 6th edition. Ukaaz Publications, Hyderabad, India.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

Botany Courses for Undergraduate Programme of study with Botany as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE (DSC-.......): Plant Cell and Developmental Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Cell and Developmental Biology DSC	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning objectives:
To understand the basics of plant cell structure, development, growth and organisation of plant body.

Learning outcomes:
On completion of the course, the students will

- become familiar with the structure and functions of various components of plant cell
- understand the processes of cell growth and its regulation
- comprehend the structure, organization and functions of various tissues of the plant organs
- get acquainted with the reproductive processes in the life cycle of angiosperms
- appreciate the interactions between the developmental pathways resulting in the differentiation of plant body
- recognise the importance of plant developmental biology in the improvement and conservation of plants

Unit 1. Introduction to Plant Cell: structure and function **5 hour**
Cell as the basic unit of life; differences between plant and animal cell, prokaryotic and eukaryotic cell; Cell Theory.
Structure and functions of cell wall; cell membrane; cell organelles- nucleus, chloroplast, mitochondria, dictyosomes, endoplasmic reticulum, microbodies, cytoskeleton.

Unit 2: **Cell growth** **3 hours**

Cell cycle, regulation (in brief) and significance; mitosis and meiosis; cytokinesis.

Unit 3. **Polarity in plant growth** **3 hours**
Plant body as a bipolar structure; apical, basal and radial patterns of body plan; growth through primary and secondary meristems; organisation of shoot and root apices.

Unit 4. **Differentiation of tissues: vegetative organs** **6 hours**
Structure and functions of tissues (simple and complex); structure of stem, root, and leaf (dicot and monocot); principles of organ differentiation: role of transcription factors in cell, tissue, organ identity and development, cell fate determination by position, and cell-cell signalling; hormones involved in organ differentiation (very briefly).

Unit 5. Differentiation of tissues: reproductive organs **6 hours**
Anther, microsporogenesis and microgametogenesis, general structure of pollen grains and male gametes, male germ unit; ovule, megasporogenesis (monosporic, bisporic, tetrasporic) and megagametogenesis (Polygonum type), ultrastructure and significance of female germ unit; Flower development (ABC model).

Unit 6. Pollination and Fertilization **3 hours**
Pollination types, agents and adaptation; pollen germination; path of pollen tube in pistil; double fertilization

Unit 7. **Development of Embryo and Seed** **4 hours**
Endosperm types, functions; development of embryo from zygote, establishment of apical-basal and radial organisation; development of seed, modes of seed dispersal.

Practicals (60 hours)
1. Study of plant cell - through peel mount (*Tradescantia,* or any other); whole mount (*Hydrilla*) - cytoplasmic streaming.
2. Study of cell components - nucleus (Feulgen/acetocarmine staining); mitochondria (Janus green B staining); cell wall (PAS staining).
3. To study mitotic index. (pictures or permanent slides -24h-period or under different temperatures/environmental conditions may be used).
4. Study tissues and organs structure through temporary preparations of macerated material and sections - T.S. of dicot stem- *Helianthus/ Cucurbita*, *Hydrilla/ Nympaea petiole, Casuarina,* stem with secondary growth - *Helianthus, Salvadora/ Bignonia;* T.S. of monocot stem - *Zea mays*, *Dracaena;* T.S. of dicot root with and without secondary growth- *Cicer*, monocot root - *Zea mays*, V.S. of dicot leaf- *Vernonia/Hamelia*etc., *Nerium, Hydrilla;* V.S. of monocot leaf- *Zea mays, Triticum/Dracaena/Crinum;* peel mountstostudy epidermal structures - types of stomata, trichomes, laticifers; Shoot apex and root apex through micrographs.
5. Study Reproductive structures (i) Anther - T.S. of anther of any large flower like *Datura/ Hamelia/ Kigelia*); whole mounts of pollen grains; ii) pollen development through micrographs of T.S. anther at different stages of development (with secretory, amoeboid tapetum); (iii) types of ovule through permanent slides/specimens/ micrographs; (iv) Polygonum type of embryo sac development through micrographs; (v) ultrastructure of egg apparatus and central cell through micrographs.
6. Study (i) pollen viability (TTC/FDA); (ii) pollen germination; (iii) growth of pollen tube in cleared pistil.

7. Study (i) dicot and monocot embryo development (through permanent slides); (ii) structure of seed (L.S. of seed)

Suggested Readings:

1. Beck, C.B. (2010). An Introduction to Plant Structure and Development. Second edition. Cambridge University Press, Cambridge, UK.
2. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA
3. Fahn, A. (1974). Plant Anatomy. Pergamon Press, USA
4. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA
5. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
6. Taiz, L., Zeiger, E., Moller, I.M., Murphy, A. (2015). Plant Physiology. 6th edition. Sinauer Associates, Sunderland. USA.
7. Hopkins, W.G., Huner, N.P.A. (2009). Introduction to Plant Physiology. Fourth edition, John Wiley & Sons, Inc. USA.
8. Bhojwani, S.S., Bhatnagar, S.P., Dantu, P.K. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publishing House.
9. Johri, B.M. (1984). Embryology of Angiosperms. Netherlands: Springer-Verlag.
10. Raghavan, V. (2000). Developmental Biology of Flowering plants. Netherlands: Springer.
11. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. New Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Additional Resources:

1. Cutler, D.F., Botha, T., Stevenson, D.W. (2007). Plant Anatomy - An Applied Aspect. Blackwell Publishing, USA
2. Bahadur, B. Rajam, M.V., Sahijram, L., Krishnamurthy, K.V. (2015). Plant Biology and Biotechnology. Volume 1: Plant Diversity, Organization, Function and Improvement. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London.
3. Shivanna, K.R., Tandon, R. (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London
4. Moza M. K., Bhatnagar A.K. (2007). Plant reproductive biology studies crucial for conservation. Current Science 92:1907.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category III:

B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest Management Botany (H) Courses for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Genetics and Molecular Biology ALSBOTDSC03	**4**	**2**	**0**	**2**	**XII pass with Science with Biology/ Biotechnology**	**NIL**

Learning Objectives:

The learning objectives of this course are as follows:

- To understand the basic concept of Mendelian genetics and comprehensive study of Mendelian extensions.
- To provide adequate knowledge about Linkage, Crossing over and Mutations.
- To provide brief knowledge of population and evolutionary genetics.
- To impart detailed understanding about the structureof nucleic acids and their types. .
- To understand key events of Molecular biology comprising mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes.
- To give comprehensive explanation of Transcriptional Regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms along with the key concept of Gene Silencing.

Learning Outcomes:

By studying this course, students will be able to:

- Analyse the basic concepts of Mendelian genetics and its extension, Linkage and Crossing over, Mutations and population genetics.

- Explicate the mechanism of replication, transcription, translation in prokaryotes and eukaryotes.
- Comprehend the mechanism of gene regulation and gene silencing.

Unit 1: Mendelian Genetics and Extensions (3 Hours)
Mendel's work on transmission of traits, Co-dominance, Incomplete dominance, Multiple alleles, Lethal Genes, Epistasis, Pleiotropy, Polygenic inheritance, Pedigree analysis.
Unit 2: Extra-chromosomal Inheritance (2 Hours)
Cytoplasmic inheritance: Chloroplast variegation in Four 'O clock plant, Kappa particles in *Paramecium*, Maternal effect-shell coiling pattern in snail.
Unit 3: Linkage, Crossing over and Chromosomal Mapping (3 Hours)
Linkage and crossing over, Recombination mapping - two point and three points.
Unit 4: Mutations (3 Hours)
Chromosomal mutations, Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy, Gene mutations.
Unit 5: Population and Evolutionary Genetics (2 Hours)
Allelic frequencies, Genotypic frequencies, Gene pool, Hardy-Weinberg Law.
Unit 6: The Genetic Material: DNA and RNA (4 Hours)
DNA structure: Salient features of double helix, Types of DNA, DNA denaturation and renaturation, Nucleosome, Chromatin structure- Euchromatin, Heterochromatin (Constitutive and Facultative), RNA structure and its types.
Unit 7: Replication of DNA (3 Hours)
Mechanism of prokaryotic DNA replication, Chemistry of DNA synthesis, Enzymes and proteins involved in DNA replication, Comparison of replication in prokaryotes and eukaryotes.
Unit 8: Transcription and Processing of RNA (4 Hours)
Mechanism of transcription in prokaryotes and eukaryotes, Split genes: concept of introns and exons, Removal of introns, Spliceosome machinery group I & group II intron splicing, alternative splicing, eukaryotic mRNA processing (5' cap, 3' poly A tail).
Unit 9: Translation (3 Hours)
Mechanism of translation in prokaryotes and eukaryotes: initiation, elongation and termination of polypeptides,Proteins and enzymes involved in translation.
Unit 10: Regulation of transcription in prokaryotes and eukaryotes (3 Hours)
Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli*, Eukaryotes: Transcription factors, Heat shock proteins, Gene silencing.

PRACTICAL (Credit: 02)
(Laboratory practical- 15 classes of 4 hours each)

1. To study Mendelian and Non- Mendelian gene interaction ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) through seeds.
2. To study linkage, recombination, gene mapping using marker-based data from *Drosophila*.

3. Karyotype and Idiogram preparation through photographs.
4. PTC testing in a population and calculation of allelic and genotypic frequencies.
5. Study of abnormal human karyotype and pedigrees.
6. Isolation of genomic DNA from Cauliflower curd.
7. Qualitative analysis of DNA using gel electrophoresis.
8. Estimation of DNA by Diphenylamine method.
9. Separation of nucleotide bases by paper chromatography.
10. Purity and quantitative estimation of isolated DNA by UV-VIS spectrophotometer.
11. Study of Molecular techniques: PCR, Southern, Northern and Western Blotting and PAGE.

Essential/ Recommended readings:

1. Snustad D.P. and Simmon M.J. (2012) *Genetics* 6 th Ed., John Wiley & Sons. (Singapore)
2. PierceB.A, (2012) *Genetics - A Conceptual Approach*, 4 th Ed., W.H. Freeman & Co. (New York)
3. Griffiths A.J.F., Wessler S. R, Carroll S. B and Doebley J. (2010) *An Introduction to Genetic Analysis*, 10th Ed., W.H. Freeman & Company (New York).
4. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2007) *Molecular Biology of the Gene*, 6th Ed. Pearson Benjamin Cummings, CSHL Press, New York, U.S.A.

Suggestive readings:

1. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009)*Concepts of Genetics*. 9th Ed. Benjamin Cummings. U.S.A.
2. Russell, P. J. (2010) *Genetics- A Molecular Approach*. 3rd Ed. Benjamin Cummings, U.S.A.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE01)

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecology, Conservation and Restoration ALS BOT DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

- To develop a scientific understanding of the diverse aspects of ecology.
- To familiarize students with the interactions between the organisms and their physical environment.
- To understand various attributes of populations and communities with the help of theoretical concepts and field studies.
- To make students understand various factors that lead to variations among populations of a species.
- To familiarize students about the concepts of conservation and restoration.

Learning Outcomes:

By studying this course,students will be able to:

- Gain knowledge aboutthebasic concepts of ecology.
- Comprehend the characteristics of the community, ecosystem development and climax theories.
- Explicate the relationship of evolution of various species and their environment.
- Analyse the basic field studies including data collection and its interpretation.
- Explicate the Conservation and Restoration methods.

Unit 1: Introduction to Ecology **(3 Hours)**
Autecology and Synecology, Laws of limiting factors, Study of physical factors: Temperature and Light.

Unit 2: Population **(4 Hours)**
Unitary and Modular populations, Unique and group attributes of population: density, natality, mortality, Life tables, Fecundity table, Survivorship curves, Intraspecific population regulation: density-dependent and independent factors.

Unit 3: Species Interactions **(5 Hours)**
Types of species interactions, Interspecific competition: Lotka-Volterra model of competition, Gause's Principle, Niche concept, Predation, Predator defence mechanisms.

Unit 4: Community **(4 Hours)**
Community characteristics: species richness, dominance, diversity, abundance, guilds, ecotone and edge effect, Ecological succession with examples and types.

Unit 5: Ecosystem **(5 Hours)**

Types of Ecosystems: terrestrial and aquatic ecosystems, Vertical stratification in tropical forest, Food chain: detritus and grazing food chains, linear and Y-shaped food chains, Food web, Energy flow through the ecosystem: Ecological pyramids and Ecological efficiencies, Biogeochemical cycles: Nitrogen cycle.

Unit 6: Conservation (5 Hours)

Ecology in wildlife conservation and management: In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries), Ex-situ conservation (botanical gardens, gene banks, seed and seedling banks, DNA banks),Principles of Environmental impact assessment.

Unit 7: Restoration (4 Hours)

Restoration ecology: Afforestation, Social forestry, Agro-forestry, Joint Forest management, Role of remote sensing in management of natural resources.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

1. Study of life tables and plotting of survivorship curves of different types from hypothetical/real data.
2. Determination of population density and abundance in a natural or a hypothetical community by quadrat method.
3. Quantitative analysis of herbaceous vegetation in the college campus and comparison with Raunkiaer's Frequency distribution law.
4. Study of morphological features of hydrophytes and xerophytes in the ecosystems.
5. Measurement of temperature, turbidity/penetration of light and pH of any two water samples.
6. Comparison of Dissolved oxygen content in different water samples using Winkler's titration method.
7. Comparison of organic carbon of two soil samples using Walkley and Black's rapid titration method.
8. Comparison of CO_2 and alkalinity in two different water samples.
9. Estimation of Total Dissolved Solids (TDS) in water samples.
10. Perform Rapid field tests to detect the presence of Carbonates, Nitrate, Sulphate, Chloride, Organic matter and Base deficiency in two soil samples.
11. A visit to a National Park/Biodiversity Park/Wildlife Sanctuary/Urban Forest.

Essential/Recommended readings:

1. Sharma, P.D. (2012). *Ecology and Environment*. Rastogi Publications.
2. Singh J.S., Singh S.P., and Gupta S. R. (2014) *Ecology, Environment Science and Conservation*. S. Chand and Company Limited.
3. Odum, E.P. and Barrett G. W. (2004) *Fundamentals of Ecology*. Indian Edition (5th)Brooks/Cole Publishers.

Suggestive readings:

1. Smith T. M. and Smith R. L. (2015). *Elements of Ecology*. 9th International Edition, Publisher: Benjamin Cummings.
2. Saha G.K. and Mazumdar S. (2020) *Wildlife Biology*, An Indian Perspective. Publisher: PHI Learning Private Limited
3. Futuyma, Douglas and Mark, Kirkpatrick (2017). *Evolutionary Biology* (3rd Edition), Oxford University Press

Category IV:
B.Sc. Biological Sciences (Hons)for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE –9 :						
Course title & Code	**Credits**	**Credit distribution of the core course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	**Tutorial**	**Practical/ Practice**		
Functional Ecology (BS-DSC303)	**4**	**2**	**-----**	**2**	**Class XII pass with Biology and chemistry, as one of the papers in Class XII**	**Nil**

Learning Objectives

• To understand the basic concepts in ecology and levels of organization in an ecosystem
• Obtain a basic understanding of the various aspects of a 'population' and interactions among individuals of the same as well as different species.
• To understand the structure and functions of the community and its processes.
• To comprehend the components of an ecosystem, energy flow and nutrient cycling.
• To appreciate the applied aspects required in restoration of degraded ecosystems.
• To understand trade-offs in life history characteristics of organisms and various behaviors shownby organisms.

Learning outcomes
By the end of the course, the student will be able to:
• To comprehend the principles and applications of ecology and ecosystem.
• Know about the importance of ecosystem in general and the effects of changes inecosystem.
• Understand the techniques used for the quantitative and qualitative estimation of bioticand abiotic components of an ecosystem.
• Gain knowledge about the density, frequency and diversity of species in an ecosystem.
• Understand about key interactions between organisms like competition , predation ,parasitism etc.
• Participate in citizen science initiatives from an ecological perspective

DISCIPLINE SPECIFIC CORE COURSE –9 :XXX
SYLLABUS OF DSC-9
Theory
Unit 1: Introduction to Ecology 3 Hours
History of ecology, Autecology and synecology, levels of Organisation, Laws of limiting factors (Liebig's law of minimum, Shelford's law of tolerance), ecological range (Eury and Steno).
Unit 2: Population Ecology 12 Hours
Population: Unitary and Modular populations; Metapopulation: Density, natality, mortality, life tables, fecundity tables, survivorship curves, sex ratio, age pyramids, dispersal and

dispersion; carrying capacity, population dynamics (exponential and logistic growth equation and patterns), r and K selection, density-dependent and independent population regulation; Niche concept, Population interactions: Positive and negative interactions; Competition, Gause's Principle for competition with laboratory and field examples, Lotka-Volterra equation for predation.

Unit 3: Community Ecology **8 Hours**

Community structure: Dominance, diversity, species richness, abundance, stratification; Diversity indices; Ecotone and edge effect; Community dynamics (succession): Primary and secondary succession, Succession on a bare rock. Climax: monoclimax and polyclimax concepts (preclimax, postclimax, disclimax etc.). Concept of keystone, indicator and flagship species with plant and animal examples.

Unit 4: Ecosystem Ecology **7 Hours**

Concept, components, and types of ecosystems (example of Pond ecosystem in detail showing abiotic and biotic components), BOD, eutrophication. Energy flow (Grazing and Detritus food chain), linear and Y-shaped energy flow model, black box model, food web. Ecological pyramids and Ecological efficiencies.

PRACTICALS CREDITS: 2 **Total 60 Hours**

1. To understand the principle and working of ecological instruments such as Anemometer, Hygrometer, Luxmeter, Rain gauge, turbidity meter, pH meter, Soil thermometer, MinMax thermometer.
2. To study biotic interactions using specimens/ photographs/ permanent slides of Parasitic angiosperms, Saprophytic angiosperms, root nodules, velamen roots, lichens , corals .
3. To study plant-microbe interactions by preparing temporary stained mounts of VAM fungi / mycorrhizal roots/ root nodules.
4. Mark recapture method for determining population density of animals
5. To determine a minimal quadrat area for sampling
6. To determine density, frequency and abundance of herbaceous vegetation by quadrat method
7. To estimate dissolved oxygen content of a given water sample using Winkler's method.
8. Plotting of survivorship curves from hypothetical life table data.XXX

REFERENCES

1. Barrick, M., Odum, E. P., Barrett, G. W., (2005) Fundamentals of Ecology.5th Edition. Cengage Learning.
2. Smith, T. M..& Smith, R. L.(2012). Elements of Ecology 8th Edition. Pearson.
3. Ricklefs, R. E., & Miller, G. L., (2000) Ecology, 4th Edition W.H. Freeman.
4. Sharma, P. D. (2017). Ecology and Environment.13th Edition. Meerut: Rastogi Publications.

MOOCs

1. 'Ecology: Ecosystem Dynamics and Conservation from American Museum of Natural History on Coursera https://www.classcentral.com/course/coursera-ecology- ecosystem-dynamics-andconservation-10618
2. https://alison.com/course/diploma-in-ecology-studies
3. https://swayam.gov.in/ Any ecology based online course that may be available during the semester, depending on its relevance to the present syllabusXXX

DISCIPLINE SPECIFIC Elective –DSE-1 :						
Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Medicinal and Ethnobotany (BS-DSE-1)	4	2	-----	2	Class XII pass with Biology and NA chemistry, as one of the papers in Class XII	Nil

Learning Objectives:

Plants are imperative to mankind with almost all plants known to possess medicinal values. There is an increased emphasis on indigenous system of medicine which has lent prime focus on medicinal plants. Keeping the therapeutic importance of medicinal plants in mind this course is designed to provide education and training on diverse perspectives of medicinal plants. The course also offers comprehensive knowledge about understanding the difference between ancient wisdom and themodern system of medicine.

Learning Outcomes:

On successful completion of the course, a student will:

• Be able to identify the common medicinal plants in their vicinity.

• Learn about the traditional healing sciences namely Ayurveda, Siddha and Unani, which have been used since the ancient times.

• Appreciate the importance of conservation strategies for medicinal plants.

• Be able to understand the importance of medicinal plants, significance of ethnobotany, role of ethnic groups in the conservation of medicinal plants.

Course Contents - Theory

Unit 1: History, Scope and Importance of Medicinal Plants No. of Hours-10

Introduction to indigenous systems of medicines- Ayurveda, Unani and Siddha system of medicine)- Ayurveda: History, origin, Panchamahabhutas, Saptadhatu and Tridosha concepts, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system. Unani: History, concept: Umoor-e- tabiya. Plants used in Ayurveda, Siddha and Unani medicine with special reference to Carum carvi, Plantago ovata, Allium sativum, Asparagus racemosus, Vitis vinifera, Linum usitatissimum, Amaranthus paniculatus. Polyherbal formulations (with special reference to Safi, Chyawanprash, Trifala, Swalin, Amukkara Choorna, Gandhak rasayana). Natural products – Compounds responsible for biological activity of medicinal plants: their biology, and pharmacology (Curcumin, Vinblastine, Vincristine, Ecliptine, Cinchonine, Azadirachtin, Artemisinin).

Unit 2: Conservation of Endangered and Endemic Medicinal Plants No. of Hours -8

Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanical Gardens, herbal gardens, Ethnomedicinal plant gardens. Germplasm conservation, cryopreservation (Cryo banks and DNA banks), Role of NBPGR and JNTBGRI in conservation of plants, Propagation of Medicinal Plants: In vitro and In vivo strategies. Adulteration of Herbal drugs. Organoleptic, microscopic and phytochemical evaluation of plant drugs.

Unit 3: Ethnobotany and Folk Medicines **No. of Hours :12**

Introduction, concept, scope and objectives; Ethnobotany in India: Methods to study ethnobotany; Folk medicines of ethnobotany, Role of ethnobotany in modern medicine with special reference to *Rauvolfia serpentina*, *Trichopus zeylanicus*, *Artemisia, Withania*. Major and minor ethnic groups of India and their lifestyles. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases. Role of ethnic groups in conservation of plant genetic resources; Brief account of biopiracy and IPR.

PRACTICAL
Credit: 2 **Total Hours - 60**

1. Identification of any ten common medicinal plants in the surrounding area and study their characteristic features.
2. Collection, identification and preparation of herbarium of any five medicinal plants.
3. Extraction and qualitative estimation of active principle compounds (alkaloids, tannins, saponins and flavanoids) from any four medicinal plants. (*Aloe vera, Ocimum* sp*, Azadirachta , Catharanthus, Adhatoda, Withania*)
4. Study of components and medicinal uses of common polyherbal formulations used in the traditional system of medicine (Ayurveda, Unani and Siddha).
5. Study of organoleptic, macroscopic and microscopic parameters of any two medicinal plants.
6. To compare the total phenolic content of few locally available medicinal plants
7. Field trip: Industries/Institutes/herbal garden/ medicinal gardens/ nurseries/tribal museum.
8. e-presentations (System of medicine, Conservation strategies, propagation of medicinal plants, folk medicines, application of natural products to certain diseases listed in the syllabus)

Essential readings:

1. Abdin, M. Z. and Abrol, Y. P., (2006). Traditional Systems of Medicine. Narosa Publishing House, New Delhi.
2. Kumar, S., (2018). Ethnobotany. Kojo press, New Delhi.
3. Purohit and Vyas, (2008). Medicinal Plant Cultivation: A Scientific Approach, Agrobios.
4. Trivedi, P. C. (2006). Medicinal Plants: Ethnobotanical Approach. Agrobios.

Additional Readigs

1. Colton, C. M., (1997). Ethnobotany: Principles and Applications. John Wiley and Sons.
2. Jain, S. K., (1990). Contributions to Indian Ethnobotany. Scientific publishers, Jodhpur.
3. Jain, S. K., (1995). Manual of Ethnobotany. Scientific Publishers, Jodhpur.

COMMON POOL OF GENERIC ELECTIVES (GE)

GENERIC ELECTIVES (GE-11): Industrial and Environmental Microbiology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical / Practice		
Industrial and Environmental Microbiology **GE-11**	4	2	0	2	Class XII pass	Nil

Learning Objectives:

- To introduce students to understand the uses of microbes in industry: concepts, principles, scope and applications.
- To introduce students to the role of microbes in the environment: concepts, principles, scope and application.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

- understand how microorganisms are involved in the manufacture of industrial products.
- know about design of bioreactors, factors affecting growth and production of bioproducts.
- understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air.
- comprehend the different types of fermentation processes and the underlying principles in upstream and down- stream processing.
- learn the occurrence, abundance, distributionandrole of microorganisms in the environment.Also, learn different methods for microbial isolation and detection from different habitats.
- understand the basic principles of environmental microbiology and their application in waste water treatment, bioremediation and role of microbes in agriculture.

Unit 1: Introduction **4 hours**

Scope and importance of microbes in Industry and Environment (Institutes of microbial research). Bioremediation. Distribution and isolation of microbes in the air, soil and water.

Unit 2: Bioreactors/ Fermenters and Fermentation process **4 hours**
Solid-state and liquid state (stationary and submerged) fermentations; batch and continuous fermentations; components of a typical bioreactor, types of bioreactors.

Unit 3: Microbial production of industrial importance **12 hours**
Microorganisms generally regarded as safe (GRAS), types of media, conditions necessary for the growth and production of industrially important products, downstream processing and uses; filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.
Production of enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin).

Unit 4: Enzyme immobilization **3 hours**
Definition, Methods of immobilization, their advantages and applications, large scale production and application of penicillin acylase.

Unit 5: Microbial flora of water **4 hours**
Microorganisms as indicators of water quality: coliform and faecal coliform; role of microbes in sewage and waste water treatment system.

Unit 6: Microbes and agriculture **3 hours**
Legume root nodule symbiosis, Mycorrhizae, Arbuscular Mycorrhiza Fungi (AMF) and its importance in agriculture.

Practicals: **60 hours**

1. Principle and functioning of instruments in microbiological laboratory (autoclave, laminar flow, incubator, fermenters).
2. Sterilization methods: Wet and dry methods, membrane filters, chemicals.
3. Preparation of different culture media (Potato dextrose agar/Czapek-Dox agar, Luria Bertani) for isolation of microorganisms from soil using serial dilution agar plating method and study of aero-microflora.
4. Culturing techniques: Streak plate method, pour plate method and spread plate method.
5. To study the ability of microorganisms to hydrolyse casein/ starch.
6. Production of alcohol using sugar/ jaggery.
7. Observation of AMF colonization in plant roots.
8. A visit to any educational institute/ industry to understand the uses of microbes for industrial applications and a report to be submitted for the same.

Suggested Readings:

1. Pelczar, M.J. Jr., Chan E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. New Delhi, Delhi: McGraw Hill Education Pvt. Ltd., Delhi.
2. Reed, G. (2004). Prescott and Dunn's Industrial Microbiology. 4thEdition , CBS Publishers and Distributors Pvt. Ltd.
3. Willey, J.M. (2023). Prescott's Microbiology, 12th edition, McGrew Hill.
4. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. 9th edition, San Francisco, SF: Pearson Benjamin Cummings.
5. Stanbury, P.F., Whitaker, A., Hall, S.J. (2017). Principles of Fermentation Technology. Amsterdam, NDL: Elsevier Publication
6. Patel, A.H. (2008). Industrial Microbiology, Bangalore, India: McMillan India Limited
7. Mohapatra. P.K. (2008). Textbook of Environmental Microbiology New Delhi, Delhi, I.K. International Publishing House Pvt. Ltd.
8. Bertrand, Jean-Claude, Caumette, P. Lebaron, P, Matheron, R., Normand, P., Sime Ngando, T. (2015). Environmental Microbiology: Fundamentals and Applications. Amsterdam, Netherlands, Springer.
9. Casida, J.R. (2019). Industrial Microbiology, 2nd Edition, New Age International Publishers, New Delhi.
10. Atlas, R.M., Bartha, R. (2009). Microbial Ecology: Fundamentals and Applications., Pearson, San Francisco
11. Sharma, P.D. (2005). Environmental Microbiology. Meerut, UP: Alpha Science International, Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-12)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Environmental Biotechnology & Management **GE-12**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:
The course aims to build awareness of:

- various global and regional environmental concerns due to natural causes and/or human activities.
- different types of pollution and their impacts on the environment.
- existing and emerging technologies that are important in the area of environmental biotechnology to fulfill Sustainable Development Goals.

Learning Outcomes:
After completion of course the student will be able to:

- demonstrate awareness about emerging concerns such as climate change, waste management; biodegradation of xenobiotic compounds; bioremediation, etc.
- relate applications of biotechnology for alleviating the environmental concerns
- appreciate the scientific, ethical and/or social issues
- understand the national and international legislations, policies and role of public participation in Environmental Protection

Unit 1: Environment **5 hours**
Basic concepts and issues, global environmental problems - ozone layer depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management. Fate of pollutants in the environment, Bioconcentration, Biomagnification.

Unit 2: Microbiology of waste water treatment 7 hours

Aerobic process - activated sludge, oxidation ponds, trickling filter. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy and sugar industries.

Unit 3: Xenobiotic compounds 7 hours

Organic (Bio degradation of petroleum products and pesticides) and inorganic (metals, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, Bioaccumulation and Biosorption of metals

Unit 4: Treatment of toxic compounds: Role of immobilized cells/enzymes, microbial remediation 5 hours

Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control. Bioindicators and Bioprospecting

Unit 5: International Legislations, Policies for Environmental Protection 3 hours
Stockholm Conference (1972) and its declaration, WCED (1983) and Brundtland Report (1987), Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol - 1987, Kyoto Protocol- 1997. Environmental ethics

Unit 6: National Legislations, Policies for Pollution Management 3 hours
Water Pollution (Prevention and Control) Act-1974, Air Pollution (Prevention and Control) Act-1981, National Environmental Policy - 2006, Central and State Pollution Control Boards: Constitution and power.

Practicals: 60 hours

1. To determine the pH and total hardness of water samples collected from different places (polluted and non-polluted sites)
2. To determine the salinity of water samples (polluted and non-polluted sites)
3. To determine the dissolved oxygen of two water samples.
4. To determine the alkalinity of water samples.
5. To determine the pH and rapid field test of soil samples (Chloride, Nitrate, and Sulphate).
6. To study microbessuspended in air and water samples.
7. A visit to any educational institute/ industry to understand the uses of microbes in environmental management and a report to be submitted for the same.

Suggested Readings:

1. De, A. K. (2022). Environmental Chemistry, 10th Edition, New Delhi. New Age International Pvt. Limited
2. Dennis, A., Seal, K.J., Gaylarde, C.C. (2004). Introduction to Biodeterioration, Cambridge University Press
3. Ahmed, N., Qureshi, F.M., Khan, O.Y. (2006). Industrial and Environmental Biotechnology, Horizon Press
4. Rochelle, P.A. (2001). Environmental Molecular Biology, Horizon Press.
5. Jadhav, H.V., Bhosale, V.M. (2015). Environmental Protection and Laws, Himalaya publishing House Pvt Ltd.
6. Trivedi, P. C. (2006). Biodiversity Assessment and Conservation, Agrobios Publ.
7. Rana, S.V.S. (2015). Environmental Biotechnology, Rastogi Publications, India.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-13): Plant Biotechnology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical / Practice		
Plant Biotechnology GE-13	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objective

To give students knowledge of techniques used in plant biotechnology and its applications.

Learning Outcomes:

After completion of this course, students will be able to:

- understand the basic concepts, principles, and methods in plant biotechnology.
- will be able to explain the usage of the acquired knowledge in biotechnological, pharmaceutical, medical, ecological, and agricultural applications.

Unit 1: Introduction and Scope of Plant Biotechnology **2 hours**

Historical perspective, Current paradigms in plant biotechnology, GM crops, International/National institutions

Unit 2: Plant Tissue Culture **10 hours**

Plasticity and Totipotency of plant cells – why and how do plants grow from a single cell; Nutrient media and role of vitamins and hormones. Regeneration of plants in the laboratory: Direct and indirect organogenesis, somatic embryogenesis; Brief account of micropropagation, haploids, triploids and cybrids and their applications; artificial seeds

Unit 3:Cloning and transformation techniques **10 hours**

What is cloning?; Restriction and modifying enzymes, plasmids as cloning vehicles, Transformation of bacterial cells, selection of transformants and clones – antibiotic selection, blue-white selection; How do we make transgenic plants: *Agrobacterium*-mediated transformation, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment. Selection of transgenic plants - selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 4: Applications **8 hours**

Applications of transgenic plants in enhancing crop productivity: Pest resistant (Bt-cotton, Bt Brinjal) and herbicide resistant plants (Round Up Ready soybean);

Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug), Edible vaccines; Genetically engineered products - Human Growth Hormone and Humulin; Transgenic plants and their role in understanding plant biology, Biosafety regulations for transgenic plants.

Practicals **60 hours**

1. a. Preparation of Murashige & Skoog's (MS) medium.
   b. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of *Nicotiana* / *Datura / Brassica*.
2. Study anther, embryo, endosperm culture, micropropagation and somatic embryogenesis (photographs/slides).
3. Study isolation of protoplasts and production of artificial seeds.
4. Study methods of gene transfer: A*grobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment (through digital resources).
5. Study various steps of genetic engineering for production of *Bt*cotton, Golden rice, Flavr Savr tomato.
6. Plasmid and genomic DNA isolation, Restriction digestion and agarose gel electrophoresis of DNA.
7. Visit to a plant tissue culture / Biotechnology laboratory and to submit a field report.

Suggested Readings:

1. Bhojwani, S.S., Bhatnagar, S.P. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Bhojwani, S.S., Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Amsterdam, Netherlands: Elsevier Science.
3. Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, 2nd Edition {Springer}
4. Glick, B.R., Pasternak, J.J. (2022). Molecular Biotechnology Principles and Applications of Recombinant DNA, 6th Edition. Washington, U.S.: ASM Press.
5. Stewart, C.N. Jr. (2016). Plant Biotechnology and Genetics: Principles, Techniques and Applications, 2nd Edition. New Jearsey, U.S.: John Wiley & Sons Inc.

Additional Resources:

1. Razdan, M. K. (2019). Introduction to Plant Tissue Culture, 3rd Edition {CBS / Oxford & IBH}
2. Singh, B. D. (2022). Plant Biotechnology, Delhi, Medtech

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-14): Plant Tissue Culture

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Tissue Culture **GE-14**	4	**2**	**0**	2	Class XII pass	**Nil**

Learning Objectives

To give students knowledge of techniques used in plant tissue culture and its applications.

Learning Outcomes

The successful students will be able to:

- learn the basic concepts, principles and processes in plant cell and tissue culture.
- understand the use of tissue culture techniques in plant improvement.
- apply the concepts and principles of plant cell and tissue culture in biotechnological and agricultural fields.
- become an entrepreneur by establishing their own plant tissue culture lab.

Unit 1 Introduction **3 hours**

Historical perspective, Important contributions of Haberlandt, White, Reinert & Steward, Murashige, Skoog, Cocking, Guha & Maheshwari, Morrel & Martin.
Terminologies: Cell culture,organ culture, explant, callus, totipotency, plasticity, regeneration, somaclonal variants.

Unit 2 Types and composition of Media **4 hours**

Role of nutrients, vitamins, hormones and supplements in nutrient medium. Composition of MS and White medium.

Unit 3 Techniques of Plant Tissue Culture **4 hours**

Collection of plant material, sterilization of tissue (maintenance of aseptic conditions by use of autoclave and laminar flow chamber), filter sterilization, inoculation.

Unit 4 Protoplast culture **5 hours**

Protoplast isolation (mechanical and enzymatic), culture, purification (viability test) and fusion (spontaneous, induced), selection of fused protoplasts, applications.

Unit 5Micropropagation **5 hours**

Selection of plant material and suitable explant, methodology, plant regeneration pathways- somatic embryogenesis, organogenesis, difference between somatic and zygotic embryos.

Unit 6 Tissue culture applications **9 hours**

Anther culture, Production of haploids, triploids and cybrids, artificial seeds (production & advantages), embryo rescue, virus elimination, secondary metabolite production; Cryopreservation; Germplasm conservation. Novel sources of variation.

Practicals **60 hours**

l. To study the equipment used in tissue culture: autoclave and laminar air flow chamber.
2. Preparation of Murashige & Skoog's (MS) medium.
3. Demonstration of sterilization and inoculation methods using leaf and nodal explants of tobacco, carrot, *Datura*, *Brassica* etc. (any two).
4. Study of anther, embryo and endosperm culture.
5. Study of micropropagation, somatic embryogenesis & artificial seeds.
6. Isolation of protoplasts.
7. Visit to a plant tissue culture laboratory and submission of field report.

Suggested Readings:

1. Bhojwani, S.S. (1990). Plant Tissue Culture: Applications and Limitations {Elsevier}
2. Bhojwani, S.S, Bhatnagar, S.P. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
3. Bhojwani, S. S. and Dantu, P. K. (2013). Plant Tissue Culture: An Introductory Text Springer
4. Bhojwani, S. S. and Razdan, M. K. (1996). Plant Tissue Culture: Theory and Practice, Revised Edition, Elsevier
5. Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, 2nd Edition Springer

Additional Resources:

1. Park, Sunghun (2021). Plant Tissue Culture: Techniques and Experiments, 4th Edition Elsevier
2. Razdan, M. K. (2019). Introduction to Plant Tissue Culture, 3rd Edition CBS / Oxford & IBH
3. Smith, R. H. (2013). Plant Tissue Culture: Techniques and Experiments, 3rd Edition {Elsevier}
4. Stewart, C. Neal (2016). Plant Biotechnology and Genetics, 2nd Edition Wiley-Blackwell
5. Trigiano, R. N. (2011). Plant Tissue Culture, Development, and Biotechnology CRC Press

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GENERIC ELECTIVES (GE-15): Inheritance in Biology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Inheritance in Biology **GE-15**	**4**	**2**	**0**	2	Class XII pass	**Nil**

Learning Objectives:

- Mendelian and non-Mendelian inheritance: How is genetic information transferred across generations?
- Genetic defects in humans: Causes, inheritance and diagnostics
- Mutations: Types and agents
- DNA fingerprinting: DNA as a tool for establishing unique identity

Learning Outcomes:

Students will get familiarized with the concepts and principles of inheritance, sex determination, causal agents of genetic changes (mutations) and defects (congenital diseases) in humans. The course will also enable students to learn how genetic information is used to detect diseases and also to establish unique identity of an individual.

Section A: Information transfer across generations: Transmission Genetics

Unit 1: Chromosomal Inheritance **7 hours**
Principles of Mendelian inheritance; Chromosomal theory of inheritance, Incomplete dominance and co- dominance; Multiple allelism; lethal alleles; Epistasis; Pleiotropy; Penetrance and expressivity; Polygenic inheritance; Linkage and crossing over.

Unit2: Extra-chromosomal Inheritance: **4 hours**
Chloroplast Inheritance: Variegation in Four O` clock plant; Mitochondrial inheritance: petite mutants in yeast; Maternal effect- shell coiling in snails.

Section B: Male or Female? What determines the gender of the offspring?

Unit 3: Sex determination **3 hours**

Mechanism of sex determination in Insects (*Drosophila*), Plants (*Melandrium, Coccinia*)and humans (Sex determination regions/genes-TDF, SRY and Testicular feminisation), Dosage compensation in humans.

Section C: Human Genetics
Unit 4: Genetic defects-Structural **3 hours**
Autosomal and sex linked, congenital defects: Hemophilia, Thalassemia, Sickle cell anemia, Phenylketonuria, Cystic fibrosis, pedigree analysis

Unit 5: Genetic Defects-Variation in Chromosome number **3 hours**
Syndromes associated with chromosomal abnormalities: Down, Turner, Klinefelter, Edward and Patau.

Section D: Molecular Genetics
Unit 6: Heritable changes (mutations) and their causes **3 hours**
Physical and chemical mutagens, Transposable genetic elements and their role in mutations.

Unit 7: Diagnostics for human genetic disorders **3 hours**
Molecular, chromosomal and biochemical testing

Unit 8: DNA fingerprinting as molecular signatures- applications **4 hours**
Forensics (case studies), Paternity testing, unique identity establishment, conservation, finding adulterants in food/drugs.

Practicals **60 hours**
1. To understand the genetic interaction involved using the given seed mixture. Genetic ratios to be calculated using Chi square analysis.
2. Pedigree analysis (Sex linked dominant and recessive; autosomal dominant and recessive)
3. To study/list human dominant and recessive traits and to observe the listed physical traits among the students present in the class. Analyse the results.
4. To study the syndrome through photographs (Klinefelter, Turner, Downs /Patau/Edwards)
5. To demonstrate variation in the ability to taste PTC (Phenylthiocarbamide) in a given population.
6. Chromosomal and gene mutations: Complex translocation ring, quadrivalents, lagging chromosomes, dicentric/inversion bridge, sickle cell anaemia, xeroderma pigmentosum
7. To study sex chromosomes in *Drosophila, Melandrium, Coccinia* and human through photographs.

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.
4. Campbell, N.A., Urry,L.A., Cain, M.L., Wasserman,S.A., Minorsky, P.V., Reece, J.B. (2020). Biology, 12th Edition. Harlow,England : Pearson

Additional Resources:

1. Hartl, D.L., Ruvolo, M. (2019). Genetics: Analysis of Genes and Genomes, 9th edition. New Delhi, Delhi: Jones and Bartlett Learning.
2. Snustad, D.P., Simmons, M.J. (2019). Principles of Genetics, 67th edition. New Delhi, Delhi: John Wiley & sons.
3. Singh, B. D. (2023). Fundamentals of Genetics, 6th edition. MedTech.

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SWAMI SHRADDHANAND COLLEGE
Bachelor of Science (Hons.) in Applied Life Sciences with
Agrochemicals and Pest Management
Botany Component

DISCIPLINE SPECIFIC CORE COURSE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Genetics and Molecular Biology ALS BOT DSC 03	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as
follows:

- To understand the basic concept of Mendelian genetics and comprehensive study of Mendelian extensions.
- To provide adequate knowledge about Linkage, Crossing over and Mutations.
- To provide brief knowledge of population and evolutionary genetics.
- To impart detailed understanding about the structure of nucleic acids and their types.
.
- To understand key events of Molecular biology comprising mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes.
- To give comprehensive explanation of Transcriptional Regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms along with the key concept of Gene Silencing.

Learning Outcomes:

By studying this course, students will be able to:

- Analyse the basic concepts of Mendelian genetics and its extension, Linkage and Crossing over, Mutations and population genetics.
- Explicate the mechanism of replication, transcription, translation in prokaryotes and eukaryotes.
- Comprehend the mechanism of gene regulation and gene silencing.

Unit 1: Mendelian Genetics and Extensions **(3 Hours)**

Mendel's work on transmission of traits, Co-dominance, Incomplete dominance, Multiple alleles, Lethal Genes, Epistasis, Pleiotropy, Polygenic inheritance, Pedigree analysis.

Unit 2: Extra-chromosomal Inheritance **(2 Hours)**

Cytoplasmic inheritance: Chloroplast variegation in Four 'O clock plant, Kappa particles in *Paramecium*, Maternal effect - shell coiling pattern in snail.

Unit 3: Linkage, Crossing over and Chromosomal Mapping **(3 Hours)**

Linkage and crossing over, Recombination mapping - two point and three points.

Unit 4: Mutations **(3 Hours)**

Chromosomal mutations, Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy, Gene mutations.

Unit 5: Population and Evolutionary Genetics **(2 Hours)**

Allelic frequencies, Genotypic frequencies, Gene pool, Hardy-Weinberg Law.

Unit 6: The Genetic Material: DNA and RNA **(4 Hours)**

DNA structure: Salient features of double helix, Types of DNA, DNA denaturation and renaturation, Nucleosome, Chromatin structure- Euchromatin, Heterochromatin (Constitutive and Facultative), RNA structure and its types.

Unit 7: Replication of DNA **(3 Hours)**

Mechanism of prokaryotic DNA replication, Chemistry of DNA synthesis, Enzymes and proteins involved in DNA replication, Comparison of replication in prokaryotes and eukaryotes.

Unit 8: Transcription and Processing of RNA **(4 Hours)**

Mechanism of transcription in prokaryotes and eukaryotes, Split genes: concept of introns and exons, Removal of introns, Spliceosome machinery group I & group II intron splicing, alternative splicing, eukaryotic mRNA processing (5' cap, 3' poly A tail).

Unit 9: Translation (3 Hours)

Mechanism of translation in prokaryotes and eukaryotes: initiation, elongation and termination of polypeptides, Proteins and enzymes involved in translation.

Unit 10: Regulation of transcription in prokaryotes and eukaryotes (3 Hours)

Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli*, Eukaryotes: Transcription factors, Heat shock proteins, Gene silencing.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

1. To study Mendelian and Non- Mendelian gene interaction ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) through seeds.
2. To study linkage, recombination, gene mapping using marker-based data from *Drosophila*.
3. Karyotype and Idiogram preparation through photographs.
4. PTC testing in a population and calculation of allelic and genotypic frequencies.
5. Study of abnormal human karyotype and pedigrees.
6. Isolation of genomic DNA from Cauliflower curd.
7. Qualitative analysis of DNA using gel electrophoresis.
8. Estimation of DNA by Diphenylamine method.
9. Separation of nucleotide bases by paper chromatography.
10. Purity and quantitative estimation of isolated DNA by UV-VIS spectrophotometer.
11. Study of Molecular techniques: PCR, Southern, Northern and Western Blotting and PAGE.

Essential/ Recommended readings:

5. Snustad D.P. and Simmon M.J. (2012) *Genetics* 6 th Ed., John Wiley & Sons. (Singapore)
6. Pierce B.A, (2012) *Genetics - A Conceptual Approach*, 4 th Ed., W.H. Freeman & Co. (New York)

7. Griffiths A.J.F., Wessler S. R, Carroll S. B and Doebley J. (2010) *An Introduction to Genetic Analysis*, 10th Ed., W.H. Freeman & Company (New York).
8. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2007) *Molecular Biology of the Gene*, 6th Ed. Pearson Benjamin Cummings, CSHL Press, New York, U.S.A.

Suggestive readings:

3. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009) *Concepts of Genetics*. 9th Ed. Benjamin Cummings. U.S.A.
4. Russell, P. J. (2010) *Genetics- A Molecular Approach*. 3rd Ed. Benjamin Cummings, U.S.A.

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DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 01)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecology, Conservation and Restoration ALS BOT DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To develop a scientific understanding of the diverse aspects of ecology.
- To familiarize students with the interactions between the organisms and their physical environment.
- To understand various attributes of populations and communities with the help of theoretical concepts and field studies.
- To make students understand various factors that lead to variations among populations of a species.
- To familiarize students about the concepts of conservation and restoration.

Learning Outcomes:

By studying this course, students will be able to:

- Gain knowledge about the basic concepts of ecology.
- Comprehend the characteristics of the community, ecosystem development and climax theories.
- Explicate the relationship of evolution of various species and their environment.
- Analyse the basic field studies including data collection and its interpretation.
- Explicate the Conservation and Restoration methods.

Unit 1: Introduction to Ecology **(3 Hours)**

Autecology and Synecology, Laws of limiting factors, Study of physical factors: Temperature and Light.

Unit 2: Population (4 Hours)

Unitary and Modular populations, Unique and group attributes of population: density, natality, mortality, Life tables, Fecundity table, Survivorship curves, Intraspecific population regulation: density-dependent and independent factors.

Unit 3: Species Interactions (5 Hours)

Types of species interactions, Interspecific competition: Lotka-Volterra model of competition, Gause's Principle, Niche concept, Predation, Predator defence mechanisms.

Unit 4: Community (4 Hours)

Community characteristics: species richness, dominance, diversity, abundance, guilds, ecotone and edge effect, Ecological succession with examples and types.

Unit 5: Ecosystem (5 Hours)

Types of Ecosystems: terrestrial and aquatic ecosystems, Vertical stratification in tropical forest, Food chain: detritus and grazing food chains, linear and Y-shaped food chains, F ood web, Energy flow through the ecosystem: Ecological pyramids and Ecological efficiencies, Biogeochemical cycles: Nitrogen cycle.

Unit 6: Conservation (5 Hours)

Ecology in wildlife conservation and management: In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries), Ex-situ conservation (botanical gardens, gene banks, seed and seedling banks, DNA banks), Principles of Environmental impact assessment.

Unit 7: Restoration (4 Hours)

Restoration ecology: Afforestation, Social forestry, Agro-forestry, Joint Forest management, Role of remote sensing in management of natural resources.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

12. Study of life tables and plotting of survivorship curves of different types from hypothetical/real data.
13. Determination of population density and abundance in a natural or a hypothetical community by quadrat method.
14. Quantitative analysis of herbaceous vegetation in the college campus and comparison with Raunkiaer's Frequency distribution law.
15. Study of morphological features of hydrophytes and xerophytes in the ecosystems.
16. Measurement of temperature, turbidity/penetration of light and pH of any two water samples.

17. Comparison of Dissolved oxygen content in different water samples using Winkler's titration method.
18. Comparison of organic carbon of two soil samples using Walkley and Black's rapid titration method.
19. Comparison of CO_2 and alkalinity in two different water samples.
20. Estimation of Total Dissolved Solids (TDS) in water samples.
21. Perform Rapid field tests to detect the presence of Carbonates, Nitrate, Sulphate, Chloride, Organic matter and Base deficiency in two soil samples.
22. A visit to a National Park/Biodiversity Park/Wildlife Sanctuary/Urban Forest.

Essential/Recommended readings:

4. Sharma, P.D. (2012). *Ecology and Environment*. Rastogi Publications.
5. Singh J.S., Singh S.P., and Gupta S. R. (2014) *Ecology, Environment Science and Conservation*. S. Chand and Company Limited.
6. Odum, E.P. and Barrett G. W. (2004) *Fundamentals of Ecology*. Indian Edition (5th) Brooks/Cole Publishers.

Suggestive readings:

4. Smith T. M. and Smith R. L. (2015). *Elements of Ecology*. 9^{th} International Edition, Publisher: Benjamin Cummings.
5. Saha G.K. and Mazumdar S. (2020) *Wildlife Biology*, An Indian Perspective.Publisher: PHI Learning Private Limited
6. Futuyma, Douglas and Mark, Kirkpatrick (2017). *Evolutionary Biology* (3rd Edition), Oxford University Press

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

CHEMISTRY COMPONENT

DISCIPLINE SPECIFIC CORE COURSE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Organic Chemistry; ALS CHEM DSC 03	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- To teach the fundamentals of organic chemistry.
- To introduce the basic concepts of stereochemistry of organic molecules.
- To familiarize students to different types of organic reactions.
- To inculcate the basics of reaction mechanism through different reactive intermediates.

Learning Outcomes:

By studying this course, students will be able to:

- Explain the relative behavior of organic compounds based on fundamental concepts learnt.
- Illustrate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Differentiate between various types of organic reactions possible on the basis of reaction conditions.

Unit 1: Basic Concepts **(6 Hours)**

Electronic displacements and their applications: Inductive, electromeric, resonance (mesomeric) effects and hyperconjugation. Dipole moment, acidic and basic behaviour of organic molecules.
Homolytic and heterolytic fission. Types, shape and relative stability of carbocations, carbanions and free radicals. Electrophiles and nucleophiles.

Unit 2: Stereochemistry **(10 Hours)**

Stereoisomerism: Concept of asymmetry and Optical activity, Chirality in molecules with one and two stereocentres. Fischer projection, enantiomers, diastereomers and meso structures. Specific rotation.

Configuration: CIP rules: Erythro/Threo, D/L and R/S designations.
Geometrical isomerism: *cis-trans, syn-anti* and *E/Z* notations.
Conformational Isomerism: Newmann, Sawhorse, Fischer and their interconversion.
Conformations, relative stability and energy diagrams of Ethane, Propane and butane. Relative stability of cycloalkanes (Baeyer strain theory), Cyclohexane conformations with energy diagram. Conformations of monosubstituted cyclohexanes.

Unit 3: Types of Organic Reactions **(10 Hours)**

Introduction to substitution, addition, elimination, rearrangement, oxidation and reduction reactions.
Nucleophilic substitution reactions-SN1 and SN2 mechanisms with stereochemical aspects and effect of solvent.
Elimination reactions: E1 and E2 mechanisms, Saytzeff, Hoffmann eliminations and Cope elimination. nucleophilic substitution vs. elimination.
Free radical substitutions: Halogenation of alkanes and concept of relative reactivity and selectivity.
Electrophilic addition reactions of alkenes and alkynes: mechanism with suitable examples, (Markownikov's/anti-Markownikov's addition), syn and anti-addition; addition of hydrogen, halogens, hydroboration-oxidation, ozonolysis and hydroxylation.

Unit 4: Aromaticity **(4 Hours)**

Concept of Aromaticity: Electrophilic aromatic substitutions (with their mechanism): halogenation, nitration, Friedel Crafts alkylation/ acylation, sulphonation. Orientation and reactivity in mono-substituted aromatic compounds.

PRACTICAL **(Credit: 02)**

(Laboratory practical- 15 classes of 4 hours each)

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Calibration of thermometer.
3. Criteria of purity: Determination of melting point.
4. Effect of impurity on the melting point.
5. Determination of boiling point of liquid compounds (boiling point lower than and more than 100 °C by distillation and inverse capillary method).
6. Detection of extra elements.

7. Separation of a mixture of two amino acids/sugars by radial/ascending paper chromatography.
8. Preparations (Mechanism of various reactions involved to be discussed):
   a. Bromination of phenol/aniline
   b. Benzoylation of phenol/aniline
   c. Nitration of nitrobenzene/toluene

The above derivatives should be prepared using 0.5-1 g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Essential/Recommended readings

1. Mehta Bhupinder; Mehta Manju (2015), *Organic Chemistry*, Second Edition, ISBN-978-81-203-5126-4, PHI Learning Pvt. Ltd. New Delhi.
2. Sykes, P.(2003), *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition Pearson Education.
3. Eliel, E. L. (2001), *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
4. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), *Organic Chemistry*, 7th Edition, Pearson Education.
5. Bahl, A; Bahl, B. S. (2019), *Advanced Organic Chemistry*, 22nd Edition, S. Chand.

Suggestive readings

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), *Vogel's Textbook of Practical Organic Chemistry*, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), *Practical Organic Chemistry*, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), *Advanced Experimental Organic Chemistry*, Manakin Press.
4. Pasricha, S.; Chaudhary, A. (2021), *Practical Organic Chemistry: Volume I*, I K International Publishing House Pvt. Ltd., New Delhi.
5. Singh, J.; Awasthi, S. K.; Singh, Jaya. (2023) *Fundamentals of Organic Chemistry-III*, Pragati Prakashan.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 01)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Heterocyclic Chemistry; ALS CHEM DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The Learning objectives of this course are as follows:

- To teach students the fundamentals of heterocyclic chemistry.
- To make them familiar with classification and nomenclature of heterocyclic compounds.
- To study structural characteristics, physical properties, synthesis and chemical reactions of heterocyclic compounds.
- To know the importance of heterocyclic compounds.

Learning Outcomes:

By studying this course, students will be able to:

- Classify and name heterocyclic compounds.
- Analyze the important synthetic routes, physical properties, chemical properties and reactivity of five and six membered heterocyclic compounds.
- Explain the heterocyclic structures in biologically active compounds.
- Apply the study of heterocyclic compounds in medicine, agrochemicals, dyes and pigments, plastics and polymers.

Unit 1: Introduction and Nomenclature **(4 Hours)**

Introduction and classification of heterocyclic compounds. Nomenclature: Trivial names of common ring systems, Systematic (Hantzsch-Widman) nomenclature for heterocyclic compounds, naming of fused ring systems and Replacement nomenclature.

Unit 2: General Properties and Synthesis of Five and Six Membered Heterocyclic Compounds **(8 Hours)**

General discussion on the following aspects of five and six membered heterocyclic compounds containing one heteroatom: Structure, aromaticity, basicity, physical properties and general methods of synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene and Pyridine (Hantzsch synthesis).

Unit 3: Reactions of Five and Six Membered Heterocyclic Compounds (10 Hours)

Furan, Pyrrole, Thiophene: Orientation and reactivity towards electrophilic substitution reactions with mechanism.
Discussion on the following reactions: Nitration, sulphonation, halogenation, formylation, acylation, mercuration and carboxylation. Reactions exhibiting acidic/basic character. Oxidation, reduction and addition reactions. Diels-Alder reaction, reaction with diazonium salt.
Pyridine: Electrophilic substitution, nucleophilic substitution, oxidation and reduction reactions.

Unit 4: Importance of Heterocyclic Compounds (8 Hours)

Structure and importance of the following selected biologically active compounds to be discussed:
Heterocyclic Amino Acids: Proline, Hydroxyproline, Histidine, Tryptophan. Heterocyclic Vitamins; Niacin (Vitamin B3), Pyridoxine (Vitamin B6), Riboflavin (Vitamin B2), Thiamin (Vitamin B1) and Ascorbic acid (Vitamin C).
Pigments of Life: Hemoglobin and Chlorophyll.
Nucleic acids: Ribonucleic Acid (RNA) and Deoxyribonucleic Acid (DNA), Purines and Pyrimidines.

Structure and importance of the following selected Natural Products**:** Alkaloids, Marine Heterocycles, Halogenated Heterocycles, Macrocycles containing Oxazoles and Thiazoles, Anthocyanins and Flavones.

Structure and importance of heterocyclic compounds in Medicine, Agrochemicals, Dyes and pigments, Plastics and polymers.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

The following synthesis should be done by using 0.5-1 g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

1. Synthesis of oxygen containing heterocyclic compounds:
   (a) Phthalic anhydride (b) 7- Hydroxy-4-methylcoumarin

2. Synthesis of nitrogen containing heterocyclic compounds:
   (a) Phthalimide (b) Phthaloylglycine
3. Synthesis of Imidazole derivatives:
   (a) Benzimidazole (b) 2-Benzylbenzimidazole (c) 2-Methylbenzimidazole
4. Synthesis of Pyrazole derivatives:
   (a) 3-Methyl-2-pyrazolin-5-one (b) 3, 5-Dimethylpyrazole
5. Synthesis of Pseudothiohydantoin

Essential/Recommended readings

1. Mehta Bhupinder and Mehta Manju (2015) "*Organic Chemistry" 2nd Edn*., PHI Learning Pvt. Ltd. New Delhi. ISBN-978-81-203-5126-4.
2. Bansal Raj K "*Heterocyclic Chemistry" 5th Ed*, New Age International Publishers. ISBN 978-81-224-3143-8.
3. J. A. Joule, K. Mills and G. F. Smith, "*Heterocyclic Chemistry" 5th Edn.,* Wiley International Publications. ISBN: 978-1-4051-3300-5.
4. Thomas. L. Gilchrist "*Heterocyclic Chemistry" 3rd Edn.*, Prentice Hall Publication. ISBN 978-0-5822-7843-1.
5. R. M. Acheson "*An Introduction to the Chemistry of Heterocyclic compounds" 3rd Edn.,* Wiley India Pvt. Ltd. ISBN-13:978-8126516605.
6. I L Finar, "*Organic Chemistry" Vol. 1*, 6th Edn., Pearson Education. ISBN 10: 8177585428.
7. T. W. Graham Solomons, "*Organic Chemistry*" 12th Edn., John Wiley. ISBN-10: 1118133579.
8. Parashar, R. K.; Negi, B., "*Chemistry of Heterocyclic Compounds"*, 2015, Ane Books. ISBN-1466517131.

Suggestive readings

1. A.O. Fitton and R.K. Smalley, "*Practical Heterocyclic Chemistry"* 1st Edn., Academic Press. ISBN:9781483270791.

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), "*Vogel's Textbook of Practical Organic Chemistry"*, Pearson.

3. Mann, F.G.; Saunders, B.C. (2009), "*Practical Organic Chemistry*", Pearson.

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ZOOLOGY COMPONENT

DISCIPLINE SPECIFIC CORE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Cell Biology and Biochemistry ALS ZOO DSC 03	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To understand structure and functions of various cellular compartments and cell organelles.
- To learn about cell-cycle and its regulation.
- To acquire the knowledge of biomolecules and metabolic pathways.
- To study about enzyme action.

Learning Outcomes:

By studying this course, students will be able to:

- correlate the structure of various cell components with their function.
- describe the metabolic fate of carbohydrates, proteins and fats and understand the mechanics of enzyme action.

Unit 1: Basic structure of cell and cell organelles (12 Hours)

Prokaryotic and eukaryotic cells. Structure of cell membrane: various models, fluidity of membrane. Eukaryotic cell organelles: Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi body and Lysosomes. Nucleus: Nuclear Envelope- structure of nuclear pore complex, chromatin- euchromatin and heterochromatin; DNA packaging in eukaryotes.

Unit 2: Cell Cycle **(3 Hours)**

Cell division: Mitosis and Meiosis. Regulation of cell cycle.

Unit 3: Biomolecules and Metabolic pathways **(11 Hours)**

Introduction to Biomolecules: Carbohydrates, Lipids, and Proteins. Glycolysis, Kreb's Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen Metabolism. β oxidation of palmitic acid. Transamination, Deamination and Urea Cycle.

Unit 4: Enzyme action and regulation **(4 Hours)**

Mechanism of action (induced fit theory), Enzyme Kinetics (Michaelis Menten equation for single enzyme single substrate reactions), Enzyme inhibition and regulation.

PRACTICAL **(Credit: 02)**

(Laboratory practical- 15 classes of 4 hours each)

1. Preparation of a temporary stained squash of onion root tip and to study various stages of mitosis.
2. Study of various stages of meiosis through permanent slides.
3. Cytochemical demonstration of DNA by Feulgen reaction.
4. Perform qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
5. Study of activity of salivary amylase under optimum conditions.
6. Separation and identification of amino acids by paper chromatography

Essential/Recommended readings

1. Becker, Kleinsmith, and Hardin (2018) *The World of the Cell*, IX Edition, BenjaminCummings Publishing, San Francisco.
2. Karp, G. (2015). *Cell and Molecular Biology: Concepts and Experiments*, VIII Edition, John Wiley & Sons Inc.
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2015) *Biochemistry*. VII Edition. W.H Freeman and Co.
4. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.

Suggestive readings

1. Cooper, G.M., Hausman, R.E. (2019) *The Cell: A Molecular Approach*. VIII Edition, ASM Press and Sinauer Associates.
2. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 01)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Biostatistics and Bioinformatics ALS ZOO DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To acquaint the students of the application of statistical methods for analysing the biological data.
- To impart the theoretical and practical knowledge of biological databases and use of various software for their analysis.

Learning Outcomes:

By studying this course, students will be able to:

- use statistical formulae for analyzing data.
- apply statistical tests like Chi-square tests, Z-test and t- test etc. for testing hypothesis.
- Use different biological databases and bioinformatic tools.

Unit 1: Introduction to Biostatistics (2 Hours)

Definition, Aim and Scope, Applications and limitations of biostatistics.

Unit 2: Measures of Central Tendency and Dispersion (6 Hours)

Mean, Median and Mode; Variance, Standard deviation, Standard error, Co-efficient of Variance.

Unit 3: Testing of Hypothesis and Statistical Tests (7 Hours)

Type-I and Type-II errors; Confidence Intervals and Confidence Levels, Chi-square test, Z-test and t-test.

Bioinformatics

Unit 4: Introduction to Bioinformatics **(3 Hours)**

Historical background, Aims and scope, Bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology, Applications and Limitations in bioinformatics.

Unit 5: Biological Databases **(5 Hours)**

Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB).

Unit 6: Basic Concepts of Sequence Alignment **(7 Hours)**

Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

PRACTICAL **(Credit: 02)**

(Laboratory practical- 15 classes of 4 hours each)

Part - A Biostatistics

1. To compute Coefficient of Variance from samples provided.
2. To collect data on different parameters of animal samples and test significant difference between means (Z-test, t-test).
3. To compute 'test of independence' and test for 'goodness of fit' with samples/data provided.
4. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

Part - B Bioinformatics

1. To learn about biological databases and their characteristics.
2. To retrieve nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST).

4. To perform multiple sequence alignment (Clustal X)

Essential/Recommended readings

1. Ghosh Z and Mallick B. (2008). Bioinformatics: *Principles and Applications*, Oxford University Press.
2. Pevsner J. (2009). *Bioinformatics and Functional Genomic*s, II Edition, Wiley Blackwell.
3. Zar, Jerrold H. (1999). *Biostatistical Analysis*, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA

Suggestive readings

1. Zvelebil, Marketa and Baum O. Jeremy (2008. *Understanding Bioinformatics*, Garland Science, Taylor and Francis Group, USA.
2. Antonisamy, B., Christopher S. and Samuel, P. P. (2010). *Biostatistics: Principles and Practice*. Tata McGraw Hill Education Private Limited, India.
3. Pagana, M. and Gavreau, K. (2000). *Principles of Biostatistics,* Duxberry Press, USA

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B.Sc (H) Biomedical Science

SEMESTER –III

Biomedical Science: ***II Year***

DISCIPLINE SPECIFIC CORE COURSE -7 (BIOMED-DSC-07) MEDICAL MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Medical Microbiology DSC-07	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

The Learning Objectives of this course are as follows:

- The Medical Microbiology course has been formulated to impart basic and medically relevant information on microbes.
- The microbial structure, growth and development. Methods of isolation and characterization of microbes and role of sterilization in the context of study of microbes.
- Pathogenic microbes and the diseases caused by them are included to broaden the perspective of the subject.
- This course will also focus on mechanisms of microbial pathogenesis and the host response, and the scientific approaches that are used to investigate these processes.
- The course also deals with the problem of emerging antimicrobial resistance with reference to known pathogens.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Medical microbiology describes a broad perspective to study structure, classification, and diseases caused by microbes including bacteria, fungi, protozoa and viruses. The course helps to understand the nature of microorganism, their systematic classification and contribution of various scientists in the discovery of disease causing pathogen and its etiology. It also describes various culture media used for cultivation of microbes, their optimum physical, chemical and cultural requirements, techniques for purification and preservation of microbes.
- This course explains the various types of microbial cells, shape, size, molecular structure and their role in pathogenesis. The basic nutrient requirements of microorganism and how they behave in variable atmospheric conditions is also included. Analyzing optimum growth conditions that facilitate in growth and cultivation of useful microorganisms are also mentioned.
- Microbial genetics helps to understand the basic phenomenon of gene functioning and effects of various mutagens on microorganism, elucidates different methods of gene transfer and explains causes of genetic variation.
- Course also elucidates the interaction between host and their pathogens, mode of transmission of infectious diseases and their cure.
- This course also explains pathogenesis, etiology, clinical symptoms, control and cure of microbial diseases in addition to introducing antimicrobial action of antibiotics. Describes basic structural and morphological variation in various viruses, classification and their life cycle. Introduction to requirements of viruses for multiplication and detailed study of common disease causing viruses, virusoids and prions is also included.

SYLLABUS OF BIOMED-DSC-07

Unit I: Fundamental concepts (10 hrs)

a) History of microbiology with special emphasis on contribution of Louis Pasteur and Robert Koch in Medical Microbiology.
b) Major Divisions of life- Domains, Kingdoms; Requirements for microbial growth, growth factors, culture media- synthetic and complex, types of media. Techniques for obtaining pure cultures of microbes, preservation and storage of bacterial cultures, growth curve and generation time, control of microbial growth.

Unit II: Bacterial cell: fine structure and function (10 hrs)

Size, shape and arrangement of bacterial cells; Cell membrane, cytoplasmic matrix, inclusion bodies (e.g.Carboxysomes, magnetosomes, gas vacuoles, cyanophycean granules, PHB granules, glycogen granules), nucleoid, ultrastructure of gram positive and gram negative bacterial cell wall, sex pili, capsule, flagella & motility and endospore.

Unit III: Microbial genetics **(08 hrs)**

Mutants-auxotrophs and prototrophs, bacterial recombination: general and site specific and replicative, bacterial plasmids fertility factor, col plasmid, bacterial conjugation (Hfr, F′, F^+, F^-), transformation, transduction- both generalized and specialized.

Unit IV: Host-pathogen relationship in the infectious diseases **(05 hrs)**

Relationship between normal microbiota and host, opportunistic microorganisms, nosocomial infections. Development and spread of infectious diseases: invasion, pathogen, parasite, pathogenicity, virulence, carriers and their types. Routes, mechanisms of invasion and establishment of infection.

Unit V: Microbial diseases **(06 hrs)**

Respiratory tract infections: with tuberculosis in detail, gastrointestinal tract infections, staphylococcal food poisoning. Life cycle of *Candida albicans* and *Plasmodium*.

Unit VI: Virus and virusoids **(06 hrs)**

General life cycle of a virus, structure, enveloped and un-enveloped viruses, plaque assay, growth curve, classification based on genetic material and detail study of influenza, SARS COV-2 and HIV virus with curative agent. Viroids, virusoids and prions.

Practical **(30 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of different media: synthetic media Davis-Mingioli media, complex media-nutrient agar or Luria agar media.
2. Isolation and purification of pure bacteria: streaking for single colonies
3. Propagation of pure bacteria in liquid culture
4. Gram's staining; gram positive and gram negative bacteria

5. Capsule staining of *Bacillus subtilis*/*Klebsiella*
6. Endospore staining of *Bacillus subtilis*
7. Study and plotting the growth curve of *E. coli* using turbidometric method
8. Isolation of bacteriophages from soil/sewer water and calculation of the plaque forming units (pfu)
9. To perform antibacterial testing by Kirby-Bauer method
10. Field visit to a clinical microbiology lab/diagnostic lab to familiarize with latest tools and techniques used in microbial research

Essential readings:

- Dorothy Wood, Joanne Willey, Kathleen Sandman (2022). 12th Edition. Prescott's microbiology. New York, USA: McGraw-Hill Education. ISBN-10: 1-264-77733-7 / 1264777337
- Cappuccino, J.G. and Sherman, N. (2013). 10th Edition. Microbiology: A laboratory manual. California, USA: Benjamin Cumming. ISBN-13: 978-0321840226.

Suggestive readings:

- Tille, P. (2013). 13th Edition. Bailey & Scott's diagnostic microbiology. Missouri, USA: Mosby Publishers. ISBN-13: 978-0323083300.
- Madigan, M.T., Martinko, J.M., Stahl, D.A. and Clark, D.P. (2010). 13th Edition. Brock biology of microorganisms. California, USA: Benjamin Cumming. ISBN-13: 978-0321649638.
- Pelczar, M.J (2001). 5th Edition. Microbiology. New York, USA: McGraw Hill International. ISBN-13: 9780074623206.
- Tortora, G.J., Funke, B.R. and Case C.L. (2006). 9th Edition. Microbiology: An introduction. California, USA: Benjamin Cummings. ISBN-13: 978-0536292117.

DISCIPLINE SPECIFIC CORE COURSE -8 (BIOMED-DSC-08) MEDICINAL CHEMISTRY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MEDICINAL CHEMISTRY DSC-08	4	3	0	1	XII Passed	Basic knowledge of Enzymes and proteins

Learning objectives

The introduction of Medicinal Chemistry course at undergraduate level to Biomedical Science students has been conceived to make them understand:

- Concealed chemical science interlinked to other science disciplines such as biophysics, chemistry, biology, biochemistry, pharmacology etc.
- Application of the area in revealing new drug design and targets through studying the drug-receptor interactions and signaling mechanism in cell for lead discovery.
- Various drug targets in the body and drug development strategies with mechanism of action and concept of drug resistance.

Learning Outcomes

- After completing the course, students shall be able to understand the various stages involved in drug development. Further, they will be able to explore various kinds of drug targets including protein, enzymes, nucleic acids etc.
- They will also appreciate the process of drug-receptor interactions; identify association between chemical structure and its physicochemical properties. After the completion of the course, the learners will demonstrate a strong foundation via problem solving, critical thinking and analytical reasoning in the fundamentals of medicinal chemistry, physicochemical principles of drug action and measurement of drug effects, comprehend the physicochemical basis for the rational drug design, analogue synthesis, and mechanism of action of drugs.
- Additionally, this course will involve extensive laboratory work. The students will be able to

design and carry out small molecule (low molecular drug-relevant compounds) synthesis. They will do the natural product isolation along with their purification and characterization through chromatography and spectroscopic methods and analyze the results of such experiments.

- They will also actively participate group exercises; communicate the results of experiments conducted in oral as well as written formats. Further, they will appreciate the central role of chemistry in our daily life and will also learn safe handling of hazardous chemicals and follow the SOP for chemical waste disposal.

SYLLABUS OF BIOMED-DSC-08

Unit-1: General introduction (02 hrs)

Definition and scope of Medicinal Chemistry

Unit-2: Principles of Drug Design (10 hrs)

Introduction to Structure Activity Relationship (SAR) of morphine/salicylic acid, strategies in the search for new lead compounds, analogue synthesis versus rational drug design, concept of prodrugs. Affinity, efficacy and potency of drugs. Concepts of agonist, antagonist and inverse agonist, competitive, non-competitive, suicide inhibitors.

Unit-3: Physicochemical principles of drug action and measurement of drug effects (10 hrs)

Partition coefficient, drug dissolution, acid-base properties, surface activity, bioavailability, stereochemical aspects of drug action, electronic structure (Hammett correlations) and determining relationship between chemical and biological data (Hansch approach). Kinetic analysis of ligand receptor interactions using Scatchard plot, Double reciprocal plot, Hill plot, forces involved, relationship between dose and effect (graded and quantal response).

Unit-4: Drug target classification (15 hrs)

a. Proteins as drug targets.
   i. Receptors: the receptor role, ion channels, membrane bound enzyme activation, desensitization and sensitization of receptors, agonist (e.g. endorphins) and antagonists(e.g. caffeine)
   ii. Enzymes: Enzyme inhibitors, medicinal use of enzyme inhibitors (e.g. clavulanic acid)

b. Nucleic acids as drug targets. Classes of drugs that interact with DNA: DNA intercalators (amsacrine), Groove binders (netropsin), DNA alkylators (amines: mechlorethamine; nitrosoureas: carmustine), concept of antisense therapy.

Unit-5: How drugs trigger the signals-molecular aspects **(08 hrs)**

Structure and functions of cell surface receptors, signal transduction mechanism (GPCRs, tyrosine kinase, guanylate-cyclase linked receptors and intracellular receptors that regulate DNA transcription).

Practical **(30 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation, recrystallization and purity of following drugs/compounds by melting point and TLC
   i. Hippuric acid.
   ii. Benzocaine,
   iii. Benzoquinone
   iv. Phenacetin
   v. s-benzyl thiouronium salt.
2. Determination of partition coefficient of aspirin in octanol-water system.
3. Extraction of caffeine from tea leaves.
4. Study absorption properties of caffeine.
5. Extraction of piperine from black pepper.
6. Phytochemical screening of *Curcuma longa* by solvent extraction: Terpenes and polyphenols

Essential Readings:

- Patrick G.I. (2017). 6th Edition. Introduction to medicinal chemistry. Oxford, UK: OxfordUniversityPress.ISBN-13: 978-0198749691.
- Silverman, R.B. and Holladay, M.W. (2015). 3rd Edition. The organic chemistry of drug design and drug action. San Diego, USA:Elsevier,AcademicPress.ISBN-13:9780123820303.
- Ashutosh Kar (2020) Advanced Practical Medicinal Chemistry 3rd Edition New Age International Private Limited, ISBN-10 : 9388818458

Suggestive Reading:

- Wermuth, C.G., Aldous, D., Raboisson, P. and Rognan, D. (2015). 4thEdition. The practice of medicinal chemistry. San Diego, USA: Elsevier, Academic Press. ISBN-13:978-0124172050.
- Nogrady, T. and Weaver, D.F. (2005). 3rd Edition. Medicinal chemistry: A molecular and biochemical approach. New York, USA: Oxford University Press. ISBN-13:978-0195104561.
- King F.D. (2003). 2nd Edition. Principles and practice of medicinal chemistry. London, UK: The Royal Society of Chemistry. ISBN-13: 978-0854046317.
- Gringauz, A. (1996). 1st Edition. Introduction to medicinal chemistry: How drugs act and why. Brooklyn, New York, USA: WileyVCH.ISBN-13:978-0471185451.

DISCIPLINE SPECIFIC CORE COURSE- 9 (BIOMED-DSC-09) BIOSTATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BIOSTATISTICS – DSC 09	**4**	**3**	**0**	**1**	**XII Passed**	**Basic knowledge of biology**

Learning objectives

The Learning objectives of this course are as follows:

- To acknowledge, appreciate and effectively incorporate the basic statistical concepts indispensable for carrying out and understanding biological hypotheses, experimentation as well as validations.
- The course is aimed to create awareness about the applications of statistics in biological sciences along with building confidence in students to test their experimental data with an appropriate test of significance.

Learning outcomes

Having successfully completed this course, students shall be able to:

- Appreciate the importance of statistics in biological sciences. They will also understand the concept of different variables and data types, and also the sampling techniques.
- Learn different measures of central tendency and dispersion with their applications. The students will also learn symmetric and asymmetric distributions, and kurtosis of distributions.
- Identify the degree of uncertainty in making important decisions, learning joint probability, conditional probability, Bayes' theorem and solving its application-level problems.
- Learn about the characteristics of normal, binomial and Poisson probability distributions. They will learn how to identify which type of distribution fits the given data and estimate

probabilities for random variables in these distributions

- Determine the strength of the relationship between two variables and also to predict the value of one variable given a value of another variable.
- Learn how to formulate statistical hypotheses for testing and application of different tests of significance for hypothesis testing for different biological problems.

SYLLABUS OF BIOMED-DSC-09

Unit I: Introduction to Biostatistics (02 hrs)

Types of data in biology, random variables: discrete and continuous. sample and population, techniques of sampling (random and stratified), sampling and non-sampling errors.

Unit II: Descriptive Statistics (08 hrs)

Measures of central tendency: arithmetic mean, mode, median and partition values. Measures of dispersion: range, standard deviation, coefficient of variance and covariance, masures of skewness: Pearson's Coefficient of skewness, and concept of kurtosis (platykurtic, mesokurtic and leptokurtic).

Unit III: Probability (05 hrs)

Basic concepts, addition and multiplication, rules of probability, conditional probability, Bayes' theorem and its applications in biostatistics.

Unit IV: Probability distributions (06 hrs)

Binomial and normal distributions along with their properties and relationships. Introduction to poisson distribution.

Unit V: Correlation and Linear Regression (06 hrs)

Correlation analysis: scatter diagrams, Pearson's and Spearman's coefficient of correlation, coefficient of determination.

Simple linear regression analysis: method of least squares, equations of lines of regression and their applications in biostatistics.

Unit VI: Hypothesis testing (18 hrs)

Sampling distributions and standard error, Null and Alternate hypothesis, Basic concept and illustrations of type I and type II errors, concept of confidence interval estimation. Large sample tests for single mean and difference of means.

Student's t-distribution: test for single mean, difference of means and paired t-test. Chi-square distribution: test for goodness of fit, independence and homogeneity. F-test, one-way and two-way analysis of variance (ANOVA).Non-parametric analysis: The Sign test and The Wilcoxon signed-rank test.

Practical **(30 hrs)**

The computer-based experiments are designed for students to solve biostatistics problems. All theoretical concepts would be covered in the practical using any spreadsheet software like MS EXCEL.

1. Represent different types of data in tables and graphs (Line chart, histogram, bar chart, frequency polygon, pie chart).
2. Calculate various measures of central tendency (Arithmetic mean, mode, median and partition values) and dispersion (Range, standard deviation, coefficient of variance and covariance).
3. Calculate probabilities for different distributions- normal and binomial.
4. Prepare scatter plot between two variables and interpret the relationship between them using correlation and simple linear regression analysis.
5. Perform large sample test for single mean and difference of means.
6. Perform Student's t-test for one sample, independent samples, and paired samples.
7. Perform Chi-square test.
8. Perform One-way ANOVA.
9. Perform Two-way ANOVA.
10. Perform Non-parametric analysis: The Sign test or The Wilcoxon signed-rank test.

Essential readings:

- Daniel, W.W. and Cross, C.L. (2019). 11th Edition. Biostatistics: A foundation for analysis in the health sciences. New York, USA: John Wiley & Sons. ISBN: 9781119588825.
- Pagano, M. and Gauvrean, K. (2018). 2nd Edition. Principles of biostatistics. California, USA: Duxbury Press. ISBN-13: 9781138593145.
- Schmuller, J. (2016). Statistical Analysis with Excel for Dummies. 5th Edition. New York, USA: John Wiley & Sons. ISBN: 9781119844549.

Suggestive readings:

- Triola M.M., Triola M.F., Roy J. (2019). Biostatistics for Biological and Health Sciences. Harlow, UK: Pearson Education Ltd.
- Zar, J.H. (2014). 5th Edition. Biostatistical analysis. USA: Pearson. ISBN: 9789332536678Glantz, S. (2012). 7th Edition. Primer of biostatistics. New York, USA: McGraw-Hill Medical. ISBN: 9780071781503.

POOL OF DSE FOR 3rd SEMESTER & 4th SEMESTER

DISCIPLINE SPECIFIC ELECTIVE COURSE –1 (BIOMED-DSE-1) PROTEINS AND ENZYMES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PROTEINS AND ENZYMES BIOMED-DSE-01	4	3	0	1	XII Passed	Basic knowledge of Biochemistry

Learning objectives

The Learning Objectives of this course are as follows:

- The objective of this course is to provide an overview of protein biochemistry and enzymology.
- Proteins and enzymes, being the most versatile functional entities, hold several applications in life sciences research as well as in industry and biomedicine.
- The biochemical, structural, and functional aspects of the interaction of proteins and enzymes will be introduced in this course.

Learning outcomes

The Learning outcomes of this course are as follows:Having successfully completed this course, students shall be able to learn and appreciate:

- The unique features and characteristics of proteins and enzymes and their applications in research, medicine, and industry.
- The relationship between three–dimensional structure of proteins and enzymes and their functions.

- The basic mode of action of enzymes and their remarkable regulation.
- The protein misfolding and the diseases associated with it.
- The students would be able to understand the various biomedical applications of enzymes.
- The students would be able to gain hands-on experience in working with proteins and enzymes from various sources. Hence, it will improve their learning skills and imbibe the basic concepts of this field.

SYLLABUS OF BIOMED-DSE 01

Unit I: Structural organization of proteins (08 hrs)

Organization of protein structure- primary, secondary, tertiary, and quaternary. Secondary structures – helices, sheets and turns. Motifs, domains and their functional importance. Native and denatured state of a protein. Physico-chemical interactions that maintain the native structure of a protein.

Unit II: Protein folding and diseases related to protein misfolding (10 hrs)

Protein folding (Hydrophobic collapse), Anfinsen theory, Levinthal paradox and protein folding in the cytoplasm. Protein denaturation by chaotropic agents such as urea, GnHCl. Concept of how mutation causes protein misfolding (loss-of-function to toxic-gain-of function) and related diseases such as Alzheimer's disease, Prion diseases, Tay-Sachs disease and Huntington disease.

Unit III: Enzymes: characteristics and kinetics (14 hrs)

Classification of enzymes and nomenclature. Concept of multi-functional enzyme and multi-enzyme complex. Fischer's lock & key and Koshland's induced fit hypotheses. Enzyme specificity. Enzyme kinetics- Michaelis-Menten equation, Lineweaver-Burk plot. To understand the physiological significance of K_m, V_{max}, K_{cat} and the factors affecting enzyme activity. Basics of enzyme inhibition- reversible (competitive, uncompetitive, non-competitive) and irreversible inhibition.

Unit IV: Regulation of enzyme activity (06 hrs)

Allosteric regulation, feedback inhibition, reversible covalent modification (Phosphorylation, glycosylation and acetylation using example of glycogen phosphorylase/glycogen synthase). proteolytic activation- zymogens.

Unit V: Biomedical application of enzymes **(07 hrs)**

Applications of enzymes in the diagnosis of diseases using creatine kinase and glucose oxidase and in therapy (streptokinase). Enzyme inhibitors as drugs. Principle of enzyme immunoassay. Enzyme immobilization and its applications, concept of abzymes. Industrial applications of enzymes (biosensor - HRP; food industry- rennin; cosmetics-collagen, etc)

Practical **(30 hrs)**

(Wherever wet-lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs, etc.)

1. Enzyme-based diagnostic assay (any one).
2. Measurement of enzyme activity and calculation of specific activity of an enzyme.
3. Effect of pH on enzyme activity.
4. Effect of temperature on enzyme activity
5. Visualization of 3D protein structure using suitable software.
6. Analysis of type of enzyme inhibition from the given experimental data
7. To study the effect of protein denaturants such as acid, alkali, heat and any organic solvent on protein.
8. Study of images of various toxic protein oligomeric species, associated with human diseases (amyloids, disordered aggregates, amorphous aggregates).

Essential readings:

- Nelson, D. L., & Cox, M. M. (2021). *Lehninger: Principles of Biochemistry* (8^{th} ed.). Macmillan. ISBN: 9781319322328.
- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). *Biochemistry*. New York, USA: W. H. Freeman and Company.
- Voet, D., Voet J., Pratt, C. (2018). *Principles of Biochemistry*(5^{th}ed.) Wiley Blackwell. ISBN: 978-1-119451662.
- Plummer, D. (2017) An Introduction to Practical Biochemistry, (3^{rd} ed.). McGraw-Hill College; ISBN-13: 978-0070841659.

Suggestive readings:

- Devlin, (2011). Textbook of Biochemistry with Clinical Correlations. UK: Wiley T & Sons.
- Campbell, M. K. and Farrel, S. O. (2012) (7th ed.). Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN: 13:978-1-111-42564-7
- Cooper, T.G. (2011). The Tools of Biochemistry (2nd ed.). Wiley-Inter science Publication (New Delhi). ISBN: 13:9788126530168.
- Sheehan, D. (2009). Physical Biochemistry (2nd ed.). Wiley-Blackwell (West Sussex), ISBN: 9780470856024/ISBN: 9780470856031.
- Nicholes,C.P., Lewis, S. (1999). Fundamentals of Enzymology (3rd ed.). Oxford University Press Inc. (New York), ISBN:0 19850229 X

DISCIPLINE SPECIFIC ELECTIVE COURSE –02 (BIOMED-DSE-02) PRACTICES IN BIOSAFETY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PRACTICES IN BIOSAFETY BIOMED-DSE-02	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

- Recent advances in the field of Biomedical Research have brought into focus the need for certain practices and strategies to prevent exposure to pathogens and toxins.
- The inventions in the field of Genetic Engineering have significantly influenced agriculture, medicine and food processing industry. Thus implementation of biosafety enables number of procedures and rules that will be helpful in protecting humans and environment from disease causing microorganisms, pests, additives, contaminants and residues etc.
- Topics such as responsible use of biotechnology, biosafety levels, genetically modified (GM) food, biosafety regulations, impact of biotech processes on environment are of major significance in present scenario.

Learning outcomes

- In this students would understand application of biotechnology in different fields like agriculture, environment, industrial manufacturing, food processes, health and medicine etc. It will enable them to recognize implication of recombinant biomolecules and organisms on our society.

- This would enable students to know about various hazardous biological substances one can come across while working in the laboratory or day today life, and the steps taken to minimize the risk. The students would understand different regulations for handling biohazard and radioactive material.
- The course should kindle the inquisitiveness in students about genetically modified and living modified organisms (GMO & LMO) and their impact on the environment.

SYLLABUS OF BIOMED-DSE-02

Unit I: Introduction to biosafety (04 hrs)

Historical background of Biosafety, definition of biosafety, application of biosafety and need for biosafety.

Unit II: Social responsibility of biotechnology and biomedical research (08 hrs)

Legal and socio-economic impacts of biotechnology. Social responsibility towards safety measures.Social and ethical implications of biological weapons (Bioterrorism).Implication of recombinant biomolecules and organisms. Implication of gain of function research. Importance of biotechnology: benefits and limitations of transgenic to human health, society and the environment.

Unit III: Biosafety and importance of containment facility (08 hrs)

Components of biosafety (biohazard and biosecurity), measures of biosafety, containment (good laboratory practices and techniques, safety equipment, design facility), types of containment (physical and biological). Biosafety levels (BSL 1, 2, 3, 4), barriers (physical and secondary).

Unit-IV: Genetically modified organism: concerns and challenges (10 hrs)

Government of India definition of genetically modified organisms (GMOs) and living modified organisms (LMOs), roles of institutional biosafety committee, review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMO in rDNA biosafety guidelines of India. Biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.

Unit-V: Handling and transportation of GM, infectious and radioactive materials (09 hrs)

Classification of infectious organisms, transportation of genetically modified/infectious organisms, General preparation of shipments for transport: Basic triple packaging system, marking of packages, labelling, precautions, monitoring strategies and methods for detecting transgenic; radiation safety and non-radio -isotopic procedures.

Unit VI: Biosafety guidelines and regulations (06 hrs)

Aim of biosafety guidelines, biosafety and risk assessment issues; regulatory framework; national biosafety policies and law, the cartagena protocol on biosafety, WTO and other international agreements related to biosafety.

Practical (30 hrs)

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs)

1. Protocol for development of recombinant / engineered proteins as therapeutics
2. Preparation of comparative account on BSL 1, 2,3,4. (poster, oral presentation, video)
3. Categorization of list of provided hazardous materials and its handling & disposal
4. To study GEAC guidelines on genetically modified crops (Bt-cotton/Bt-brinjal)
5. To develop an understanding of the role and composition of an ethical committee for research by a presentation mode.
6. To study and develop a flowchart to demonstrate spread and containment of any two infectious diseases (typhoid, SARS, Ebola, Dengue, Tuberculosis and Covid).
7. Preparation of chart explaining significance of various symbols used in chemistry and biology laboratories/ reagent bottles and equipment.

Essential Readings:

- Hunt, E. F. and Colander, D. C. (2019). 17th edition. Social science: An introduction to the study of society. Boston, USA: Pearson/Allyn and Bacon. ISBN 9781138592537.
- Helga, K. and Peter, S. (2016). 3rdedition. A companion to bioethics. New Jersey, USA: John Wiley and Sons. ISBN 9781118941508.
- Beauchamp, T.L and Childress, J.F. (2013). 8th edition. Principles of biomedical ethics.

Oxford, UK: Oxford University Press. ISBN 9780190640873.

- Peter, A. S. and Viens, A. M. (2008). 1st edition. The Cambridge textbook of bioethics. Cambridge, UK: Cambridge University Press.ISBN 9780521872843.
- Sateesh, M.K. (2008). 1st edition. Bioethics and Biosafety. New Delhi, India: I K International Pvt Ltd. ISBN 978-8190675703.

Suggestive readings:

- Rebecca, G.; James, F. H.; Karim, M. M.; Cholani,W. (2011). 1st edition. Environmental safety of genetically engineered crops. Michigan, USA: Michigan State University Press. ISBN 978-1611860085.
- Sreekrishna, V. (2007). 1st edition. Bioethics and biosafety in biotechnology. New Delhi, India: New Age International (P) Ltd. ISBN 978-8122420852.
- Rajmohan, J. (2006). 1st edition. Biosafety and bioethics. New Delhi, India: Isha Books. ISBN 13: 9788182053779.
- Tomme, Y. (2004). 1st edition. Genetically modified organisms and biosafety. Gland, Switzerland: World Conservation Union publications. ISBN 2831707986

DISCIPLINE SPECIFIC ELECTIVE COURSE –03 (BIOMED-DSE-03) SOCIAL AND PREVENTIVE MEDICINE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
SOCIAL AND PREVENTIVE MEDICINE **BIOMED-DSE-03**	**4**	**3**	**0**	**1**	**XII Passed**	Student should have studied science (Biological science/ Physical sciences)

Learning objectives

- The origin of medicine to alleviate human suffering from disease, and control of disease is as old as origin of human itself. Various civilizations practiced their own methods to treat and control diseases.
- The modern form of medicine that has evolved over time, is composed of two main branches viz: Curative medicine and Preventive medicine/Public health. It has been realized that causes of diseases are multifactorial- a disease can have multiple causes/factors such as social, economic, genetic, psychological and environmental factors.
- In the centre of modern medicine is epidemiology, which is concerned with measuring distribution patterns and determinants of disease in a Population/community, and needs of health related services.
- The health related services are delivered through health programmes and health systems to various risk groups such as at risk-mothers, at risk-infants, elderly or chronically ill patients.

Learning outcomes

- Introduction to various concepts of health and disease, factors determining health of individuals or population/community, interaction of factors in causing disease. Students will also be introduced to the concepts of levels of prevention adopted to achieve a state of health or to preserve health.
- Epidemiology is in the core of basic science of social preventive and medicine, and is concerned with study/measurement of the distribution and determinants of health related issues. Students will be introduced to the concepts of epidemiology, various methods and approaches that are used to measure the intensity and distribution of health related issues in the community/population.
- Introduction to the various definitions/ concepts related to natural history of disease viz: mode of disease transmission and progress of infection/disease in the host. Students would get opportunity to learn natural history of communicable disease, diagnosis, treatment and control, and various health programmes for prevention (with examples of certain prevalent diseases in India. Through examples of few diseases prevalent in India and globally, epidemiology of those diseases which are considered as lifestyle diseases or multi-factorial diseases will be introduced.
- The definition of health also includes dimensions of social and mental well-being. Therefore, mental illness has been recognized as one of the important health issues. Students will be introduced to the various types of mental illness and its prevention.
- Infertility is a worldwide problem, and estimates of infertility in India are about 4-6 percent. Childlessness is social and demographic implications. The etiology of infertility is variable. Mother and children are considered as special-risk group in a population, and is a priority group in any community. The mother, and the growth and development of fetus/ infants are at the risk of several health problems. Further, under certain circumstances, their survival too is at risk. The multitude of problems affecting the health of mother and child constitutes serious health problems in a developing country. Students will be introduced to the various maternal and child health related problems/ complications (and their prevention), from conception to the birth of infants.
- Health has been declared a fundamental human right and has to be delivered by the governments to all. Therefore, there is a system to promote and provide health services to every individual living in urban or rural settings. Students will be introduced briefly about the system of health care and various levels of health care in India.

SYLLABUS OF BIOMED-DSE-03

Unit I: Basic concepts of health and disease **(06 hrs)**

Definition, determinants and indicators of health and disease, demography (transition, and sources of demographic data, registries), survey methodology including census procedures and sampling. epidemiological triad. Multi-factorial aetiology of disease. Concepts of prevention and control.

Unit II: Epidemiology and epidemiological methods **(06 hrs)**

Definition and history, components of epidemiological studies viz. disease frequency, distribution and determinants. Basic measurements/tools in epidemiology: rates, ratios and proportions (mortality and morbidity rates and ratios, prevalence, incidence); epidemiological studies: descriptive, analytical, randomized controlled trials. Concept of association and causation. Brief introduction to modern epidemiological tools.

Unit III: Epidemiology of diseases **(16 hrs)**

Various definitions: epidemic, endemic, pandemic, sporadic, nosocomial infections etc. Cases, carriers, transmission of disease, concept of incubation period, generation time, communicable period and secondary attack rate.

a. Communicable diseases: control and health care programs for of national importance (extent of problem in India and worldwide, main clinical features, diagnosis, treatment & resistance, immunization and prevention practices, health programmes (if applicable):

Respiratory infections:	*Tuberculosis*
Intestinal infections:	*Cholera*
Arthropod-borne infections:	*Malaria*
Zoonosis:	*Rabies*
Sexually transmitted infection:	*AIDS*

b. Non-communicable disease: control and health care programs for of national importance (extent of problem, diagnosis, treatment and control, health programmes (if applicable): Hypertension, stroke, diabetes, breast cancer.

Unit IV: Mental health **(05 hrs)**

Introduction and scope. Features of mentally healthy person, signs of poor mental health, types of mental health (anxiety and depression), and prevention. National Mental Health Programme

(NMHP).

Unit V: Infertility, mother and child health (06 hrs)

Measures of fertility and factors affecting fertility, child health, maternal health, immunization programme.

Unit VI: Health care system in India (06 hrs)

Concept of health care, levels of health care, brief introduction to Primary Health Care in India (village level, sub-centre level, primary health centre level, community health centre level, hospitals).National Programme for Health Care of the Elderly (NPHCE).

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To explore any publically available database for tuberculosis/typhoid and study its epidemiology in the Indian population.
2. To study the epidemiology of malaria including geographical and seasonal distributions in India through a public database.
3. To study various parameters like risk factors, incidence, prevalence, mortality rate and DALYs. for any specific type of cancer prevalent in India through NCRP or any other public database.
4. To study the burden and causes of any hematological disorder in the Indian population.
5. To explore and analyse various national and international disease databases like ICMR/WHO/CDC/ etc.
6. To prepare a questionnaire for any health condition studied in S.No. 1-5.

7-10. To prepare a poster/ presentation using any digital media to communicate about the epidemiology and to create awareness about any health condition studied in S.No. 1-5.

Essential reading

- Park, K. (2021), 26th Edition, *Park's Textbook of Preventive and Social Medicine*,

Banarsidas Bhanot Publisher, ISBN-13 : 978-9382219163.

Suggestive reading:

- Bonita, Ruth, Beaglehole, Robert, Kjellström, Tord& World Health Organization. (2006) 2nd edition. *Basic Epidemiology*, World Health Organization, ISBN 978 92 4 154707 9.

GENERIC ELECTIVE COURSE -04 (BIOMED-GE-04): BIOCHEMICAL BASIS OF LIFE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BIOCHEMICAL BASIS OF LIFE BIOMED-GE-04	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

The Learning Objectives of this course are as follows:

- The objective of this course is to address how the wonderful and remarkable properties of living organisms arise from the various biomolecules, the building blocks.
- The course focuses on the chemical complexity and organization of molecules in a living cell, extraction and transformation of energy
- It gives insights into the changes that occurred during the gradual evolution of life.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The fundamental Chemistry of Life: students will gain an understanding of the elements found in living systems and appreciate the importance of water as the solvent for living systems. It is important to learn about the units used for expressing the biochemical basis of a living system. Students will learn the unit system for the molecular mass of biomolecules, units used for the concentration of solutions, and units for expressing the distances, etc.
- Cellular foundations of life**: a** stepwise organization of a living system, starting from the smallest unit to an entire living organism would be the focal point in this unit.

- Molecular basis of life: students will understand the monomeric forms of different types of biomolecules. In addition, the relationship between the structure and function of biomolecules would also be learnt.
- Physical foundation of life: students would learn the concept of enthalpy, entropy and free energy in a living system and understand the importance of the energy currency and the significance of coupled biochemical reactions.
- Biochemical events in the origin of life: students would learn the origin of life and the nature of transformative changes that occurred for life to evolve from the pre-biotic world to the modern times.

SYLLABUS OF BIOMED-GE-04

Unit I: The fundamentals of chemistry of life (06 hrs)

Carbon chemistry of life, structure and importance of water, diverse inorganic ions, major elements (C, H, O, N, S), trace elements. Units used in biochemistry such as those expressed for the atomic mass unit (daltons), concentration (moles/litre) and distance (in nanometer-scale).

Unit II: Cellular foundations of life (06 hrs)

Levels of organization in a living system. The important features of living cells, subcellular organelles in eukaryotic cells and subcellular organization in prokaryotic cells. Brief description on phototrophs, chemotrophs, autotrophs and heterotrophs.

Unit III: Molecular basis of life (12 hrs)

Common functional groups and linkages in biomolecules.

Macromolecules: classification, building blocks, structural and functional diversity. Structural and functional forms of macromolecules: Proteins (collagen, albumin, hormones (insulin), enzyme (proteases, nucleases, amylases and lipases); Polysaccharides (starch, glycogen, cellulose), Nucleic acids, Lipids (cholesterol and triglycerides).

Unit IV: Physical foundation of life (11 hrs)

Enthalpy, Entropy, Free Energy, Standard Free Energy, Equilibrium constant, Open and closed systems, endergonic and exergonic reactions, the energy currency in a biological system (ATP), energy coupling reactions.

Unit V: Biochemical events in the origin of life **(10 hrs)**

Landmark events in the evolution of life. Biochemical basis of the origin of aerobic and anaerobic world. Evolution of biological monomers and polymers from pre-biotic compounds. Properties of DNA as genetic material. Structural and functional analysis of eukaryotes and prokaryotes, with suitable examples.

Practical **(30 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of buffer at a specific molarity and pH.
2. Numerical problems based on Enthalpy, Free Energy and Entropy.
3. Comparative analysis of protein content in egg white and egg yolk using Bradford method.
4. Detection of a glucose polymer (starch) in rice/potato/corn, using iodine test.
5. To assess the differential solubility of lipids in aqueous and organic solvents.
6. Extraction of DNA from plant/microbial cells by the spooling method.
7. Demonstration of agarose gel electrophoresis for analyzing the isolated DNA.
8. To compare the structural features of a prokaryotic and eukaryotic cell by studying their electron micrographs.

Essential readings

- Nelson, D.L. and Cox, M.M. (2021). Lehninger: Principles of Biochemistry(7th ed.). W.H. Freeman & Company (New York), ISBN:13:9781319322328
- Pratt, C.W. and Cornely, K.(2017). Essential Biochemistry (4th ed.) John Wiley& Sons, Inc.ISBN:9781119012375
- Plummer, D.T. (2012). An Introduction to Practical Biochemistry. New Delhi, India: McGraw-Hill College.

Suggestive readings:

- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). Biochemistry. New York, USA: W. H. Freeman and Company.
- Campbell, M. K. and Farrell, S. O. (2017) 9th Edition. Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN-13: 978-1305961135

GENERIC ELECTIVE-05 (BIOMED-GE-05) HEALTH AND BODY DEFENSE SYSTEM

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
HEALTH AND BODY DEFENSE SYSTEM BIOMED-GE-05	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

The Learning Objectives of this course are as follows:

- Characteristics of a healthy body and ways to improve one's health and well-being.
- Body defense system is a comprehensive study of the organization and functioning of the immune system with its network of cells and molecules. Understanding the biology of the immune system is key to developing strategies towards prevention and cure to a number of disorders and diseases that result due to malfunctioning and dysregulation of the immune system.
- This paper covers the organization and functioning of the various branches of immune system, namely, Innate and adaptive Immunity to combat different pathogens. Various Immunological techniques will also be taught to the students.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students learn various aspects of health and immune system in normal and infectious stage which equips students to design better strategies for combating the immunological disorders. Students will be given an overview to various pathogens and immune system in Invertebrates and Vertebrates.

- Students learn historical perspective of the extensive field of Immunology. They are introduced to the important concepts of Immunology.
- Students will be familiarized with origin and maturation of all blood cell types in bone marrow and thymus. They will understand the process of haematopoiesis, functions of various types of cells and roles played by them in generating immune responses against pathogens.
- The unit entails different barriers of Innate Immunity, Cells, Complement system, Patterns on the pathogens recognized by receptors of Innate Immune system, pathogen killing by the immune cells and concept & the importance of the Inflammation in an Immune response.
- Students will learn about the cells of adaptive immune system, the concept of antigen, antibody molecules and role of major histocompatibility complex & associated cells in the processing and presentation of antigen. The students will explore the branches of adaptive immunity - the humoral and cell mediated, their components and interplay of these components in combating the infection. The students will also be able to understand the significance of various kinds of growth factors and cytokines in the activations of various lymphocytes
- The students will be given knowledge about the principle, methodology and applications of various laboratory techniques involving antigen-antibody reaction.
- Vaccine based immunotherapies and their designing will assist them to think about new path for combating with pathogens and working mechanisms of immune system.
- The students will be made aware about the importance of diet and lifestyle in promoting Immunity and health.

SYLLABUS OF BIOMED-GE-05

Unit I: Hallmarks of health (06 hrs)

Basic aspects of healthy body: cells, tissue and organ system, difference between prokaryotes and eukaryotes. Key differences between bacteria, fungi, protozoans and viruses.
Requirements for ahealthy body according to age and gender. Survival strategies of host against the invading pathogens: bacterial defense against bacteriophage, immune system of plants, invertebrates (mollusca) and vertebrates.

Unit II: Introduction and Organization of Immune System (06 hrs)

Historical background, general concepts of the immune system, innate and adaptive immunity; active and passive immunity, contributions of Sir Edward Jenner and Louis Pasteur in vaccine development. Lymphoid organs: thymus, bone marrow and haematopoiesis, lymph nodes, spleen

Unit III: Innate Immune response (09 hrs)

Physical and chemical barriers; cells of the innate immune system: natural killer cells, monocytes and macrophages; neutrophils, eosinophils, basophils, mast cells and dendritic cells: structure, phenotypic and functional aspects.

Complement system: components of the complement activation classical, alternative and lectin pathways; biological consequence of complement activation.

Mechanisms of pathogen killing by macrophages and neutrophils: receptor/non receptor mediated endocytosis, phagosome formation, phagolysosome formation, respiratory burst phenomenon.

Inflammation: concept, hall marks of inflammation.

Unit IV: Adaptive Immune Response (10 hrs)

Cells of the adaptive immune system: T and B lymphocytes; characteristics of adaptive immune response: self and non-self recognition, specificity, diversity and memory, primary and secondary immune response, allergen/ allergy.

Antigens: antigenicity and immunogenicity, haptens. Properties (foreignness, molecular size, heterogeneity, route and dose of administration, solubility and degradability); host factors (genotypes, gender, nutrition);blood group antigens and transfusion reactions.

Basic function of major histocompatibility complex

Importance of Antigen presentation; types of antibodies and their function; cell mediated immune response. Major steps in T cell differentiation in thymus: thymic selection, self MHC restriction, T cell receptor assembly. Phenotypic characteristics of naïve T-cells ($CD4^+$ and $CD8^+$ T-cells). Migration of naïve T-cells from thymus to secondary lymphoid organs. Activation of T-cells, proliferation of clonally selected T cells and their effector functions, concepts of T-helper 1 (TH_1) and T-helper 2 (TH_2) cells. Basic introduction to cytokines: IL-2, IL-4 and IFN-γ. Contribution of MHC, B-cell receptor (BCR) and T-cell receptor (TCR) to diversity in adaptive immune response

Unit V: Immunological principles of various reactions and techniques (05 hrs)

Basic concepts of antigen-antibody interactions (epitope-paratope), affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immune-electrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), western blotting, immunofluorescence microscopy, immunohistochemistry and lateral flow assay.

Unit VI: Diet, nutrition and life style in promoting health and Immunity (09 hrs)

Importance of a well- balanced nutrition, the role of Immunity boosters and immunomodulators from kitchen shelf (Any two: turmeric, ashwagandha, tomato & giloy), vitamins and minerals in improving health and defense. Role of probiotics, gut microbiota and prebioticsin regulating health and immunity. Role of physical activity and emotional & Mental state in regulation of immunity status, holistic health and happiness. A primer on our traditional practices, yogic lifestyle and meditation in creating homeostasis in the body (balancing *Vatta, Pitta* and *Kapha*) will also be given.

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Visualization of antigen-antibody interaction by Ouchterlony method
2. To perform Immuno-diffusion by Mancini Method
3. To perform Complement fixation assay
4. To perform sandwich dot ELISA
5. To perform Widal test (Indirect/passive agglutination) for the detection of typhoid antigen and blood group determination (direct agglutination)
6. To perform SARS-CoV-2 rapid antigen test(Lateral flow Assay)
7. Project work based on historical research work in the area of immunology.
8. Case studies on hypersensitivity reactions(seafood hypersensitivity, erythroblastosis fetalis)

Essential readings:

- Punt, J. Stranford, S. Jones, P. and Owen, J. (2019). 8th Edition. Kuby Immunology. New York, USA: W.H. Freeman and Company. ISBN- 13: 978-1464189784.
- Delves, P.J. Martin, S.J. Burton, D.R. and Roitt, I. M. (2017). 13th Edition. Roitt's Essential Immunology. New Jersey, USA: Wiley-Blackwell Science. ISBN: 13: 978- 1118415771.

Suggestive readings for basics:

- Ananthanarayan R and Jayaram Paniker CK (Author), Reba Kanungo (Editor) (2020) Ananthanarayan and Paniker's Textbook of Microbiology, Eleventh Edition. Universities Press (India) Pvt. ISBN **9389211433**
- Willey, J. Sherwood, L and Woolverton, C.J. (2016). 10th Edition. *Prescott's Microbiology*. New York, USA: McGraw-Hill Education. ISBN-13:978-1259281594.
- Satomi Oshima; Zhen-Bo Cao; Koichiro Oka (2015) 'Physical Activity, Exercise, Sedentary, Behavior and Health' Springer Tokyo Heidelberg New York Dordrecht London ISBN 978-4-431-55333-5 (eBook)
- Guglielmo M Trovato (2012) Behavior, nutrition and lifestyle in a comprehensive health and disease paradigm: skills and knowledge for a predictive, preventive and personalized medicine. Trovato EPMA Journal 2012, 3:8 (Review Article)
- Kindt T. J., Osborne B. A., Goldsby R. A. (2007). 6th Edition *Kuby Immunology*. New York, USA: W.H. Freeman and Company. ISBN-13: 978-1429202114 ISBN-10: 1429202114.
- Hay, F.C. and Westwood, O.M.R. (2002). 4th Edition. *Practical Immunology*. New Jersey, USA: Blackwell Science. ISBN:9780865429611
- Practical Ayurveda: Find Out Who You Are and What You Need to Bring Balance to Your Life Paperback – 5 June 2018 by Sivananda Yoga Vedanta Centre. Publisher : DK; Illustrated edition (5 June 2018) ISBN-10 : 1465468498, ISBN-13 : 978-1465468499.
- BYG-002 Yoga and Health, Block 4 Yogic Lifestyle, School of Health Science, Indira Gandhi National Open University (https://drive.google.com/file/d/10j00rWXLsCEV5cTbzK-hM43ezlNvn0hl/view)

GENERIC ELECTIVE -06 (BIOMED-GE-06) UNDERSTANDING THE HUMAN BODY SYSTEMS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
UNDERSTANDING THE HUMAN BODY SYSTEM BIOMED-GE-06	4	3	0	1	XII Passed	Basic knowledge of human physiology

Learning objectives

The Learning Objectives of this course are as follows:

- This is an introductory course dealing with the structure and function of the human organism and the issues facing the human in today's world.
- It is intended for students with limited science background. It would make them familiar with basic physiological concepts.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students will have an increased understanding and appreciation for the workings of the human body. They will be familiar with the terminology and physiology of the major organ systems
- They will be able to explain the relation between form and function in biology, as expressed in molecular, cellular, and whole-organism physiology.
- Students will be able to recognize the anatomical structures and explain the physiological functions of the body systems.
- Recognize the anatomical structures and explain the physiological functions of the body systems. Develop scientific terminology to describe the parts and processes of the human body.

SYLLABUS OF BIOMED-GE- 06

Unit I: Body organization and integumentary system (05 hrs)

General anatomy of the body, introduction to various kinds of body planes, cavities and their membranes, tissues level of organization and classification (types, origin, function & repair). Structure and functions of human skin. Blood as connective tissue

Unit II: Nervous and Endocrine system (10 hrs)

Organization of the central and peripheral nervous system. Nerve physiology, motor and sensory physiology(special senses). General mechanism of hormone action, structure, function and regulation of the major gland of the body: pituitary, hypothalamus, thyroid, pancreas and adrenals. Basic concepts about hypo and hyper secretion of hormones.

Unit III: Muscular and skeletal system (05 hrs)

Functional anatomy of muscular system, types of muscles, neuromuscular junction structure, property and transmission, general characteristics of muscle contraction using skeletal muscle as example.

Unit IV: Cardiovascular and respiratory system (08 hrs)

Functional anatomy of heart, the cardiac cycle, electrocardiogram. Circulatory system: Blood vessels, hemodynamics and regulatory mechanisms. Lymphatic circulation - hemodynamics and regulation, micro-circulation, functional anatomy of the respiratory system. Mechanisms of pulmonary and alveolar, gaseous exchange, transport of gases, respiratory and nervous control and regulation of respiration.

Unit V: Gastrointestinal system and Renal physiology (11 hrs)

Anatomy and histology of the digestive tract. General principles of gut motility secretion, digestion, absorption and assimilation. Functional anatomy of kidney, histology of nephron and its physiology, process of urine formation. Urinary bladder: structure, micturition and its regulation

Unit VI: Reproductive System (06 hrs)

Structure and function of male and female reproductive organs. Basic concepts of gametogenesis (oogenesis and spermatogenesis), fertilization, implantation, menopause and contraception.

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To prepare a blood smear and identify different types of white blood cells.
2. Estimation of hemoglobin (Sahli's method)
3. Physiological data acquisition based experiments (ECG/PFT/EMG).
4. Blood Pressure recordings in humans.
5. To study a simple reflex arc
6. To study the sensation of taste, touch and smell.
7. To study various types of contraceptives (condoms, IUDs, oral and injectable contraceptives)
8. To study different human organs and their sections through permanent histological slides T.S. of brain, spinal cord, skeletal fibers, cardiac muscles, skeletal muscles, T. S. of thyroid, liver, thymus, spleen, ovary, artery, vein, capillaries, testis, pancreas, esophagus, adrenal, kidney (cortex and medulla), urinary bladder, fallopian tubes, epididymis, lungs, trachea, heart. (minimum 8 slides covering the systems mentioned in theory).

Essential readings:

- Guyton and Hall Textbook of Medical Physiology, 14th edition (2020), J. E. Hall; W B Saunders and Company, ebook ISBN: 978-0-3236-4003-9; Hardcover ISBN: 978-0-3235-9712-8
- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6. (e book), ISBN: 978-1-119-70438-6 (for print book).
- Textbook of Practical Physiology, 9th edition (2019), CL Ghai; Jaypee Publication, ISBN-9789352705320.
- Human Physiology, 16th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN10: 1260720462; ISBN13: 978-1-26-072046-4.

Suggestive readings:

- Ganong's Review of Medical physiology, 26th edition (2019), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-26-012240-4 (for ebook) ISBN:978-1-26-012241-1 (for print Book)

DEPARTMENT OF PHYSICS
B. SC. (HONOURS) PHYSICS

DISCIPLINE SPECIFIC CORE COURSE – DSC - 7: MATHEMATICAL PHYSICS III

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Mathematical Physics III DSC – 7	4	3	0	1	Class 12^{th} Pass	Should have studied DSC - 1 and DSC - 4 of this program or its equivalent

LEARNING OBJECTIVES

The emphasis of course is on applications in solving problems of interest to physicists. The course will also expose students to fundamental computational physics skills enabling them to solve a wide range of physics problems. The skills developed during course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Determine continuity, differentiability and analyticity of a complex function, find the derivative of a function and understand the properties of elementary complex functions.
- Work with multi-valued functions (logarithmic, complex power, inverse trigonometric function) and determine branches of these functions.
- Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula.
- Find the Taylor series of a function and determine its radius of convergence.
- Determine the Laurent series expansion of a function in different regions, find the residues and use the residue theory to evaluate a contour integral and real integral.
- Understand the properties of Fourier transforms and use these to solve boundary value problems.
- Solve linear partial differential equations of second order with separation of variable method.
- In the laboratory course, the students will learn to,
    - create, visualize and use complex numbers
    - use Gauss quadrature methods to numerically integrate proper and improper definite integrals
    - Solve the boundary value problems numerically
    - Compute the fast Fourier transform of a given function

SYLLABUS OF DSC – 7

THEORY COMPONENT

Unit - I **(28 Hours)**

Complex Analysis: The field of complex numbers. Graphical, Cartesian and polar representation. Algebra in the complex plane. Triangle inequality. Roots of complex numbers. Regions in the complex plane – idea of open sets, closed sets, connected sets, bounded sets and domain.

(3 Hours)

The complex functions and mappings. Limits of complex functions. Extended complex plane and limits involving the point at infinity. Continuity and differentiability of a complex function, Cauchy-Riemann equations in Cartesian and polar coordinates, sufficient conditions for differentiability, harmonic functions. Analytic functions, singular points. Elementary functions. Multi-functions, branch cuts and branch points.

(10 Hours)

Integration in complex plane: contours and contour integrals, Cauchy-Goursat Theorem (No proof) for simply and multiply connected domains. Cauchy's inequality. Cauchy's integral formula. Taylor's and Laurent's theorems (statements only), types of singularities (removable poles and essential), meromorphic functions, residues and Cauchy's residue theorem, Jordan Lemma (statement only), evaluation of real integrals by contour integration (excluding integrands with branch points)

(15 Hours)

Unit – II **(9 Hours)**

Fourier Transform: Fourier Integral theorem (Statement only), Fourier Transform (FT) and Inverse FT, existence of FT, FT of single pulse, finite sine train, trigonometric, exponential, Gaussian functions, properties of FT, FT of Dirac delta function, sine and cosine function, convolution theorem. Fourier Sine Transform (FST) and Fourier Cosine Transform (FCT)

Unit – III **(8 Hours)**

Partial Differential Equations: Solutions to partial differential equations (2 or 3 independent variables) using separation of variables: Laplace's equation in problems of rectangular geometry. Solution of wave equation for vibrational modes of a stretched string. Solution of 1D heat flow equation (Wave/Heat equation not to be derived)

References:

Essential Readings:

1) Mathematical methods for Scientists and Engineers, D.A. McQuarrie, Viva Book, 2003
2) Essential Mathematical Methods, K. F. Riley and M. P. Hobson, Cambridge Univ. Press, 2011
3) Mathematical Methods for Physicists, G. B. Arfken, H.J. Weber, F. E. Harris, 7th Edition, Elsevier, 2013
4) Complex Variables and Applications, J. W. Brown and R. V. Churchill, 9th Edition, Tata McGraw-Hill, 2021
5) Complex Variables: Schaum's Outline, McGraw Hill Education, 2009
6) Fourier analysis: With Applications to Boundary Value Problems, Murray Spiegel, McGraw Hill Education, 2017
7) Fourier series and boundary value problems, J. W. Brown and R. V. Churchill, 5th

Edition, Tata McGraw-Hill, 1993.
8) Applied Mathematics for Engineers and Physicists, 3rd edition, L. A. Pipes and L. R. Harvill, Dover Publications.

Additional Readings:

1) Mathematical Physics with Applications, Problems and Solutions, V. Balakrishnan, Ane Books, 2017
2) Complex Variables, A. S. Fokas and M. J. Ablowitz, 8th Edition, Cambridge Univ. Press, 2011
3) Fourier Transform and its Applications, third edition, Ronald New Bold Bracewell, McGraw Hill, 2000
4) A Students Guide to Fourier Transforms: With Applications in Physics and Engineering, 3rd edition, Cambridge University Press, 2015
5) Partial Differential Equations for Scientists and Engineers, S. J. Farlow, Dover Publications, 1993
6) Differential Equations – Theory, technique and practice, George F. Simmons and Steven G. Krantz, Indian Edition McGraw Hill Education Pvt. Ltd, 2014

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

The aim of this lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- The course will consist of practical sessions and lectures on the related theoretical aspects of the laboratory.
- Assessment is to be done not only on the programming but also on the basis of formulating the problem.
- The list of recommended programs is suggestive only. More programs may be done in the class with physics applications. Emphasis should be given to formulate a physics problem as mathematical one and solve it by computational methods.
- At least 6 programs must be attempted (taking at least one from each unit). The implementation can be either in Python/ C++/ Scilab. Inbuilt libraries can be used wherever applicable.

Unit 1

Handling of Complex Numbers: Syntax for creating complex numbers in Python/C++/Scilab, accessing real and imaginary parts, calculating the modulus and conjugate of a complex number, complex number arithmetic, plotting of complex numbers as ordered pairs of real numbers in a plane, conversion from Cartesian to polar representation.

Recommended List of Programs:

a) Determine the nth roots of a complex number and represent it in Cartesian and polar form.
b) Transformation of complex numbers as 2-D vectors e.g. translation, scaling, rotation, reflection.
c) Visualisation of mappings of some elementary complex functions w = f(z) from z-plane to w-plane.

Unit 2

Gauss Quadrature Integration Methods: Gauss quadrature methods for integration: Gauss Legendre, Gauss Lagaurre and Gauss Hermite methods.

Recommended List of Programs:

a) Solving a definite integral by Gauss Legendre quadrature method. Application – representation of a function as a linear combination of Legendre polynomials.
b) Solving improper integrals over entire real axis or the positive real axis using Gauss Lagaurre and Gauss Hermite quadrature method. Comparison of results with the ones obtained by contour integration analytically.
c) Comparison of convergence of improper integral computed by Newton Cotes and Gauss Quadrature Methods.

Unit 3

Fast Fourier Transform: Discrete Fourier transform, Any algorithm for fast Fourier transform.

a) Computation of Discrete Fourier Transform (DFT) using complex numbers.
b) Fast Fourier Transform of given function in tabulated or mathematical form e.g function $\exp(-x^2)$.

Unit 4

Numerical Solutions of Boundary Value Problems: Two-point boundary value problems, types of boundary conditions – (Dirichlet, Neumann and Robin), importance of converting a physics problem to dimensionless form before solving numerically. Finite difference method, Shooting method with bisection/Secant/Newton method for solving non-linear equation and using RK methods for solving IVP (The programs developed in the last semester may be used here).

Algorithm for any one numerical method to solve Partial Differential Equations e.g. Finite Difference method, relaxation methods, Crank-Nicolson method

Recommended List of Programs:

(a) The equilibrium temperature of a bar of length L with insulated horizontal sides and the ends maintained at fixed temperatures.
(b) Solve for the steady state concentration profile y(x) in the reaction-diffusion problem given by $y''(x) - y(x) = 0$ with $y(0) = 1, y'(1) = 0$.
(c) Use any numerical method to solve Laplace equation/ Wave equation/ Heat equation.

References (for Laboratory Work):

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Schaum's Outline of Programming with C++, J. Hubbard, 2000, McGraw-Hill Education.
4) An Introduction to Computational Physics, T. Pang, Cambridge University Press, 2010
5) Introduction to Numerical Analysis, S. S. Sastry, 5th Edition, 2012, PHI Learning Pvt. Ltd.
6) Numerical Recipes: The art of scientific computing, William H. Press, Saul A. Teukolsky and William Vetterling, Cambridge University Press; 3rd Edition, 2007
7) Computational Problems for Physics, R. H. Landau and M. J. Páez, CRC Press, 2018

DISCIPLINE SPECIFIC CORE COURSE – DSC - 8: THERMAL PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Thermal Physics DSC – 8	**4**	**3**	**0**	**1**	Class 12^{th} Pass	NIL

LEARNING OBJECTIVES

This course deals with the relationship between the macroscopic and microscopic properties of physical systems in equilibrium. It reviews the concepts of thermodynamics learnt at school from a more advanced perspective and how to develop them further to build new concepts. The course gives an understanding about the fundamental laws of thermodynamics and their applications to various systems and processes. It also includes a basic idea about the kinetic theory of gases, transport phenomena involved in ideal gases, phase transitions and behaviour of real gases. The students will be able to apply these concepts to several problems on heat. The lab course deals with providing the knowledge of the concepts of thermodynamics studied in the theory paper with the help of experiments and give the students a hands-on experience on the construction and use of specific measurement instruments and experimental apparatuses used in the Thermal Physics lab, including necessary precautions.

LEARNING OUTCOMES

At the end of this course, students will be able to

- Comprehend the basic concepts of thermodynamics, the first and the second law of thermodynamics.
- Understand the concept of reversibility, irreversibility and entropy.
- Understand various thermodynamic potentials and their physical significance with respect to different thermodynamic systems and processes.
- Deduce Maxwell's thermodynamical relations and use them for solving various problems in Thermodynamics.
- Understand the concept and behaviour of ideal and real gases.
- Apply the basic concept of kinetic theory of gases in deriving Maxwell-Boltzmann distribution law and its applications.
- Understand mean free path and molecular collisions in viscosity, thermal conductivity, diffusion and Brownian motion.
- While doing the practical, the students will have an opportunity to understand and hence use the specific apparatus required to study various concepts of thermodynamics. Hence, the student will be able to comprehend the errors they can encounter while performing the experiment and how to estimate them.

SYLLABUS OF DSC - 8

THEORY COMPONENT

Unit – I - Zeroth and First Law of Thermodynamics (6 Hours)

Fundamental idea of thermodynamic equilibrium and Zeroth Law of Thermodynamics, concept of work and heat, First law of Thermodynamics and its differential form, internal energy, applications of First law: General relation between C_P and C_v, work done during various processes (all four) and related problems, adiabatic lapse rate, Compressibility and Expansion Co-efficient for various processes.

Unit – II - Second law of Thermodynamics (6 Hours)

Reversible and Irreversible processes, Carnot engine and Carnot's cycle, Refrigerator, efficiency of Carnot engine and refrigerator, Second Law of Thermodynamics: Kelvin-Planck and Clausius statements and their equivalence, Carnot's theorem, Applications of Second Law of Thermodynamics in the light of Phase Change, Thermodynamic Scale of Temperature and its equivalence to Perfect Gas Scale.

Unit – III – Entropy (6 Hours)

Concept of Entropy, Entropy changes in Reversible and Irreversible processes with examples, Clausius Theorem, Clausius inequality, Second Law of Thermodynamics in terms of Entropy. Temperature-Entropy diagrams for Carnot's cycle and related problems, Entropy of perfect and real gases, conceptual problems related to Entropy during a Phase Change, Nernst Heat Theorem: Unattainability of Absolute Zero and Third Law of Thermodynamics.

Unit – IV - Thermodynamic Potentials and Maxwell's Relations (12 Hours)

Basic concept of Thermodynamic Potentials, Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, Magnetic work and basic idea about cooling due to adiabatic demagnetization, Phase Transitions : First order and Second order Phase Transitions with examples, Clausius Clapeyron Equation, Ehrenfest Equations, Derivation of Maxwell's Thermodynamic Relations and their applications in Clausius Clapeyron Equation, value of C_P – C_v, TdS equations, Energy equations, evaluation of C_P /C_v and Ratio of Adiabatic to Isothermal elasticity.

Unit – V - Kinetic Theory of Gases and Molecular Collisions (8 Hours)

Constrained maximization using Lagrange multipliers, Maxwell-Boltzmann law of distribution of velocities in an ideal gas and its experimental verification with any one method. Mean, Root Mean Square and Most Probable Speeds, Maxwell-Boltzmann equation for distribution of Energy: Average Energy and Most Probable Energy, Mean Free Path, Collision Probability, estimation of Mean Free Path, transport phenomena in ideal gases: viscosity, thermal conductivity and diffusion with continuity equation

Unit – VI - Real Gases (7 Hours)

Behaviour of Real Gases: Deviations from the ideal gas equation, Andrew's experiments on CO_2 Gas, Virial equation, Continuity of liquid and gaseous states, Boyle temperature, Van der Waals equation of state for real gases (derivation not required), comparison with experimental curves: P-V diagrams, value of critical constants, law of corresponding states, free adiabatic expansion of a perfect gas, Joule Thomson Porous - Plug Experiment, Joule Thomson Coefficient for Ideal and Van der Waals Gases, Temperature of Inversion and Joule Thomson cooling.

References:

Essential Readings:

1) Heat and Thermodynamics: M. W. Zemansky and R. Dittman, Tata McGraw-Hill, 1981
2) Thermal Physics: S. C. Garg, R. M. Bansal and C. K. Ghosh, 2nd Edition, Tata McGraw-Hill.
3) Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears and Salinger, Narosa, 1988
4) Concepts in Thermal Physics: Blundell and Blundell, 2nd Edition, Oxford University Press, 2009
5) Thermal Physics, A. Kumar and S. P. Taneja, R. Chand Publications, 2014
6) A Text Book of Heat and Thermodynamics for Degree Students, J. B. Rajam, S. Chand, 1981

Additional Readings:

1) An Introduction to Thermal Physics: D. Schroeder, Oxford University Press (earlier published by Pearsons), 2021
2) Thermal Physics: C. Kittel and H. Kroemer, 2nd Edition, W.H. Freeman, 1980
3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company
4) Thermal Physics: Concepts and practices, A. L. Wasserman, Cambridge University Press, 2012
5) Fundamentals of Thermal and Statistical Physics, Frederick Reif, McGraw-Hill, 1965

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

At least six experiments to be done from the following:

1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2) To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3) To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method using steam or electrical heating.
4) To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT) using Carey Foster's Bridge.
5) To determine the Temperature Coefficient of Resistance using Platinum Resistance Thermometer (PRT) by Callender-Griffith Bridge.
6) To study the variation of thermo-e.m.f. of a thermocouple with difference of temperature of its two junctions using a null method.
7) To calibrate a thermocouple to measure temperature in a specified range by direct method and/or by using Op Amp and to determine Neutral Temperature.
8) To determine the coefficient of thermal conductivity of Copper (Cu) by Angstrom's method.

References (for Laboratory Work):

1) Advanced Practical Physics for students: B. L. Flint and H. T. Worsnop, Asia Publishing House, 1971

2) A Text Book of Practical Physics : Indu Prakash and Ramakrishna, 11th Edition, Kitab Mahal
3) Advanced level Practical Physics: Nelkon and Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4) An Advanced Course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, New Central Book Agency, 1990
5) Practical Physics: G. L. Squires, Cambridge University Press, 1985
6) B. Sc Practical Physics: Harnam Singh, P. S. Hemne, revised edition 2011, S. Chand and Co.
7) B. Sc Practical Physics: C. L. Arora, 2001, S. Chand and Co.
8) B.Sc. Practical Physics: Geeta Sanon, R. Chand and Co.

DISCIPLINE SPECIFIC CORE COURSE – DSC - 9: LIGHT AND MATTER

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Light and Matter DSC – 9	4	2	0	2	Class 12^{th} Pass	NIL

LEARNING OBJECTIVES

The objective of this course reviews the concepts of light and matter, their properties and their dual nature. This course provides an in depth understanding of dual nature of light, interference and diffraction with emphasis on practical applications of both. It prepares the student for the modern physics and quantum mechanics courses.

LEARNING OUTCOMES

On successfully completing the requirement of this course the student will have the skill and knowledge to,

- Appreciate the dual nature of light which is part of the electromagnetic spectrum and the dual nature of matter simultaneously.
- Understand the phenomena of interference and diffraction exhibited by light and matter, their nuances and details.
- Delve in to the depth of understanding wave optics with its various kinds of interference and diffraction exhibited by light.
- Demonstrate basic concepts of diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhofer and Fresnel diffraction.
- Learn about the application of matter waves in latest technological developments of electron microscope e.g. SEM and TEM used widely for characterization in several fields of physics such as material science, nanotechnology etc.
- In the laboratory course, students will gain hands-on experience of using various optical instruments, measurement of resolving power and dispersive power, and making finer measurements of wavelength of light using Newton’s rings experiment. They will also find wavelength of Laser sources by single and double slit experiment, wavelength and angular spread of He-Ne Laser using plane diffraction grating.

SYLLABUS OF DSC - 9

THEORY COMPONENT

Unit – I - Duality of Light and matter (5 Hours)

Light an EM wave - Hertz’s experiments; Particle characteristics by photoelectric effect and Compton effect (concepts only) and wave characteristics by interference and diffraction.
Wave properties of particles: de Broglie hypothesis, wavelength of matter waves; particle

wave complementarity: Velocity of de Broglie wave and need of a wave packet; Group and phase velocities and relation between them; equivalence of group and particle velocity, dispersion of wave groups.

Unit – II – Interference **(10 Hours)**

Division of amplitude and wave-front. Two-slit interference experiment with photons: Young's double slit experiment. Lloyd's mirror. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringe). Newton's Rings: Measurement of wavelength and refractive index. Single photon interference. Two-slit interference experiment with electrons.

Unit – III – Diffraction **(15 Hours)**

Fraunhofer diffraction: Single slit, double slit, diffraction grating, resolving power of grating.
Fresnel diffraction: Fresnel's assumptions, Fresnel's half-period zones for plane wave, explanation of rectilinear propagation of light, theory of a zone plate: multiple foci of a zone plate, Fresnel diffraction at straight edge, a slit and a wire by Fresnel half period zones.
Diffraction of photons (e.g. X-rays, gamma rays etc.) and particles by matter, experimental study of matter waves: Davisson-Germer experiment; Electron microscope: applications SEM, TEM.

References:

Essential Readings:

1) Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, 2002
2) Modern Physics by R. A. Serway, C. J. Moses and C. A. Moyer, Thomson Brooks Cole, 2012
3) Modern Physics for Scientists and Engineers by S. T. Thornton and A. Rex, 4th Edition, Cengage Learning, 2013
4) Optics, Ajoy Ghatak, McGraw-Hill Education, New Delhi, 7th Edition
5) Fundamentals of Optics, F. A. Jenkins and H. E. White, McGraw-Hill, 1981
6) Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, R. Chand Publications, 2011
7) A Textbook of Optics N. Subrahmanyam, Brij Lal, M. N. Avadhanulu, S. Chand & Co Ltd.
8) Introduction to Optics I - Interaction of Light with Matter, Ksenia Dolgaleva, Morgan and Claypool, 2021
9) Physics for scientists and Engineers with Modern Physics, Jewett and Serway, Cengage Learning, 2010
10) Modern Physics, G. Kaur and G. R. Pickrell, McGraw Hill, 2014
11) Schaum's Outline of Beginning Physics II: Waves, electromagnetism, Optics and Modern Physics, Alvin Halpern, Erich Erlbach, McGraw Hill.
12) Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edition, Tata McGraw-Hill Publishing Co. Ltd.

Additional Readings:

1) Principles of Optics, Max Born and Emil Wolf, 7th Edition, Pergamon Press, 1999
2) Introduction to Optics, Pedrotti Frank L. Cambridge University Press.
3) Optics, Eugene Hecht, 4th Edition, Pearson Education, 2014
4) Six Ideas that Shaped Physics: Particle Behave like Waves, T. A. Moore, McGraw Hill, 2003

5) Thirty years that shook physics: the story of quantum theory, George Gamow, Garden City, NY: Doubleday, 1966.
6) Quantum Mechanics: Theory and Applications, (Extensively revised 6th Edition), Ajoy Ghatak and S. Lokanathan, Laxmi Publications, 2019
7) Optics, Karl Dieter Moller, Learning by computing with model examples, Springer, 2007
8) Modern Physics for Scientists and Engineers, J. R. Taylor, C. D. Zafiratos, M. A. Dubson, Viva Books Pvt Ltd, 2017
9) Physics of Atom, Wehr, Richards and Adair, Narosa, 2002

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

Mandatory activity:

- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Applications of the specific experiments done in the lab.
- Familiarization with Schuster's focusing; determination of angle of prism.

At least 6 experiments from the following list.

1) Determination of refractive index of material of prism using mercury (Hg) light.
2) To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
3) To determine wavelength of sodium light using Newton's Rings.
4) To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
5) To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
6) To determine dispersive power of a plane diffraction grating using mercury lamp.
7) To determine resolving power of a plane diffraction grating using sodium lamp.
8) To determine the wavelength of laser source using diffraction of single slit.
9) To determine the wavelength of laser source using diffraction of double slit.
10) To determine wavelength and angular spread of He-Ne laser using plane diffraction grating.

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal.
3) Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
4) A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub
5) B.Sc. Practical Physics, Geeta Sanon, R. Chand and Co.

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 1: BIOPHYSICS

<table>
<tr><th rowspan="2">Course Title & Code</th><th rowspan="2">Credits</th><th colspan="3">Credit distribution of the course</th><th rowspan="2">Eligibility Criteria</th><th rowspan="2">Pre-requisite of the course</th></tr>
<tr><th>Lecture</th><th>Tutorial</th><th>Practical</th></tr>
<tr><td>Biophysics

DSE – 1</td><td>4</td><td>3</td><td>0</td><td>1</td><td>Class XII Pass</td><td>NIL</td></tr>
</table>

LEARNING OBJECTIVES

This course familiarizes the students with the basic facts and ideas of biology from a quantitative perspective. It shows them how ideas and methods of physics enrich our understanding of biological systems at diverse length and time scales. The course also gives them a flavour of the interface between biology, chemistry, physics and mathematics.

LEARNING OUTCOMES

After completing this course, students will

- Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective.
- Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution.
- Be able to apply the principles of physics from areas such as mechanics, electricity and magnetism, thermodynamics, statistical mechanics, and dynamical systems to understand certain living processes.
- Get exposure to complexity of life at i) the level of cell, ii) level of multi cellular organism and iii) at macroscopic system – ecosystem and biosphere.
- Gain a systems level perspective on organisms and appreciate how networks of interactions of many components give rise to complex behaviour.
- Perform mathematical and computational modelling of certain aspects of living systems.
- Get exposure to models of evolution.
- Be able to perform experiments demonstrating certain physical processes that occur in living systems.

SYLLABUS OF DSE – 1

THEORY COMPONENT

Unit – I **(4 Hours)**

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales.

Unit - II **(12 Hours)**

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation.

Unit - III **(12 Hours)**

Molecular motion in cells: Random walks and applications to biology: Diffusion; models of macromolecules. Mechanical, entropic and chemical forces: Osmosis, cell assembly, molecular motors, bacterial chemotaxis.

Unit - IV **(12 Hours)**

The complexity of life: At the level of a cell: Intracellular biochemical networks. Dynamics of metabolic networks; the stoichiometric matrix. The implausibility of life based on a simplified probability estimate, and the origin of life problem. At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cellular differentiation and development. Brain structure: neurons and neural networks. At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self-sustaining ecosystems. Allometric scaling laws.

Unit - V **(5 Hours)**

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution.

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

List of experiments

1) Demonstration of diffusion, effect of medium, temperature, molecular weight and size on the rate of diffusion.
2) Demonstration of osmosis in a living system.
3) Demonstration of the relationship between viscosity and density.
4) Demonstration of how microscopic particles travel in air through aerosols.
5) Graphic visualization and demonstrations of 3D structure of biomolecules using in-silico visualization tools.
6) Estimation of serum protein using BSA as the standard. (Optional).

References:

Essential Readings:

1) Biological Physics: Energy, Information, Life; Philip Nelson (W. H. Freeman & Co, NY, 2004)
2) Cell Biology by the Numbers; Ron Milo and Rob Phillips (Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2016)
3) Physical Biology of the Cell (2nd Edition); Rob Phillips et al (Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2013)
4) Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd Edition).

Additional Readings:

1) Physics in Molecular Biology; Kim Sneppen and Giovanni Zocchi (Cambridge University Press, Cambridge UK, 2005)
2) Biophysics: Searching for Principles; William Bialek (Princeton University Press, Princeton USA, 2012).

DISCIPLINE SPECIFIC ELECTIVE COURSE – DSE 2: NUMERICAL ANALYSIS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
NUMERICAL ANALYSIS DSE – 2	4	2	0	2	Class 12th Pass	NIL

LEARNING OBJECTIVES

The main objective of this course is to introduce the students to the field of numerical analysis enabling them to solve a wide range of physics problems. The skills developed during the course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Analyse a physics problem, establish the mathematical model and determine the appropriate numerical techniques to solve it.
- Derive numerical methods for various mathematical tasks such as solution of non-linear algebraic and transcendental equations, system of linear equations, interpolation, least square fitting, numerical differentiation, numerical integration, eigen value problems and solution of initial value and boundary value problems.
- Analyse and evaluate the accuracy of the numerical methods learned.
- In the laboratory course, the students will learn to implement these numerical methods in Python/C++/Scilab and develop codes to solve various physics problems and analyze the results.

SYLLABUS OF DSE – 2

THEORY COMPONENT

Unit – I **(3 Hours)**

Approximation and Errors in computing: Introduction to numerical computation, Taylor's expansion and mean value theorem. Floating Point Computation, overflow and underflow. Single and double precision arithmetic. Rounding and truncation error, absolute and relative error, error propagation.

Unit – II **(8 Hours)**

Linear Systems: Solution of linear systems by Gaussian elimination method, partial and complete pivoting, LU decomposition, norms and errors, condition numbers, Gauss-Seidel method, diagonally dominant matrix and convergence of iteration methods. Solution of Tridiagonal systems; Eigenvalue Problem: Power method, inverse power method.

Unit – III **(5 Hours)**

Interpolation: Lagrange and Newton's methods (divided difference) for polynomial interpolation, theoretical error of interpolation. Inverse Interpolation. Optimal points for interpolation and Chebyshev Polynomials. Minimax Theorem (Statement only)

Unit – IV **(7 Hours)**

Numerical Integration: Newton Cotes quadrature methods. Derivation of Trapezoidal and Simpson (1/3 and 3/8) rules from Lagrange interpolating polynomial. Error and degree of precision of a quadrature formula. Composite formulae for Trapezoidal and Simpson methods.

Gauss Quadrature methods. Legendre, Lagaurre and Hermite quadrature methods.

Unit – V **(7 Hours)**

Initial and Boundary Value Problems: Solution of initial value problems by Euler, modified Euler and Runge Kutta (RK) methods. Local and global errors, comparison of errors in the Euler and RK methods

Finite difference and shooting method for solving two-point linear boundary value problems.

References:

Essential Readings:

1) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, India, 2007
2) Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, 2008
3) Introduction to Numerical Analysis, S. S. Sastry, 5th Edition, PHI Learning Pvt. Ltd, 2012
4) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edition, Wiley India Edition, 2007

Additional Readings:

1) Numerical Recipes: The art of scientific computing, William H. Press, Saul A. Teukolsky and William Vetterling, Cambridge University Press; 3rd Edition, 2007
2) Numerical methods for scientific and engineering computation, M. K. Jain, S. R. K. Iyenger, New Age Publishers, 2012

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

The aim of this lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics. Assessment is to be done not only on the programming but also on the basis of formulating the problem. The list of recommended programs is suggestive only. Students should be encouraged to do more physics applications. Emphasis should be given to formulate a physics problem as mathematical one and solve by computational methods. The students should be encouraged to develop and present an independent project. At least 10 programs must be attempted (taking at least two from each unit).The implementation can be either in Python/ C++/Scilab.

Unit 1 - Linear Systems

a) Solve a system of linear equations using Gauss Elimination method with pivoting (application to electric networks).
b) Solve a system of linear equations using Gauss-Seidel method and study the convergence (application to spring mass system).
c) Determine the inverse of a square matrix using Gauss-Jordan method.
d) Solve a tri-diagonal system of linear equations.
e) Study an example of ill-conditioned systematic
f) Find the LU equivalent of a matrix.
g) Determine the largest and smallest eigenvalues using Power and inverse power methods. Consider a case where power method fails.

Unit 2 - Interpolation

a) Given a dataset (x, y) with equidistant x values, prepare the Newton's forward difference, backward difference and divided difference tables.
b) Given a dataset (x, y) corresponding to a physics problem, use Lagrange and Newton's forms of interpolating polynomials and compare. Determine the value of y at an intermediate value of x not included in the data set. This may be done with equally spaced and non-equally spaced x-values.
c) Given a tabulated data for an elementary function, approximate it by a polynomial and compare with the true function.
d) Compare the interpolating polynomial for a given dataset (following a known form e.g. exponential) with the approximation obtained by least square fitting.
e) Compare the interpolating polynomial approximating a given function in a given range obtained with uniformly spaced points and by Chebyshev points.
f) Compare the Chebyshev and Maclaurin series expansions of an exponential or sinusoidal function.

Unit 3 - Integration

a) Use integral definition of error function to compute and plot erf(x) in a given range. Use Trapezoidal, Simpson and Gauss Legendre methods and compare the results for small and large values of x.
b) Use the definition of erf(x) and numerically take the limit x going to infinity to get the value of Gaussian integral using Simpson method. Compare the result with the value obtained by Gauss Hermite and Gauss Lagaurre methods.
c) Verify the degree of precision of each quadrature rule.
d) Use Simpson methods to compute a double integral over a rectangular region.

e) Approximate the value of π by evaluating the integral $\int_0^{\infty} \frac{1}{x^2+1} dx$using Simpson, Gauss Hermite and Gauss Lagaurre methods.

Unit 4 - Initial Value Problems (IVP)

a) Compare the errors in Euler, RK2 and RK4 by solving a first order IVP with known solution. Reduce the step size to a point where the round off errors takes over.
b) Solve a system of n first order differential equations by Euler and RK methods. Use it to solve an nth order IVP. Solve a damped free and forced harmonic oscillator problem using this.
c) Solve a physics problem like free fall with air drag or parachte problem using RK method.
d) Solve a compound spring system (3 springs) by solving a system of differential equations using Euler and RK for a given set of i1nitial conditions.
e) Obtain the current flowing in a series LCR circuit with constant voltage for a given set of initial conditions.

Unit 5 - Boundary value problems (BVP)

a) Solve a linear BVP using shooting and finite difference method and compare the results.
b) Solve a non-linear BVP using the finite difference and shooting method and compare the results.
c) Determine the temperature distribution along a rod made of two dissimilar materials (of different thermal conductivities) welded together when temperatures at two ends are maintained at given temperatures.
d) Design a physics problem that can be modelled by a BVP and solve it by any method.

References for laboratory work:

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Computational Physics, Darren Walker, 1st Edition, Scientific International Pvt. Ltd, 2015
4) An Introduction to Computational Physics, T. Pang, Cambridge University Press, 2010
5) Computational Problems for Physics, R. H. Landau and M. J. Páez, CRC Press, 2018

Category II

Physical Science Courses
with Physics discipline as one of the Core Disciplines

(B. Sc. Physical Science with Physics as Major discipline)

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 3: HEAT AND THERMODYNAMICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
HEAT AND THERMODYNAMICS PHYSICS DSC – 3	4	2	0	2	Passed 12th Class	NIL

LEARNING OBJECTIVES

This course will review the basic concepts of thermodynamics, kinetic theory of gases with a brief introduction to statistical mechanics. The primary goal is to make the student understand the applications of fundamental laws of thermodynamics to various systems and processes. This coursework will enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through a brief knowledge of statistical mechanics. The lab course deals with providing the knowledge of the concepts of thermodynamics along with Planck's law and Stefan Boltzmann laws related to black body radiation.

LEARNING OUTCOMES

At the end of this course, students will be able to,

- gain an essence of the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations along with Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, mean free path of molecular collisions, viscosity, thermal conductivity and diffusion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- gain the basic knowledge about quantum statistics: the Bose-Einstein statistics and the Fermi-Dirac statistics.
- In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of

resistance, study variation of thermo-e.m.f. across two junctions of a thermocouple with temperature etc.

SYLLABUS OF PHYSICS DSC – 3

THEORY COMPONENT

Unit – I - Laws of Thermodynamics (10 Hours)

Fundamental basics of Thermodynamic system and variables, Zeroth Law of Thermodynamics and temperature, First law and internal energy, various thermodynamical processes, Applications of First Law: general relation between C_P and C_V, work done during various processes, Compressibility and Expansion Coefficient, reversible and irreversible processes, Second law: Kelvin-Planck and Clausius statements, Carnot engine, Carnot cycle and theorem, basic concept of Entropy, Entropy changes in reversible and irreversible processes, Clausius inequality, Entropy-temperature diagrams.

Unit – II - Thermodynamic Potentials and Maxwell's Relations (5 Hours)

Basic concept of Thermodynamic Potentials, Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, derivation of Maxwell's Thermodynamic Relations and their applications in Clausius Clapeyron Equation, value of $C_P – C_v$, TdS Equations, Energy equations for ideal gases, evaluation of C_P /C_v

Unit – III - Kinetic Theory of Gases and Molecular Collisions (6 Hours)

Maxwell-Boltzmann Law of Distribution of Velocities in an ideal gas and its experimental verification, Mean, Root Mean Square and Most Probable Speeds, Mean Free Path (Zeroth order), Transport Phenomena in ideal gases: Viscosity, Thermal Conductivity and Diffusion (for vertical case)

Unit – IV - Theory of Radiation (5 Hours)

Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law

Unit – V - Statistical Mechanics (4 Hours)

Macrostate and Microstate, phase space, Entropy and thermodynamic probability, Maxwell-Boltzmann law, qualitative description of Quantum statistics – Bose Einstein and Fermi Dirac, comparison of three statistics.

References:

Essential Readings:

1) Heat and Thermodynamics: M. W. Zemansky and R. Dittman, Tata McGraw-Hill, 1981
2) Thermal Physics: S. C. Garg, R. M. Bansal and C. K. Ghosh, 2nd Edition, Tata McGraw-Hill.
3) Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears and Salinger, Narosa, 1988
4) Concepts in Thermal Physics: Blundell and Blundell, 2nd Edition, Oxford University Press, 2009
5) Thermal Physics, A. Kumar and S. P. Taneja, R. Chand Publications, 2014
6) A Text Book of Heat and Thermodynamics for Degree Students, J. B. Rajam, S. Chand, 1981

Additional Readings:

1) An Introduction to Thermal Physics: D. Schroeder, Oxford University Press (earlier published by Pearsons), 2021
2) Thermal Physics: C. Kittel and H. Kroemer, 2^{nd} Edition, W. H. Freeman, 1980
3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be done from the following:

1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2) To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3) To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method using steam or electrical heating.
4) Measurement of Planck's constant using black body radiation.
5) To determine the temperature coefficient of resistance by Platinum Resistance Thermometer using Carey Foster's bridge.
6) To study the variation of thermo-e.m.f. across two junctions of a thermocouple with temperature.
7) To determine Stefan's Constant.
8) To determine the Temperature Coefficient of Resistance using Platinum Resistance Thermometer (PRT) by Callender-Griffith Bridge

References for laboratory work:

1) Advanced Practical Physics for students: B. L. Flint and H. T. Worsnop, Asia Publishing House, 1971
2) A Text Book of Practical Physics: Indu Prakash and Ramakrishna, 11^{th} Edition, Kitab Mahal
3) Advanced level Practical Physics: Nelkon and Ogborn, 4^{th} Edition, reprinted 1985, Heinemann Educational Publishers.
4) An Advanced Course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, 1990, New Central Book Agency.
5) Practical Physics: G. L. Squires, Cambridge University Press, 1985
6) B.Sc. Practical Physics: Harnam Singh, P. S. Hemne, revised edition 2011, S. Chand and Co.
7) B. Sc. Practical Physics: C. L. Arora, S. Chand and Co.
8) B. Sc. Practical Physics: Geeta Sanon, R. Chand and Co.

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 13a: BIOPHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Biophysics PHYSICS DSE 13a	4	3	0	1	Passed 12th Class	NIL

LEARNING OBJECTIVES

This course familiarizes the students with the basic facts and ideas of biology from a quantitative perspective. It shows them how ideas and methods of physics enrich our understanding of biological systems at diverse length and time scales. The course also gives them a flavour of the interface between biology, chemistry, physics and mathematics.

LEARNING OUTCOMES

After completing this course, students will

- Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective.
- Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution.
- Be able to apply the principles of physics from areas such as mechanics, electricity and magnetism, thermodynamics, statistical mechanics, and dynamical systems to understand certain living processes.
- Get exposure to complexity of life at i) the level of cell, ii) level of multi cellular organism and iii) at macroscopic system – ecosystem and biosphere.
- Gain a systems level perspective on organisms and appreciate how networks of interactions of many components give rise to complex behaviour.
- Perform mathematical and computational modelling of certain aspects of living systems.
- Get exposure to models of evolution.
- Be able to perform experiments demonstrating certain physical processes that occur in living systems.

SYLLABUS OF PHYSICS DSE – 13a

THEORY COMPONENT

Unit – I **(4 Hours)**

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales.

Unit - II **(12 Hours)**

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation.

Unit - III **(12 Hours)**

Molecular motion in cells: Random walks and applications to biology: Diffusion; models of macromolecules. Mechanical, entropic and chemical forces: Osmosis, cell assembly, molecular motors, bacterial chemotaxis.

Unit - IV **(12 Hours)**

The complexity of life: At the level of a cell: Intracellular biochemical networks. Dynamics of metabolic networks; the stoichiometric matrix. The implausibility of life based on a simplified probability estimate, and the origin of life problem. At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cellular differentiation and development. Brain structure: neurons and neural networks. At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self-sustaining ecosystems. Allometric scaling laws.

Unit - V **(5 Hours)**

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

List of experiments

1) Demonstration of diffusion, effect of medium, temperature, molecular weight and size on the rate of diffusion.
2) Demonstration of osmosis in a living system.
3) Demonstration of the relationship between viscosity and density.
4) Demonstration of how microscopic particles travel in air through aerosols.
5) Graphic visualization and demonstrations of 3D structure of biomolecules using in-silico visualization tools.
6) Estimation of serum protein using BSA as the standard. (Optional).

References:

Essential Readings:

1) Biological Physics: Energy, Information, Life; Philip Nelson (W. H. Freeman & Co, NY, 2004)
2) Cell Biology by the Numbers; Ron Milo and Rob Phillips (Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2016)
3) Physical Biology of the Cell (2nd Edition); Rob Phillips et al (Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2013)
4) Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd Edition).

Additional Readings:

1) Physics in Molecular Biology; Kim Sneppen and Giovanni Zocchi (Cambridge University Press, Cambridge UK, 2005)
2) Biophysics: Searching for Principles; William Bialek (Princeton University Press, Princeton USA, 2012).

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 13b: MATHEMATICAL PHYSICS I

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
MATHEMATICAL PHYSICS I PHYSICS DSE – 13b	**4**	**3**	**1**	**0**	Passed 12^{th} Class	NIL

LEARNING OBJECTIVES

The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists. The mathematical tools might be building blocks to understand the fundamental computational physics skills and hence enable them to solve a wide range of physics problems. Overall, to help students develop critical skills and knowledge that will prepare them not only for doing fundamental and applied research but also prepare them for a wide variety of careers

LEARNING OUTCOMES

After completing this course, student will be able to,

- Learn the functions more than one variable using the concepts of calculus.
- Solve first order differential equations and apply it to physical problems.
- Represent a periodic function by a sum of harmonics using Fourier series.
- Obtain power series solution of differential equation of 2^{nd} order with variable coefficients using Frobenius mehod.
- Learn beta and gamma functions

SYLLABUS OF PHYSICS DSE 13b

THEORY COMPONENT

Unit – I **(18 Hours)**

Calculus of functions of more than one variable: Partial derivatives, chain rule for partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions. Application to Summing of Infinite Series.

Unit – II **(12 Hours)**

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre Differential Equations and its solution. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations.

Unit – III **(15 Hours)**

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry. Solution of 1D wave equation.

References:

Essential Readings:

1) An introduction to ordinary differential equations, E.A. Coddington, PHI learning, 2009
2) Differential Equations, George F. Simmons, McGraw Hill, 2007
3) Mathematical methods for Scientists and Engineers, D. A. McQuarrie, Viva Book, 2003
4) Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5th Edition, Jones and Bartlett Learning, 2012
5) Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, 2008
6) Fourier Analysis: With Applications to Boundary Value Problems, Murray Spiegel, McGraw Hill Education, 2017
7) Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris, 7th Edition, Elsevier, 2013
8) Essential Mathematical Methods, K. F. Riley and M. P. Hobson, Cambridge Univ. Press, 2011

Additional Readings:

1) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4th Edition, Cambridge University Press, 2017
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, Narosa Publishing House, 2008
3) Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5th Edition, Jones and Bartlett Learning, 2012
4) Mathematical Tools for Physics, James Nearing, Dover Publications, 2010
5) Mathematical Physics, A. K. Ghatak, I. C. Goyal and S. J. Chua, Laxmi Publications Private Limited, 2017

Category II

Physical Science Courses (with Electronics) with Physics and Electronics discipline as Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 5: HEAT AND THERMODYNAMICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
HEAT AND THERMODYNAMICS PHYSICS DSC 5	4	2	0	2	Passed 12^{th} Class	NIL

LEARNING OBJECTIVES

This course will review the basic concepts of Thermodynamics, Kinetic Theory of gases with a brief introduction to Statistical Mechanics. The primary goal is to make the student understand the applications of fundamental laws of thermodynamics to various systems and processes. This coursework will enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through a brief knowledge of statistical mechanics. The lab course deals with providing the knowledge of the concepts of Thermodynamics along with Planck's Law and Stefan Boltzmann laws related to black body radiation.

LEARNING OUTCOMES

At the end of this course, students will be able to

- gain an essence of the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations along with Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, mean free path of molecular collisions, viscosity, thermal conductivity and diffusion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- gain the basic knowledge about quantum statistics: the Bose-Einstein statistics and the Fermi-Dirac statistics.
- In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo-e.m.f. across two junctions of a thermocouple with temperature etc.

SYLLABUS OF PHYSICS DSC – 5

THEORY COMPONENT

Unit – I - Laws of Thermodynamics (10 Hours)

Fundamental basics of Thermodynamic system and variables, Zeroth Law of Thermodynamics and temperature, First law and internal energy, various thermodynamical processes, Applications of First Law: general relation between C_P and C_V, work done during various processes, Compressibility and Expansion Coefficient, reversible and irreversible processes, Second law: Kelvin-Planck and Clausius statements, Carnot engine, Carnot cycle and theorem, basic concept of Entropy, Entropy changes in reversible and irreversible processes, Clausius inequality, Entropy-temperature diagrams.

Unit – II - Thermodynamic Potentials and Maxwell's Relations (5 Hours)

Basic concept of Thermodynamic Potentials, Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, derivation of Maxwell's Thermodynamic Relations and their applications in Clausius Clapeyron Equation, value of $C_P – C_v$, TdS Equations, Energy equations for ideal gases, evaluation of C_P /C_v

Unit – III - Kinetic Theory of Gases and Molecular Collisions (6 Hours)

Maxwell-Boltzmann Law of Distribution of Velocities in an ideal gas and its experimental verification, Mean, Root Mean Square and Most Probable Speeds, Mean Free Path (Zeroth order), Transport Phenomena in ideal gases: Viscosity, Thermal Conductivity and Diffusion (for vertical case)

Unit – IV - Theory of Radiation (5 Hours)

Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law

Unit – V - Statistical Mechanics (4 Hours)

Macrostate and Microstate, phase space, Entropy and thermodynamic probability, Maxwell-Boltzmann law, qualitative description of Quantum statistics – Bose Einstein and Fermi Dirac, comparison of three statistics.

References:

Essential Readings:

1) Heat and Thermodynamics: M. W. Zemansky and R. Dittman, Tata McGraw-Hill, 1981
2) Thermal Physics: S. C. Garg, R. M. Bansal and C. K. Ghosh, 2nd Edition, Tata McGraw-Hill.
3) Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears and Salinger, Narosa, 1988
4) Concepts in Thermal Physics: Blundell and Blundell, 2nd Edition, Oxford University Press, 2009
5) Thermal Physics, A. Kumar and S. P. Taneja, R. Chand Publications, 2014
6) A Text Book of Heat and Thermodynamics for Degree Students, J. B. Rajam, S. Chand, 1981

Additional Readings:

1) An Introduction to Thermal Physics: D. Schroeder, Oxford University Press (earlier published by Pearsons), 2021
2) Thermal Physics: C. Kittel and H. Kroemer, 2nd Edition, W. H. Freeman, 1980
3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

At least six experiments to be done from the following:

1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2) To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3) To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method using steam or electrical heating.
4) Measurement of Planck's constant using black body radiation.
5) To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer using Carey Foster's bridge.
6) To study the variation of thermo-e.m.f across two junctions of a thermocouple with temperature.
7) To determine Stefan's Constant.
8) To determine the Temperature Coefficient of Resistance using Platinum Resistance Thermometer (PRT) by Callender-Griffith Bridge

References for laboratory work:

1) Advanced Practical Physics for students: B. L. Flint and H. T. Worsnop, Asia Publishing House, 1971
2) A Text Book of Practical Physics: Indu Prakash and Ramakrishna, 11th Edition, Kitab Mahal
3) Advanced level Practical Physics: Nelkon and Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
4) An Advanced Course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, New Central Book Agency, 1990
5) Practical Physics: G. L. Squires, Cambridge University Press, 1985
6) B.Sc. Practical Physics: Harnam Singh, Dr P. S. Hemne, revised edition 2011, S. Chand and Co.
7) B. Sc. Practical Physics: C. L. Arora, S. Chand and Co.
8) B. Sc. Practical Physics: Geeta Sanon, R. Chand and Co.

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 6: COMMUNICATION ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
COMMUNICATION ELECTRONICS PHYSICS DSC – 6	**4**	**2**	**0**	**2**	Passed 12^{th} Class	NIL

LEARNING OBJECTIVES

This paper aims to describe the concepts of electronics in communication. Communication techniques based on analog modulation, analog and digital pulse modulation including PAM, PWM, PPM, ASK, PSK, FSK are described in detail. Communication and Navigation systems such as GPS, satellite and mobile telephony systems are introduced.

LEARNING OUTCOMES

At the end of this course, students will be able to develop following learning outcomes:

- This paper aims to describe the concepts of electronics in communication. In this course, students will receive an introduction to the principle, performance and applications of communication systems.
- Students will learn the various means and modes of communication. They will gain an understanding of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India.
- They will gain an insight on the use of different modulation and demodulation techniques used in analog communication
- Students will be able to analyse different parameters of analog communication techniques.
- They will learn the need of sampling and different sampling techniques where they can sample analog signal
- Students will learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing.
- They will gain an in-depth understanding of different concepts used in a satellite communication system.
- This paper will essentially connect the text book knowledge with the most popular communication technology in real world.

SYLLABUS OF PHYSICS DSC 6

THEORY COMPONENT

Unit – I **(10 Hours)**

Electronic communication: Introduction to communication – means and modes. Power measurements (units of power). Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals.

Analog Modulation: Amplitude Modulation: Frequency spectrum of AM waves, average power, average voltage, modulation index, AM-modulator circuits (collector modulation), AM-demodulator (diode detector), single side band generation and detection.

Angle Modulation: Frequency and phase modulation, frequency spectrum of FM waves, intersystem comparisons (FM and AM), FM generation using VCO, FM detector (slope detector)

Unit – II **(5 Hours)**

Analog Pulse Modulation: Channel capacity, Sampling Theorem and Nyquist Criterion, Basic Principles – Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), modulation and detection technique for PAM only, Multiplexing – Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM).

Unit – III **(6 Hours)**

Digital Pulse Modulation: Need for digital transmission, Pulse Code Modulation (PCM), Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK)

Unit – IV **(6 Hours)**

Satellite Communication: Introduction, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Transponders (C - Band), Uplink and downlink, path loss, Satellite visibility, Ground and earth stations. Simplified block diagram of the earth station.

Unit – V **(3 Hours)**

Mobile Telephony System: Basic concept of mobile communication, frequency bands used in mobile communication, the concept of cell sectoring and cell splitting, SIM number, IMEI number, GPS navigation system (qualitative idea only).

References:

Essential Readings:

1) Communication Electronics, Principles and Applications, L. E. Frenzel, Tata McGraw-Hill.
2) Communication Systems: Analog and Digital, R. P. Singh and S. D. Sapre, Tata McGraw-Hill.
3) Analog and Digital Communications, H. Hsu, Schaum's Outline Series, Tata McGraw-Hill.
4) Electronic Communications Systems: Fundamentals Through Advanced, Wayne Tomasi, Fifth Edition, Pearson.

5) Communication Systems, S. Haykin, Wiley India

Additional Readings:

1) Electronic Communication, L. Temes and M. Schultz, Schaum's Outline Series, Tata McGraw- Hill.
2) Electronic Communication Systems, G. Kennedy and B. Davis, Tata McGraw-Hill
3) Analog and Digital Communication Systems, M. J. Roden, Prentice Hall of India.

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

Every student must perform at least 06 experiments.

1) To study AM – Generation and Detection circuit
2) To study FM – Generation and Detection circuit
3) To study Time Division Multiplexing (TDM)
4) To study Pulse Amplitude Modulation (PAM)
5) To study Pulse Width Modulation (PWM)
6) To study Pulse Position Modulation (PPM)
7) To study Amplitude Shift Keying (ASK)
8) To study Frequency Shift Keying (FSK)
9) To study Phase Shift Keying (PSK)

References (for Laboratory Work):

1) Introduction to Analog and Digital Communication – by M. A. Bhagyaveni, R. Kalidoss and K. S. Vishvaksenan, River Publishers Series in Communications
2) Communication Systems – by Michael Moher Simon Haykin, Wiley
3) Wireless Communication – by Goldsmith Andrea, Cambridge University Press
4) Digital Communications: Fundamentals and Applications – Bernard Sklar and Pabitra Kumar Ray, Pearson Education India

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 1: BIOPHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Biophysics PHYSICS DSE 1	4	3	0	1	Passed 12th Class	NIL

LEARNING OBJECTIVES

This course familiarizes the students with the basic facts and ideas of biology from a quantitative perspective. It shows them how ideas and methods of physics enrich our understanding of biological systems at diverse length and time scales. The course also gives them a flavour of the interface between biology, chemistry, physics and mathematics.

LEARNING OUTCOMES

After completing this course, students will

- Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective.
- Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution.
- Be able to apply the principles of physics from areas such as mechanics, electricity and magnetism, thermodynamics, statistical mechanics, and dynamical systems to understand certain living processes.
- Get exposure to complexity of life at i) the level of cell, ii) level of multi cellular organism and iii) at macroscopic system – ecosystem and biosphere.
- Gain a systems level perspective on organisms and appreciate how networks of interactions of many components give rise to complex behaviour.
- Perform mathematical and computational modelling of certain aspects of living systems.
- Get exposure to models of evolution.
- Be able to perform experiments demonstrating certain physical processes that occur in living systems.

SYLLABUS OF PHYSICS DSE – 1

THEORY COMPONENT

Unit – I **(4 Hours)**

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales.

Unit - II **(12 Hours)**

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation.

Unit - III **(12 Hours)**

Molecular motion in cells: Random walks and applications to biology: Diffusion; models of macromolecules. Mechanical, entropic and chemical forces: Osmosis, cell assembly, molecular motors, bacterial chemotaxis.

Unit - IV **(12 Hours)**

The complexity of life: At the level of a cell: Intracellular biochemical networks. Dynamics of metabolic networks; the stoichiometric matrix. The implausibility of life based on a simplified probability estimate, and the origin of life problem. At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cellular differentiation and development. Brain structure: neurons and neural networks. At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self-sustaining ecosystems. Allometric scaling laws.

Unit - V **(5 Hours)**

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution.

PRACTICAL COMPONENT

(15 Weeks with 2 hours of laboratory session per week)

List of experiments

1) Demonstration of diffusion, effect of medium, temperature, molecular weight and size on the rate of diffusion.
2) Demonstration of osmosis in a living system.
3) Demonstration of the relationship between viscosity and density.
4) Demonstration of how microscopic particles travel in air through aerosols.
5) Graphic visualization and demonstrations of 3D structure of biomolecules using in-silico visualization tools.
6) Estimation of serum protein using BSA as the standard. (Optional).

References:

Essential Readings:

1) Biological Physics: Energy, Information, Life, P. Nelson, W. H. Freeman & Co, NY, 2004
2) Cell Biology by the Numbers, R. Milo and R. Phillips, Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2016
3) Physical Biology of the Cell, R. Phillips et al, 2nd edition, Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2013
4) Evolution, M. Ridley, Blackwell Publishers, 2009, 3rd edition

Additional Readings:

1) Physics in Molecular Biology, K. Sneppen and G. Zocchi, Cambridge University Press, Cambridge UK, 2005
2) Biophysics: Searching for Principles, W. Bialek, Princeton University Press, Princeton USA, 2012

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 2: MATHEMATICAL PHYSICS I

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
MATHEMATICAL PHYSICS I Physics DSE 2	**4**	**3**	**1**	**0**	Passed 12th Class	NIL

LEARNING OBJECTIVES

The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists. The mathematical tools might be building blocks to understand the fundamental computational physics skills and hence enable them to solve a wide range of physics problems. Overall, to help students develop critical skills and knowledge that will prepare them not only for doing fundamental and applied research but also prepare them for a wide variety of careers

LEARNING OUTCOMES

After completing this course, student will be able to,

- Learn the functions more than one variable using the concepts of calculus.
- Solve first order differential equations and apply it to physical problems.
- Represent a periodic function by a sum of harmonics using Fourier series.
- Obtain power series solution of differential equation of 2^{nd} order with variable coefficients using Frobenius mehod.
- Learn beta and gamma functions

SYLLABUS OF PHYSICS DSE 2

THEORY COMPONENT

Unit – I **(18 Hours)**

Calculus of functions of more than one variable: Partial derivatives, chain rule for partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions. Application to Summing of Infinite Series.

Unit – II **(12 Hours)**

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre Differential Equations and its solution. Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality. Simple recurrence relations.

Unit – III **(15 Hours)**

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry. Solution of 1D wave equation.

References:

Essential Readings:

1) An introduction to ordinary differential equations, E. A. Coddington, PHI learning, 2009
2) Differential Equations, George F. Simmons, McGraw Hill, 2007
3) Mathematical methods for Scientists and Engineers, D. A. McQuarrie, Viva Book, 2003
4) Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5th Edition, Jones and Bartlett Learning, 2012
5) Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, 2008
6) Fourier Analysis: With Applications to Boundary Value Problems, Murray Spiegel, McGraw Hill Education, 2017
7) Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F.E. Harris, 7th Edition, Elsevier, 2013
8) Essential Mathematical Methods, K. F. Riley and M. P. Hobson, Cambridge University Press, 2011

Additional Readings:

1) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4th Edition, Cambridge University Press, 2017
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, Narosa Publishing House, 2008
3) Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5th Edition, Jones and Bartlett Learning, 2012
4) Mathematical Tools for Physics, James Nearing, Dover Publications, 2010
5) Mathematical Physics, A. K. Ghatak, I. C. Goyal and S. J. Chua, Laxmi Publications Private Limited, 2017

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVE (GE – 4): INTRODUCTION TO ELECTRONICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisites
		Lecture	Tutorial	Practical		
INTRODUCTION TO ELECTRONICS GE – 4	4	2	0	2	Passed 12^{th} Class	NIL

LEARNING OBJECTIVES

This paper aims to introduce fundamentals of electronics to students not majoring in physics. Basics of Analog and Digital Electronics are envisioned to be introduced with emphasis on applications of diodes, transistor (BJT), operational amplifier, 555 timer, number systems, basic gates and digital circuits.

LEARNING OUTCOMES

At the end of this course, students will be able to imbibe the following learning outcomes:

- This paper aims to describe the concepts of basic electronics in real-life. In this course, students will receive an introduction to the principle, performance and applications of basic electronic components.
- The students will gain an insight on the existence of analog and digital signals and their necessity. Specifically they would know the difference between active and passive electronic components including filters.
- Students will learn about diodes and its uses in rectification (analog) and switching properties thereof (digital). They will gain an insight into working principle of Photodiodes, Solar Cells, LED and Zener Diode as Voltage Regulator.
- They will gain an understanding of construction and working principle of bipolar junction transistors (BJTs). Specifically, they would understand the fundamentals of amplification.
- Students will be able to seamlessly understand and work on different numbers systems including binary, octal, hexadecimal besides decimal.
- They will learn about the existence of digital gates besides their need in electronic decision making thus laying the foundation for basic artificial intelligence.
- Students will learn the fundamentals of operation amplifier and their regular application including those used to sum, subtract and compare two or more signals.
- They will gain an in-depth understanding of working of Cathode Ray Oscilloscope which effectively acts as an electronic stethoscope for analysis of electronic signal in any laboratory.
- This paper will essentially connect the text book knowledge with the most common electronic components available that influence design of technology in a real world.
- The project component included in the practical section is envisaged to impart much

needed hands-on skill sets to the student. Therein he/she gets an experience in correctly choosing components required to build an electronic circuit, identifying the procurement source (online/offline) besides gaining valuable experience in trouble-shooting

SYLLABUS OF GE - 4

THEORY COMPONENT

Unit – I **(4 Hours)**
Analog and digital signals, Active and passive electronic components, RC integrator and differentiator (use as low pass and high pass filter): Qualitative analysis and frequency response.

Unit – II **(6 Hours)**
I-V characteristics of a diode and it's applications as rectifier (Half and full wave rectifier configurations), Clipper and Clamper circuits (Qualitative Analysis only). Principle and working of Photodiodes, Solar Cells, LED and Zener Diode as Voltage Regulator.

Unit – III **(4 Hours)**
Input and output characteristics of a bipolar junction transistor (BJT) in CB and CE configurations, identifying active, cut-off and saturation regions. Transistor parameters alpha and beta, and relation between them. Application of BJT as a switch and an amplifier in CE configuration (Graphical Analysis)

Unit – IV **(6 Hours)**
Review of basic and Universal Logic Gates, Binary to decimal and Decimal to binary conversion, binary addition and subtraction using 2's complement, Half and Full Adder, Half and Full Subtractor using NAND Gates.

Unit – V **(6 Hours)**
Operational Amplifier (Black Box Approach): Pinout diagram of IC 741; Characteristics of Op-amp (Voltage Gain, offset voltage, slew rate, CMRR, Bandwidth, Input Impedance and Output Impedance). Open loop configuration and its application as a comparator and zero crossing detector. Closed Loop Configuration and its Applications as Inverting and Non-inverting Amplifier (Voltage gain using concept of virtual ground), Summing Amplifier and Subtractor

Unit – VI **(4 Hours)**
Block diagram of CRO, Voltage and frequency measurement. Pin-out diagram of IC 555 and its application as Astable Multivibrator

References:
Essential Readings:

1) Electronic Devices, Thomas L Floyd; Pearsons Education
2) Op Amps and Linear Integrated Circuits, Ramakant A Gaekwad, Pearson Education
3) Microelectronic circuits, A. S. Sedra, K. C. Smith, A. N. Chandorkar, Oxford University Press
4) Electronic Principles, A. Malvino, D. J. Bates, 7th Edition, Tata Mc-Graw Hill Education, 2018

5) Electronic Devices and circuit theory, R. L. Boylestad and L. D. Nashelsky, Pearson Learning
6) Digital Principles and Applications, Donald P Leach, Albert Paul Malvino and Goutam Saha, Pearson Education, Tata Mc-Graw Hill.

Additional Readings:

1) Electronic Fundamental and Applications, John D Ryder; PHI Learning
2) Electronic Devices and Circuits, J. Millman and C. C. Halkias, Tata Mc-Graw Hill.

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

Every student must perform either "04 Experiments and 01 Project" or "At least six experiments"

1) Voltage and frequency measurement using CRO
2) Study of RC circuits as an Integrator and Differentiator
3) IV characteristics for pn junction diode and Zener diode
4) Study of Zener diode as voltage regulator circuit
5) Study of transistor characteristics in CE configuration
6) Half Adder and Full Adder using NAND gates
7) Half Subtractor and Full Subtractor using NAND gates
8) Design Astable Multivibrator using IC 555
9) Study the Frequency Response of Op Amp in Inverting and Non Inverting configurations.
10) Study of zero crossing detector using Op amp IC 741
11) Addition of two dc voltages using OP Amp in inverting and non-inverting configurations.

References (for Laboratory Work):

1) An Analog Electronics Companion: Basic Circuit Design for Engineers and Scientists – by Scott Hamilton, Cambridge University Press
2) Practical Electronics – by Ralph Morrison, Wiley
3) Practical Electronic Design for Experimenters (ELECTRONICS) – by Louis E. Frenzel, McGraw Hill Education
4) Practical Electronics for Inventors – by Paul Scherz and Simon Monk, McGraw Hill
5) Analog Electronics with Op-amps: A Source Book of Practical Circuits (Electronics Texts for Engineers and Scientists) – by Anthony Peyton and Vincent Walsh, Cambridge University Press

GENERIC ELECTIVE (GE – 5): SOLID STATE PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
SOLID STATE PHYSICS GE – 5	4	3	1	0	Passed 12th Class	NIL

LEARNING OBJECTIVES

This course introduces the basic concepts and principles required to understand the various properties exhibited by condensed matter, especially solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. It also communicates the importance of solid state physics in modern society. Emphasis should be given on the applications and uses of solids.

LEARNING OUTCOMES

On successful completion of the module students should be able to,

- Elucidate the concept of lattice, basis and symmetry in crystals. Learn to appreciate structure and symmetry of solids.
- Understand the elementary lattice dynamics and its influence on the properties of materials.
- Describe the main features of the physics of electrons in solids: origin of energy bands.
- Introduction to dia-, para-, ferri and ferro-magnetic properties of solids and their applications.
- Introduction to dielectric properties exhibited by solids and the concept of polarizability.
- Introduction to superconductivity.

SYLLABUS OF GE - 5

THEORY COMPONENT

UNIT – I **(21 Hours)**

Review of Atomic Structure and bonding in solids: Classification of matter as solid, liquid and gas: salient features and properties, Qualitative discussion on Rutherford Model and Bohr model of atom, qualitative idea about discrete energy levels, wave-mechanical concept of the atom, forces between atoms, Ionic bonding, covalent bonding, metallic bonding, Hydrogen bonding and Van der Waals bonding, Properties of solids exhibiting different bonding.

Crystal structure: Periodicity in crystals: lattice points and space lattice, translational, rotational and reflection symmetry elements, lattice with a basis and crystal structure, unit cells and lattice parameters, Bravais lattices (in 2D and 3D) and crystal systems SC, BCC and FCC lattices, conventional and primitive unit cell, Wigner Seitz unit cell, amorphous and crystalline materials. Planes, Miller Indices, directions, density of atoms in different planes, inter-planar spacing, concept of Reciprocal Lattice, Brillouin zones (2 D lattice)

Atomic Packing and Imperfections in crystals: Packing of spheres in 2D and 3D, hexagonal close packing, packing fraction of SC, FCC, and BCC. Point defects and line defects and their consequences on the crystal properties
X-rays: Their generation and properties, Bragg's law and Laue Condition, single crystal method and powder diffraction method, simple problems related to X-Ray diffraction in SC, BCC, FCC

UNIT – II **(4 Hours)**
Elementary Lattice Dynamics: Lattice vibrations and phonons: linear monoatomic and diatomic chains, acoustic and optical phonons, qualitative description of the phonon spectrum in solids.

UNIT – III **(10 Hours)**
Electrical properties of metals: Free electron theory of metals (Drude model), its success and drawbacks, concept of relaxation time, collision time and mean free path, electrical conductivity, mobility and Ohm's law, thermal conductivity of metals, Wiedemann-Franz-Lorentz law.
Band Theory: The Kronig-Penney model (Qualitative idea), Band Gap, direct and indirect bandgap, concept of effective mass, Hall Effect (Metal and Semiconductor).
Optical properties of solids: (Qualitative) Absorption process, transmission and reflectance in solids. Discussion on photoconductivity, photoluminescence.

UNIT – IV **(3 Hours)**
Magnetic Properties of solids: Dia-, Para-, Ferri- and Ferro- magnetic Materials, definition in terms of susceptibility.Weiss's Theory of FerromagnetismandFerromagnetic Domains (qualitative treatment only),B-H curve, soft and hard material and their applications(discussion only) as cores in generators, transformers and electromagnets, energy lossin Hysteresis curve.

UNIT – V **(4 Hours)**
Dielectric Properties of solids: Dipole moment, polarization,local electric field in solids. Depolarization field, electric susceptibility, various sources of polarizability,piezo-, pyro- and ferroelectric materials and their applications(discussion only) as transducers, pickups, sensors, actuators, delay lines.

UNIT – VI **(3 Hours)**
Superconductivity: (Qualitative treatment only) Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, applications of superconductors. Discussion on applications in MRI, particle collider, power transmission, magnetic levitation etc.

References:
Essential Readings:

1) Solid State Physics, M. A. Wahab, 3rd Edition, Narosa Publications, 2015
2) Solid State Physics, S. O. Pillai, New Age International Publishers
3) Introduction to Solid State Physics, Charles Kittel, 8th Edition, Wiley India Pvt. Ltd, 2004
4) Elements of Solid State Physics, J. P. Srivastava, 2nd Edition, Prentice-Hall of India, 2006
5) Solid State Physics, A. J. Dekker, Macmillan Education, 2008

Additional Readings:

1) Introduction to Solids, Leonid V. Azaroff, Tata Mc-Graw Hill, 2004
2) Solid State Physics, N. W. Ashcroft and N. D. Mermin, Cengage Learning, 1976
3) Elementary Solid State Physics, M. Ali Omar, Pearson, 2006
4) Solid State Physics, Rita John, McGraw Hill, 2014
5) Superconductivity: A Very short Introduction – Stephen J Blundell – Audiobook
6) Crystallography applied to solid state physics, A. R. Verma and O. N. Srivastava, New Age International Publishers, 2005

GENERIC ELECTIVE (GE – 7): BIOLOGICAL PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
BIOLOGICAL PHYSICS GE – 7	4	3	1	0	Passed 12th Class	NIL

LEARNING OBJECTIVES

This course familiarizes the students with the basic facts and ideas of biology from a quantitative perspective. It shows them how ideas and methods of physics enrich our understanding of biological systems at diverse length and time scales. The course also gives them a flavour of the interface between biology, chemistry, physics and mathematics.

LEARNING OUTCOMES

After completing this course, students will

- Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective.
- Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution.
- Appreciate how fundamental principles of physics can be applied to gain an understanding of biological systems.
- Get exposure to complexity of life at i) the level of cell, ii) level of multi cellular organism and iii) at macroscopic system – ecosystem and biosphere.
- Gain a systems level perspective on organisms and appreciate how networks of interactions of many components give rise to complex behaviour.
- Perform mathematical modelling of certain aspects of living systems.
- Get exposure to models of evolution.

SYLLABUS OF GE 7

THEORY COMPONENT

Unit – I **(4 Hours)**

Overview: The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales.

Unit - II **(12 Hours)**

Molecules of life: Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation.

Unit - III **(12 Hours)**

Molecular motion in cells: Random walks and applications to biology: Diffusion; models of macromolecules. Molecular motors: Transport along microtubules. Flagellar motion: bacterial chemotaxis.

Unit - IV **(12 Hours)**

The complexity of life: At the level of a cell: Intracellular biochemical networks. Dynamics of metabolic networks; the stoichiometric matrix. The implausibility of life based on a simplified probability estimate, and the origin of life problem. At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cellular differentiation and development. Brain structure: neurons and neural networks. At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self-sustaining ecosystems. Allometric scaling laws.

Unit - V **(5 Hours)**

Evolution: The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution.

References:

Essential Readings:

1) Biological Physics: Energy, Information, Life, P. Nelson, W H Freeman & Co, NY, 2004
2) Cell Biology by the Numbers, R. Milo and R. Phillips, Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2016
3) Physical Biology of the Cell, R. Phillips et al, 2nd edition, Garland Science, Taylor & Francis Group, NY USA and Abingdon UK, 2013
4) Evolution, M. Ridley, Blackwell Publishers, 2009, 3rd edition

Additional Readings:

1) Physics in Molecular Biology, K. Sneppen and G. Zocchi, Cambridge University Press, Cambridge UK, 2005
2) Biophysics: Searching for Principles, W. Bialek, Princeton University Press, Princeton USA, 2012

GENERIC ELECTIVE (GE – 8):

NUMERICAL ANALYSIS AND COMPUTATIONAL PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
NUMERICAL ANALYSIS AND COMPUTATIONAL PHYSICS GE – 8	4	2	0	2	Passed 12th Class	Differential calculus, integration and ordinary differential calculus at the class 12 level.

LEARNING OBJECTIVES

The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists. To expose students to fundamental computational physics skills and hence enable them to solve a wide range of physics problems.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Develop numerical methods to understand errors and solution of Algebraic and Transcendental equations.
- Understand interpolation, least square fitting, Numerical differentiation, Numerical integration and solution of ordinary differential equations.

In the laboratory course, the students will learn to,

- apply appropriate numerical method to solve selected physics problems using user defined and inbuilt functions
- solve non-linear equations
- perform least square fitting of the data taken in physics lab by user defined functions
- Interpolate a data by polynomial approximations
- numerically integrate a function and
- solve first order initial value problems numerically

SYLLABUS OF GE - 8

THEORY COMPONENT

Unit – I **(8 Hours)**

Errors and iterative Methods: Truncation and Round-off Errors. Floating Point Computation, Overflow and underflow. Single and Double Precision Arithmetic, Iterative Methods. Review of Taylor's Theorem and Mean value Theorem (No proofs).

Solutions of Algebraic and Transcendental Equations: Bisection method, Secant Method, Newton Raphson method. Comparison and error estimation

Unit – II **(10 Hours)**

Interpolation: Concept of Interpolation, Lagrange Form of interpolating polynomial, Newton's Forward and Backward Differences, Newton's Forward and Backward Interpolation Formulas.

Regression: Algorithm for Least square fitting of a straight line, Fitting a Power function, and Exponential Function using conversion to linear relation by transforming the variables.

Unit – III **(7 Hours)**

Numerical Differentiation: Approximating the derivative of a function given in the form of discrete data, Numerical Computation of First and second order derivative of a function given in closed form (using Taylor's expansion) , errors in Numerical Differentiation.

Numerical Integration: Newton Cotes Quadrature methods for evaluation of definite integrals numerically, Trapezoidal Rule, Simpson's 1/3 and 3/8 Rules. Derivation of composite formulae for these methods and discussion of error estimation

Unit – IV **(5 Hours)**

Solution of Ordinary Differential Equations: First Order ODE's: solution of Initial Value problems: (1) Euler's Method and (2) Runge Kutta methods

References:

Essential Readings:

1) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edition, Wiley India Edition, 2007
2) Introduction to Numerical Analysis, S. S. Sastry, 5th Edition, PHI Learning Pvt. Ltd, 2012
3) Computational Physics, Darren Walker, 1st Edition, Scientific International Pvt. Ltd, 2015
4) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, 2007

Additional Readings:

1) An Introduction to Computational Physics, T. Pang, Cambridge University Press, 2010
2) Numerical Recipes: The art of scientific computing, William H. Press, Saul A. Teukolsky and William Vetterling, Cambridge University Press, 3rd Edition, 2007
3) Computational Problems for Physics, R. H. Landau and M. J. Páez, CRC Press, 2018

PRACTICAL COMPONENT

(15 Weeks with 4 hours of laboratory session per week)

The aim of this lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- The course will consist of practical sessions and lectures on Python.
- Assessment is to be done not only on the programming but also on the basis of formulating the problem.
- The list of recommended programs is suggestive only. Students should be encouraged to do more physics applications. Emphasis should be given to formulate a physics problem as mathematical one and solve by computational methods.
- At least 6 programs must be attempted (taking at least one from each unit).

Unit I

Basic Elements of Python: The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability, formatting in the print statement

Control Structures: Conditional operations, i*f, if-else, if-elif-else, while* and *for* Loops, indentation, break and continue, List comprehension. Simple programs for practice like solving quadratic equations, temperature conversion etc.

Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules. Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers, etc. Generating pseudo random numbers

Recommended List of Programs

(a) Make a function that takes a number *N* as input and returns the value of factorial of *N*. Use this function to print the number of ways a set of *m* red and *n* blue balls can be arranged.
(b) Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions.
(c) Generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion.

Unit II

NumPy Fundamentals: Importing *Numpy*, Difference between List and NumPy array, Adding, removing and sorting elements, creating arrays using *ones(), zeros(), random(), arange(), linspace()*. Basic array operations (*sum, max, min, mean, variance*), 2-d arrays, matrix operations, reshaping and transposing arrays, savetxt() and loadtxt().

Plotting with Matplotlib: *matplotlib.pyplot* functions, Plotting of functions given in closed form as well as in the form of discrete data and making histograms.

Recommended List of Programs

(a) Given a function in closed form y=f(x), generate numpy arrays for x and y and plot y as a function of x with appropriate scale and legend.
(b) Generate data for coordinates of a projectile and plot the trajectory.
(c) Given the expressions in closed form, plot the displacement-time and velocity-time graph for the un-damped, under damped critically damped and over damped oscillator.

Unit III

Root Finding

a) Determine the depth up to which a spherical homogeneous object of given radius and density will sink into a fluid of given density.
b) Solve transcendental equations like $\alpha = \tan(\alpha)$.
c) To approximate nth root of a number up to a given number of significant digits.

Unit IV

Least Square fitting

Make function for least square fitting, use it for fitting given data (*x,y*) and estimate the parameters *a, b* as well as uncertainties in the parameters for the following cases:

a) Linear ($y = ax + b$)
b) Power law ($y = ax^b$)

c) Exponential ($y = ae^{bx}$)

Interpolation:
(a) Write program to determine the unique polynomial of a degree n that agrees with a given set of $(n+1)$ data points (x_i, y_i) and use this polynomial to find the value of y at a value of x not included in the data.
(b) Generate a tabulated data containing a given number of values $(x_i, f(x_i))$ of a function f(x) and use it to interpolate at a value of x not used in table.

Unit V
Numerical Differentiation
a) Given displacement at equidistant time values, calculate velocity and acceleration and plot them.
b) Compute the left, right and central approximations for derivative of a function given in closed form. Plot both the function and derivative (forward, backward and central derivatives) on the same graph. Plot the error as a function of step size on a log-log graph, study the behaviour of the plot as step size decreases and hence discuss the effect of round off error.

Numerical Integration:
a) Given acceleration at equidistant time values, calculate position and velocity and plot them.
b) Use integral definition of ln(x) to compute and plot ln(x) in a given range. Use trapezoidal and Simpson methods and compare the results.
c) Verify the rate of convergence of the composite Trapezoidal and Simpson methods by approximating the value of a given definite integral.

References
1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Computational Physics, Darren Walker, 1st Edition, Scientific International Pvt. Ltd, 2015
4) Introduction to Numerical Analysis, S. S. Sastry, 5th Edition, PHI Learning Pvt. Ltd, 2012
5) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edition, Wiley India Edition, 2007
6) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, 2007

GENERIC ELECTIVE (GE – 9): APPLIED DYNAMICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
APPLIED DYNAMICS GE – 9	4	3	1	0	Passed 12th Class	NIL

LEARNING OBJECTIVES

This course introduces the main topics of low-dimensional nonlinear systems, with applications to a wide variety of disciplines, including physics, engineering, mathematics, chemistry, and biology. This course begins with the first order dynamical system and the idea of phase space, flows and trajectories and ends with the elementary fluid dynamics. The nature of the subject demands that the tutorials should include only computational problems.

LEARNING OUTCOMES

Upon successful course completion, a student will be able to:

- Demonstrate understanding of the concepts that underlay the study of dynamical systems.
- Learn various forms of dynamics and different routes to chaos.
- Understand basic Physics of fluids and its dynamics

SYLLABUS OF GE 9

THEORY COMPONENT

Unit – I **(22 Hours)**

Introduction to Dynamical systems: Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Concept of stability and un-stability. Simple mechanical systems as first order dynamical systems: simple and damped harmonic oscillator. Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems. Examples of dynamical systems – Population models e.g. exponential growth and decay, logistic growth, predator-prey dynamics.

Unit – II **(16 Hours)**

Introduction to Chaos: Bifurcations: Saddle-Node bifurcation, Transcritical bifurcation, Pitchfork bifurcation and Hopf bifurcation. Chaos in nonlinear equations: Logistic map and Lorenz equations. Sensitivity to initial states. Parameter dependence: steady, periodic and chaotic states. Cobweb iteration. Simple examples from physics, chemistry, engineering and lifesciences.

Unit – III **(7 Hours)**

Elementary Fluid Dynamics: Basic physics of fluids: The continuum hypothesis-concept of fluid element or fluid parcel; Definition of a fluid- shear stress; Fluid properties- viscosity, thermal conductivity, mass diffusivity and equation of state.

References:

Essential Readings:

1) Nonlinear Dynamics and Chaos, S. H. Strogatz, Westview Press, 2nd Edition, 2014
2) Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer New York, 1995
3) Nonlinear Dynamics: Integrability, Chaos and Patterns, M. Lakshmanan and S. Rajasekar, Springer, 2003
4) An Introduction to Fluid Dynamics, G. K. Batchelor, Cambridge University Press, 2002
5) Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1987

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