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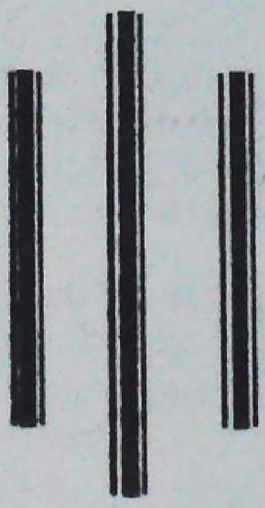
New Syllabus

Three Years Programme

(Including 1st, 2nd & 3rd Years)



Bachelor of Science (B.Sc.)



2062/2063

Price 40/-

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Three-Year Bachelor of Science

The terminal objective of the programme is as follows :

On completion of the 3-year B.Sc., the students will be able a) to work as a scientific officer in various laboratories in the country and b) to work as science teachers in secondary schools.

The course structure : Total Weightage : 1400 Marks.

a. **Major 600 marks** (Theory 400 + Practical 200) in any one of the following subjects :

1. Physics	2. Chemistry
3. Zoology	4. Botany
5. Mathematics	6. Statistics
7. Geology	8. Meteorology
9. Microbiology	10. Environmental Science
11. Computer Science	

b. **Minors : 600 marks** : - First Minor : 300 marks and second Minor : 300 marks Two subjects other than the one offered as the major subject but included as permissible subjects with the major subject offered are to be chosen from the above list. Each minor subject carries a weightage equivalent to 150 marks (Theory 100 + Practical 50) in the first year and the second year.

c. **Compulsory : 100 Marks** :- A compulsory course related to the research methodology and writing of scientific report will be offered in the third year.

d. **Elective 100 : Marks** :- One of the subjects, either from language group or from interdisciplinary subject group or from applied science group has to be selected depending upon the availability of facility in the campus.

Course structure and cycle at a glance

Academic year	Subject	Paper	Full Marks		
			Theory	Practical	Total
First year	Major	I	100	50	150
	Minor 1	I	100	50	150
	Minor 2	I	100	50	150
	Total Mark		**300**	**150**	**450**
Second Year	Major	II	100	50	150
	Minor 1	II	100	50	150
	Minor 2	II	100	50	150
Total Marks			**300**	**150**	**450**
Third year	Major	III	100	50	150
	Major	IV	100	50	150
	Compulsory	-	100	X	100
	Elective	-	100	X	100
Total Marks			**400**	**100**	**500**

Evaluation :

Minimum Pass Mark : THEORY 35% AND PRACTICAL 40%

A student having passed his/her 3 year of study will be graded as follows:

1st Division - 60 percent (3 years' average)

2nd Division –45 percent (3 years' average)

3rd Division –35 percent (3 years' average)

To be eligible for entry into the Third Year, a student will have to pass the First Year annual examination. The student will have to pass separately in theory and practical examination. If a student does not pass the examination, he/she will be permitted to take the make-up examination in the paper/s concerned. However, a student will have to be clear in all the subjects in 5 academic years. For example, after the Third Year annual examination, he/she will be given two more chances to pass in the subjects in which he/she has failed.

T.U.
NEW SYLLABUS
THREE-YEAR BACHELOR OF SCIENCE
Level : B.Sc.

1. Botany

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	Total Marks
First Year	BOT. 311 (Major/Minor)	100	BOT. 312 (Major/Minor)	50	150
Second Year	BOT. 321 (Major/Minor)	100	BOT. 322 (Major/Minor)	50	150
Third Year	BOT. 331 (Major) BOT. 333 (Major)	100 100	BOT. 332 (Major) BOT. 334 (Major)	50 50	300

(a) Cryptogamic Botany, Gymnosperms and Angiospers

Course No. : BOT. 311 — Full Marks : 100
Nature of the course : Theory — Pass Marks : 35
Year : I

Course Objectives : (BOT 311 & : BOT 312)

- To introduce the concept of diversity of lower organisms
- To give an idea of their life cycle patterns
- To recognise the evolutionary trends operating in different group of lower organisms
- To give an idea of cell structure and functions and the mode of heredity

Contents

Unit I

1. **Algae :** (a) General account, classification, characteristics and economic importance. b) Structure and life cycle of the following types : *Oscillatoria, Chlamydomonas, Anabaena, Volvox, Oedogonium, Vaucheria, Chara, Fucus, Batrachospermum, Navicula.*
2. **Fungi :** a) General account, classification, charateristics and economic importance. b) Structure and life cycle of the following types : *Plasmodiophora, Saprolegnia, Albugo, Eurotium, Peziza, Puccinia, Agaricus, Alternaria, Helminthospreium.*
3. **Plant Pathology :** 1) Introduction and scope of plant pathology. 2) Symptoms of plant diseases caused by - a. Fungi, b. Bacteria,

c. Viruses. 3) Dissemination of the inoculum through - a. Soil. b. Insects. c. Water. d. Men. e. Fungi. f. Seed. g. Wind. h. Birds. 4. Disease control through - a. Chemical. b. Biological. c. Genetical methods. 5. Study of the casual organism. symptoms. etiology and control of following diseases - a. Late blight of potato. b. Downy mildew of spinach. c. Loose smut of Maize. d. Ring rot of potato. e. Bean Mosaic.

Unit II

1. **Bacteria :** Structure. Nutrition. Reproduction and Economic importance.
2. **Virus :** Structure. Chemical composition. Reproduction and Mode of Transmission.
3. **Lichens :** Structure. Different forms. Lichens as the bioindicators of air pollution and as pioneers in plant succession.

Unit III

1. **Bryophytes :** Morphology. anatomy. life cycle. classification and evolution of sporophytes with reference to following genera : *Riccia. Marchantia. Pellia. Porella. Anthoceros. Polytrichum.* Economic importance of bryophytes.
2. **Pteridophytes :** a) General account classification and characteristics features. b) Stelar system. c) Heterospory. d) Habit and Habitat. life cycle. development of sex organs with reference to following types : *Lycopodium. Selaginella. Equisetum. Pteris* and *Marsilea.* Economic importance. Distribution with reference to Nepal.
3. **Gymnosperms :** a) Classification and characteristics features. b) Morphology. anatomy and life cycle of the following genera : i) *Pinus.* ii) *Ephedra.* c) Distribution and economic importance of gymnosperms of Nepal.
4. **Palaeobotany :** a) Introduction. b) General account of geological eras and periods with examples. c) Morphology and anatomy of *Rhynia.* d) Mode of fossil formation. types of fossils.

Unit IV

1. **Plant Taxonomy :** a) Introduction : Principles and significance of plant taxonomy. b) Taxonomic hierarchy and botanical nomenclature. c) History and development of angiosperm classification : System proposed by Bentham and Hooker. Engler and Prantel. d) Systematic study. economic importance and affinities of the following : Dicotyledenae-Ranunculaceae. Caryophyllaceae. Rutaceae. Lamiaaceae. Polygonaceae. Rosaceae. Euphorbiaceae. Scrophulariaceae. Monocotyledoae-Orchideceae. Poaceae.
2. **Economic Botany :** a) Botany. distribution. cultivation and economic importance of the following plants : Rice. Potato. Soyabean. Mustard. Serpentina. Sissoo. b) Ethnobotany : Introduction with selected examples.

Text Books :

1. Pandey, S.N. & Trivedi, P.S., *Botany Vol. I & II.* Vikas Publication, Delhi, 1990.
2. Ganguly and Kar., *College Botany.* Central Educational Enterprises, Calcutta India, 1987.
3. Alexopoulos, C.J., *Introductory Mycology,* Wiley Estern University Edition, 1962
4. Tar, S.A. J., *Principles of Plant Pathology,* McMillan Press, London, 1972.
5. Rangaswamy, G., *Disease of crop plants of India.*
6. Parihar, N.S., *An introduction of Embryophyta (Bryophyte).*
7. Parihar, N.S., *An introduction to Embryophyta (Pteridophyte).*
8. Lawrence, G.H.M. *Taxonomy of Vascular Plants,* McMillan Company, 1951
9. Sharma, O.P., *Plant Taxonomy,* Tata McGraw Hill Publishing Co. Ltd. 1993.
10. Hill, A., *Economic Botany.* McGraw Hill, 1952.
11. Bhatt, D.D., *Natural History and Economic Botany of Nepal.* Orient Longman Ltd. 1970.
12. Sporne K.R., *The Morphology of Gymnosperms.*
13. Andrews, H.N. *Studies in Palaeobotany.*

(b) Cryptogamic Botany, Gymnosperms and Angiosperms

Course No. : BOT. 312
Nature of Course : Practical

Full Marks : 50
Pass Marks : 20
Year : I

Contents :

1. **Algae :** Study of the habit, structure of vegetative and reproductive parts of the following types : *Oscillatoolia, Chlamydomonas, Volvox, Oedogonium, Vaucheria, Chara, Fucus, Batrachospermum, Navicula.*
2. **Fungi :** a) Study of the habit, structure of vegetative and reproductive parts of the following types : *Saprolegnia, Albuga, Eurotium, Peziza, Puccinia graminis, Agaricus, Alternaria, Helminthospoeium.*
3. **Plant Pathology :** a) application of autoclave, hot-air oven, pH-meter, incubator b) Preparation of culture media : liquid medium and solid medium .c) Preparation O stains : lactophenol, gram stains d) experiments on : study O symptoms, isolation, inoculation and control of any one of the following diseases (late blight of potato, leaf spot disease, rice blast disease)
4. **Bacteria :** Study of gram positive and negative bacterial structure through gram staining process.
5. **Virus :** Study of viralsymptoms with the help infected plants.
6. **Lichens :** Study of different lichen thalli (a) Crustose (b) Foliose (c) Fruticose.

7. **Bryophytes** : Monographic study of the following types : (a) Riccia (b) Marchantia (c) Pellia (d) Anthoceros (e) Polytrichum.
8. **Pteridophytes** : 1. Study of museum specimens. 2. Anatomical study of Lycopodium, Equisetum and Pteris. 3. Herbarium specimens.
9. **Gymnosperms** : 1. Study of herbarium Specimens : (a) Pinus, (b) Cycas, (c) Taxus, (d) Cedrus. 2. Museum specimens : Male and female cone of Pines. 3. Anatomical study of (a) Stem-Pinus and Cedrus.
10. **Taxonomy and Economic Botany** : 1. Systematic study of plants from the families mentioned in the syllabus with reference to local flora. 2. Preparation of herbarium specimens of local plants. 3. Field visit to observe floristic composition. 4. Practicals on economic botany based on topics mentioned in the syllabus.

(a) Ecology, Physiology, Cytology and genetics, Embryology and Anatomy

Course No : Bot 321 (Major/Minor) Full Marks : 100
Nature of the course : Theory Pass Marks : 35
Year : II

Course Objectives : (Bot 321 & Bot 322)

- To introduce the concept of internal and external organization in higher plants
- To highlight the impact of environment on structure and functions
- To emphasize the role of plants in human affairs

Unit I **Lecture hours**

1. **Ecology** : **a.** General introduction, previews, branches and scopes of ecology. **b.** Biotic and abiotic factors. **c.** Biogeochemical cycles of Carbon, Water, Phosphorous, Nitrogen and Sulphur. **d.** Communities and Successions. **e.** Structure and function of major eco-systems (forest, grassland and fresh water). **f.** Vegetation in Nepal. **g.** Environmental pollution (air, water, soil and noise). **h.** Nature conservation in the context of Nepal (National Parks and Reserves). **i.** Ecological anatomy. 40

Unit II

2. **Plant Physiology** :
   1. **Nutrition and Transport in Plants** : **a.** The soil: Composition of soil, soil water. **b.** Water movement through plants. **c.** Diffusion, Osmosis, Turgor, Transpiration, Antitranspirants, Wilting, Absorption of water by roots, Water movement in plants and its rate, factors regulating

transpiration rate. d. Plant nutrients : Macro-and micro-nutrients. Role of plant nutrients. Mineral deficiencies. Fertilizers. Hydroponics.

2. **Plant development** : Differentiation in plants : Tissue culture. Regeneration. Polarity. Seed germination : Seed dormancy. vernalization.
3. **Regulation of plant growth** : Definition of growth. Plant Hormones : Concept of hormones. Role of Auxins. Cytokinins Gibberellins. Ethylene. Abscissic acid. Apical dominance and senescence.
4. **Tropism** : Phototropism. Gravotropism. Thigmotropism.
5. **Photoperiodism. Vernalization and Photomorphogenesis**
6. **Metabolism** : **a.** Anabolism and catabolism **b.** Respiration : An overview of respiration. ultrastructure of mitochondria. anaerobic and aerobic respiration. glycolysis. Kreb's cycle. respiratory chain. **c.** Photosynthesis : An overview of photosynthesis. ultrastructure of chloroplast. chloroplast pigments. radiant energy. light reaction. Hill reaction dark reaction. factors affecting photosynthesis. concept of limiting factors. Concept of C_3 and C_4 plants. 40

Unit III

1. **Cytology and Genetics** : a) Structural organisation of prokaryotic and Eurkaryotic cells. b) Ultrastructure and function of cell wall. cell membrane. endoplasmic reticulum. Golgi bodies. vacuoles. microbodies. mitochondria. plastids. microtubules. centrosome. flagella. nucleus and nucleolus. c) Physical and chemical nature of chromosomes. d) Mitosis and Meiosis: cell cycle. Different phases and their significances. e) Process and significance of crossing over and chiasma formation: linkage. f) Elementary idea of chromosomal aberrations. polyploidy and gene mutation: their application in crop improvement g) Mendel's laws of inheritance. expression and interaction of genes and multiple alleles. h) Structure and function of Nucleic acids: Double helix. circular DNA and RNA.
2. **Plant Breeding** : a) Nature and scope of Plant Breeding. b) Method of crop improvement : selection. hybridization and Mutation breeding. c) General principles and methods of breeding for resistance. 35

Unit IV

1. **Embryology** : a. Structure and development of Microsporangium. Microsporogenesis and the male gametophyte. b. Structure and development of megasporangium. megasporogenesis and the female gametophyte.

c. Fertilization, endosperm, d. Embryogenesis in typical dicot and monocot plants. e. Palynology : Introduction and its scope. 15

Unit V

1. **Anatomy** : a. Meristems - Structure, classification and theories of differentiation of root and shoot apices. b. Secondary growth and anamalous structures. c. General anatomy of different plant parts (root, stem and leaf.) 15

Text Books :

1. Eames, A.J., *An Introduction to Plant Anatomy*, Tata-McGraw Hill, Delhi.
2. Noggle, G. Ray and Fritz, George J., *Introductory Plant Physiology*, Prentice Hall of India, New Delhi, 1986.
3. Sinha, V. & Sinha, S., *Cytogenetics, Plant breeding and evolution*, Vikas, Delhi, 1995.
4. Odum, R.C.P., *Ecology*, I.B.H. Publication Co., Delhi, 1975.
5. Bhojwani, S.S. and Bhatnagar, S.P., *The Embryology of Angiosperms*, Vikas Publication, Delhi, 1993.
6. Srivastava, S. and Tyagi, *Recent Advances in Genetics*, Amol Publication, New Delhi, 1994.
7. Gardner E.J., Simmons M.J. and Snustad D.P., *Principles of Genetics*, John Wiley and Sons Inc. New York, Singleton, 1991.
8. Verma, P.S. and Agrawal, V.K. : *Principles of Ecology*, S. Chhanda & Co (P.) Ltd. Ram Nagqar, New Delhi - 110555, India.
9. Odum E.P. : *Fundamentals of Ecology*, WB Saunders: Toppan Co. Ltd. Tokyo, Japan.
10. Ambâsht, R.S. : *Environment and Pollution, Students*, Friends & Co., Lanka, Varanasi 221005, India.
11. Salisbury, T.B. and Ross C., *Plant Physiology*, Wordsworth Publishing Co. London.
12. Devlin, R.M., *Plant Physiology*, Affiliated East West Pvt., New Delhi.
13. Dutta, S.C., *Plant Physiology*, Wiley International Ltd., New Delhi.
14. Bhamrah, H.S. and Juneja, K., *Cytology and Genetics*, Amol Publication, New Delhi, 1993.

(b) Ecology, Physiology, Cytology and genetics, Embryology and Anatomy

Course No : Bot 322 (Major/Minor) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : II

1. **Ecology** : a) To enumerate plants of the study area., b) To determine the minimum size of the quadrat by species-area curve method., c) To determine

the minimum number of quadrats to be laid down in the field under study.. d) To determine density and frequency of different species by quadrat method.. e) To study the physical characteristics (temperature. colour. texture. moisture.) of soil.. f) To study the biotic component of a pond.. g) field. visit to understand factors affecting plant community.

2. **Physiology** : a) To study the movement of the chloroplast under the microscope.. b) To perform the classical plasmolysis method for determining the Osmotic potential of cell solutions.. c) To study the effects of various environmental factors upon the rate of transpiration using a Potometer., d) To study the distribution. shape of the guard cells and the mechanism of opening and closing of stomata.. e) To study the effect of different light colours on the rate of Photosynthesis.. f) To perform the aerobic respiration by Ganong's respiroscope.. g) To perform anaerobic respiration in germinating gram seeds.. h) To distinguish C3 and C4 plants on anatomical basis.. i) To study the effect of light on the dark grown seedling of *Viciafaba* (photomorphogenesis).
3. **Cytology and Genetics** : a) Mitosis - Study of different stages of mitosis in onion root tip.. b) Meiosis : study of behaviour of chromosomes during meiosis in pollen mother cells.
4. **Embryology** : To study embryological slides related to syllabus.
5. **Anatomy** : To prepare permanent slides of stem showing anomalous structure.

(a) Plant Bio-chemistry and plant Biotechnology

Course No. : Bot 331 (Major) — Full Marks : 100
Nature of the course : Theory — Pass Marks : 35
Year : III

Course Objectives (Bot. 331 & 332)

- To understand the chemical basis of Biological macromolecules.
- To understand the chemistry of various metabolic processes and
- The structure and functional aspects of enzymes.
- To understand the techniques and principle of plant tissue culture.

Unit I (Plant Biochemistry)

1. **Introduction** : (a) Plant biochemistry as a science. (b) Relationship between plant biochemistry and plant physiology 2
2. **Bio-molecules** : (a) Water : Molecular structure. Properties. water as a solvent. ionization of water. pH scale. buffer. (b) Carbohydrates : Importance. general structure and examples of monosaccharides. di-sac-

charides and polysaccharides, isomers. (c) Lipids : Importance and general structure, glycerol, fatty acids, kinds of lipids, phospholipids. (d) Proteins : Amino-acids, peptide bonds, polypeptides; primary, secondary, tertiary and quarternary structures of proteins; kinds of proteins; functions of proteins. (e) Nucleic acids : Building components of nucleic acids, bases, sugars, phosphates, types of nucleic acids, structure of nucleic acids, roles of nucleic acids. 50

3. **Enzymes :** (a) Properties and chemical structure.. (b) Mechanism of action. (c) Denaturation. (d) Factors affecting enzyme action. (e) Allosteric protein and feedback. (f) Classification and nomenclature. 15
4. **Vitamins :** Introduction and their role, fat soluble vitamins, water soluble vitamins.
5. **Plant Pigments :** Structure and functions of chlorophylls, carotenoids, anthocyanins phycobillins.

Unit II (Plant Biotechnology)

1. **Plant Biotechnology :** Introduction, Scope and importance of Biotechnology.
2. **In vitro culture techniques and principles :** totipotency, basic procedures of culture techniques, composition and selection of media.
3. **Culture methods of plant materials :** Protoplast culture, cell culture, tissue culture, organ culture.
4. **Application of in vitro cultures :** a) Production of improved varieties of crop plants (High yielding and disease resistant) b) Micropropogation c) In vitro establishment of Mycorrhiza d) Biosynthesis of secondary products.
5. **Plant - Microbe Interaction :** Symbiotic and asymbiotic organisms for soil fertility and crop improvement : a) Rhizobia b) Blue Green Algae (BGA) c) Frankia d) Mycorrhiza.
6. **Cryopreservation :** Principles, methods and uses.

References :

1. Jain, *Fundamentals of biochemistry*, S.Chand and company 1993.
2. R.C. Dubey, *A Text book of biotechnology*, S.Chand and company 1993.
3. Salisbury, T.B. and Ross C., *Plant Physiology*, Wordsworth Publishing Co. London.
4. Lehninger, *Biochemistry*.

(b) Plant Bio-chemistry and Plant Biotechnology

Course No. : Bot. 332 (Major) Full Marks : 50
Nature of the course : Practical Pass Marks : 20
Year : III

1. **Plant Biochemistry :** a) Preparation of different kinds of buffer solution of different pH.. b) Extraction and qualitative identification of carbohydrates. lipids, proteins and nucleic acids. c) Quantitative estimation of total sugar. lipids, proteins and nucleic acids. d) Extraction of catalyse and estimation of its activity. e) Extraction and estimation of total chlorophyll. f) Extraction and estimation of vitamin C (ascorbic acid) g) Bioassay of indole-acetic acid.
2. **Plant Biotechnology :** a) Preparation of different culture media.. b) Understanding the principles of sterilization, Surface sterilization. Autoclave. Laminar flow.. c) Culture technique of tissue culture. Root tip culture.. Stem culture. Shoot tip culture. Pollen culture. Anther culture and Seed culture.. d) Regeneration of plantlets through in vitro cultures.

(c) Environment and Biodiversity

Course No. : Bot. 333 (Major) Full Marks : 100
Nature of the course : Theory Pass Marks : 35
Year : III

Course Objectives (Bot. 333 & 334)

- To understand different aspects of environment.
- To understand the importance of biodiversity.
- To understand the principles of biodiversity conservation.
- To understand the concept of environmental conservation.

Unit I (Environment) :

1. **Brief history of environmental Science** 2
2. **Environmental issues :** Population, deforestation, development activities. Urbanization. Pollution. waste disposal. Pesticide use and abuse. fertilizer. 6
3. **Biosphere, biomes and climate :** Major biomes. Structure and composition of the biosphere. Weather and climate. 10
4. **Matter, Energy and Ecosystem :** Matter : forms and structure. Energy : Types. laws. Ecological pyramids. food chain. tropic level. 15
5. **Environmental pollution and control measures :** Air. Soil. Water. Noise. Environmental hazards. 10
6. **Natural resources and their conservation :** Water. land mineral. forest. 10

7. **Environmental Affairs :** Education, legislation, Organization. 6
8. Environmental Impact Assessment Methodology. 6

Unit II (Biodiversity)

1. **Biodiversity : an overview :** a. Definition, Principles, Levels and Scope. Systematics and Biodiversity. b. Vegetation and forest types in Nepal. c. Checklist, monograph, flora; fauna and red data book. d. Herbarium, museum and botanical garden. 10
2. **Loss of biodiversity :** Causes and consequences, species extinction. Threatened species. 5
3. **Uses and values of biodiversity :** a. Plant use - Food, Medicinal, Timber, Rattans, Ornamental, Industrial. b. Biodiversity and economics - current use of diverse resources in Nepalese perspectives, Community use of natural resources, ecotourism. c. The value of forest wetlands, grassland. d. Centres of crop diversity agricultural, and wild genetic diversity. 20
4. **Enthnobotany and Community development :** a. Scope and future perspectives. b. Methods of ethno-botanical study. c. Traditional ecological knowledge, use of plant resources for community development. 10
5. **Conservation and Management of Biodiversity :** a. Wildlife conservation - a historical perspective. Fundamentals of wildlife management. b. Current practices in conservation, Protected areas categories, network and biodiversity. Park-People conflict, and case studies from protected areas of Nepal. c. Plant germ plasma. d. An introduction to National legislation and international conventions and treaties. e. An introduction to biodiversity prospecting and Intellectual property rights (IPRs). 20

Environment and Biodiversity Text Book :

1. Verma, P.S. and Agrawal, V.K. : *Principles of Ecology*, S. Chhada & Co (P) Ltd. Ram Nagqar, New Delhi - 110555, India.
2. Zobel, D.B. Jha, P.K., Behan, M.J. and Yadav, U.K.R. : *A Practical Manual for Ecology*, Nepal.
3. Odum E.P. : *Fundamentals of Ecology*, WB Saunders; Toppan Co. Ltd. Tokyo, Japan.
4. Groombridge B.(Ed.) 1992 : *Golbal Biodiversity - Status of earth's Living Resources*, Chapman and Hall.
5. Martin, G. 1995 : *Ethnobotany - a methods manual*, Chapman and Hall.

References :

1. Bhatta, D.D. 1970 : *Natural History and Economic Botany of Nepal*, Orient Publisher, Calcutta, India.

2. Ambasht, R.S. : *Environment and Pollution, Students*, Friends & Co., Lanka, Varanasi 221005, India.
3. Miller, G.T. Jr. : *Living in the Environment (Principles, Conservation and Solution)*. Wadsworth Publishing Co. Belmont, California, USA.
4. Stainton, J.D.A. 1972 : *Forests of Nepal*, John Muray, London.
5. Majupuria, T.C. (Ed.) 1983-84 : *Nepal Nature's Paradise*, Craftsman Press, Bangkok.
6. Wilson, E.D. (Ed.) 1988 : *Biodiversity*. National Academy Press.
7. McNeely, et.al., 1990 : *Conserving the world's biological diversity*. IUCN, Switzerland, Gland.
8. Jha, P.K. 1992 : *Environment and Man in Nepal*. Craftsman Press, Bangkok.

(d) Environment and Biodiversity

Course No. : Bot. 334 (Major)
Nature of the course : Practical

Full Marks : 50
Pass Marks : 20
Year : III

1. **Biodiversity (Practical) :** a) An overview of plant diversity (Use herbaria, slides, transparencies, etc.). b) Study (with the help of living and preserved materials) : Medicinal plants Food plants Timber plants Ornamental plants Rattan and fibre plants., c) Exploration of plant diversity of a specified area (a long term group project). d) Practical assignment of Ethnobotany.. e) Field visit/Study in nearest protected areas.
2. **Environment (Practical) :** a) Analyze biotic and biotic components of any aquatic ecosystem., b) Determine requisite size and requisite number for quadrate study for vegetation and analyze vegetation quantitatively (Density, RD, Frequency, Relative Frequency, coverage, relative coverage, important value index).. c) Analyze soil samples (texture, water holding capacity, soil pH, porosity)., d) Analyze water samples and compare results with water quality standard of WHO.. e) Study pollution effected plants and compare it with plants grassing in undisturbed area., f) Record climatic informations (temperature, rainfall, relative humidity) and summarize it in graphs., g) Assess environmental impact of any development project or industrial belt.. h) Visit any national part to understand management measures.

2. Chemistry

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	**Total Marks**
First Year	CHEM. 311 (Major /Minor)	100	CHEM. 312 (Major/Minor)	50	**150**
Second Year	CHEM. 321 (Major/Minor)	100	CHEM. 322 (Major/Minor)	50	**150**
Third Year	CHEM. 331 (Major) CHEM. 333 (Major)	100 100	CHEM. 332 (Major) CHEM. 334 (Major)	50 50	**300**

(a) Basic Chemistry

Course No. : Chem. 311 (major/minor) Full Marks : 100
Nature of the course : Theory Pass Marks : 35
Year : I

Course Objectives :

The outcome of this course will be :

- to stimulate, create and sustain their interest in the study of chemistry
- to provide a body of chemical knowledge appropriate for higher studies.
- to make aware the importance of scientific method of accurate experimental work.

Group A : Inorganic Chemistry

1. **Atomic Structure :** Bohr's theory and refinements, wave mechanical model of the atom, matter waves, de Broglie's equation, Heisenberg's uncertainty principle, Schroedinger's wave equation (time independent), physical significance of wave function, probability density pattern for hydrogen atom radial and angular wave functions, radical distribution curves, shapes of s, p, d orbital: quantum numbers and their significance, energy level diagram.
2. **Multi-electron system :** Pauli exclusion principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, energy level diagrams, stability of completely filled, half filled and empty orbital.
3. **Nuclear Chemistry :** Composition of nucleus (nuclear stability), binding energy, radioactivity, half life determination and nuclear reaction.
4. **Periodic classification of elements and physical properties :** Periodicity of elements, s, p, d and f blocks, long form of periodic table, discussion of properties like atomic, ionic and covalent radii, ionization potential, screening or shielding effect, electronegativity, electron affinity.

5. **Chemical bonding :** Ionic bond : packing of ions in crystal. radius ratio. lattice energy. Born equation. Born-Haber cycle. covalent character in ionic compounds. polarizing power and polarizability (Fajan's rule). bond moment and dipole moments. percentage ionic charater from dipole moments and electronegativity differences. characteristics of ionic compounds. structure of ionic solids. ionic compounds of type AX (NaCl, CsCl, ZnS); Ax_2 (CaF_2 TiO_2). layer structure. stoichiometric and non stoichiometric defects.
6. **Covalent Bond :** General characteristics of coordinate- covalent bond. valence bond approach. directional characteristics of covalent bond. resonance energy. hybridization. multiple bonding. three electron bond. two electron three centered bond. sigma and pi bonds. bond length and bond order. bond strength. valence shell electron pair repulsion theory (VSEPR). theory of directed valence. shapes of simple inorganic molecules and ions containing bonds and ion pairs. hydrogen bond (theories of hydrogen bonding. valence bond treatment). metallic bond. elementary idea of L.C.A.O. and concept of united atoms in molecular orbital theory. bonding antibonding. and non-bonding orbitals. M.O. configuarations of simple diatomic molecules (H_2. He_2. N_2. O_2. F_2. CO. NO. HCl and related species).
7. **Acids and Bases :** Lewis acid base concept. hard and soft acids and bases (HSAB) application of HSAB principle. relative strengths of acids and bases and the effect of substituents and solvents on them.
8. **Principles of qualitative and quantitative Analysis :** Solubility product. common ion effect. their application in group separation. principles of gravimetric and volumetric analysis.

Group B : Organic Chemistry

9. **Alkane :** Energetics of reaction. energy profile diagram. exothermic and endothemic reactions. free rotations about the cabon- carbon single bond. conformations of n-butane. physical properties. industrial source. industrial source vs laboratory preparation. the Grignard reagent. coupling of alkyl halides with organometallic compounds. reaction- halogenation. mechanism of halogenation. orientation of halogenation. relative reactivity of alkanes towards halogenation. ease of abstraction of hydrogen atom. stability of free radicals. ease formation of free radicals. reactivity and selectivity. combustion. the green house effect. pytolysis.
10. **Stereochemistry :** Stereochemistry and stereoisomerism. optical actjvity. the polarimeter. specific rotation. enantiomerism and tetrahedral carbon. enantiomerism and optical activity. prediction of enantiomerism (chirality). the chiral centre. enantiomers. the recemic modification. configuration. specification of configurations (R and S). sequence rules. diastereomers.

11. **Alkyl halide (Nucleophillic substitution) :** Homolytic and heterolytic fission. structure. classification and nomenclature of alkyl halides. physical properties. preparation. nucleophilic. aliphatic. substitution reactions, nucleophiles and leaving groups. rate of reaction. the SN^2 reaction (mechanism and kinetics). the SN^2 reaction (stereochemistry. reactivity). the SN^1 reaction (mechanism and kinetics) carbocations (structure and relative stability). SN^1 reaction (stereochemistry).
12. **Alcohols and Ethers :** Introduction. structure. physical properties. industrial source. fermentation. fuel from carbohydrate. ethanol : preparation reaction. alcohols and acids and bases. reaction alcohols with hydrogen halides. Formation of alkyl sulphonates. oxidation of alcohols. industrial source of ethers preparation of ethers. Williamson synthesis, reactions of ethers.
13. **Alkenes :** Structure of ethylene. hybridization and orbital size. geometrical isomerism. physical properties. industrial source. preparation. dehydrohalogenation of alkyl halide. kinetics of dehydrohalogenation. the E_2 mechanism : the E_2 mechanism (orientation and reactivity). the E_1 mechanism : E_1 mechanism (orientation). dehydration of alcohols. reactions of alkenes. reaction at the carbon-carbon double bond. hydrogenation. addition of hydrogen halides. addition of hydrogen bromide (peroxide effect). addition of sulphuric acid. addition of water. electrophillic addition (mechanism). electrophilic addition (orientation and reactivity). addition of halogens. mechanism of addition of halogens. halohydrin formation. oxymercuration-demercuration. hydroboration-oxidation. orientation and mechanism of hydroboration. free radical addition (mechanism), orientation of free radical addition. hydroxylation. ozonolysis. analysis of alkenes.
14. **Alkynes :** Structure of acetylene. physical properties. industrial source of acetylene. preparation alkynes. Reaction of alkynes, reduction to alkenes. electrophilic addition to alkyne. hydration of alkynes. acidity of alkynes. reactions of metal acetylides. formation of carbon-carbon bonds.

Group C : Physical Chemistry

15. **Gaseous State :** Postulates of kinetic molecular theory and their significance. cause of gas pressure. derivation of kinetic gas equation for ideal gas. derivation of gas laws from kinetic equation, distribution of velocity of gas molecules : Maxwell's distribution of velocities of gas molecules (no derivation). average velocity, most probable velocity. root mean square velocity. calculation of root mean square velocity from Maxwell's equation. relationship between different types of velocities. concept of collision number. Collision frequency. collision diameter and mean free path. deviation of real gas from ideal behavior. Van der Waals

equation of state, virial equation of state. Liquefaction of gas : critical state and critical constants. Van der Waals constant a and b. liquefaction of gas ; critical state and critical constants. Van der Waals constant a and b. liquefaction of gas.

16. **Liquid State :** Qualitative treatment of liquids. vapour pressure. vapour pressure and boiling point. surface tension and its determination using stalagnometer. viscosity and its determination by Ostwald viscometer method and applications of surface tension and viscosity measurements.
17. **Solid State :** Crystalline and amorphous solids. classification of solids on the basis of dominant type of bond.
18. **Chemical Equilibrium :** Reversible reaction. the law of mass action. relation between K_p and K_c. applications of law of mass action to homogeneous equilibrium. effect of temperature. pressure and components on chemical equilibrium. Le Chatelier's principle and its applications.
19. **Ionic Equilibrium :** Strong and weak electrolysis. Ostwald's dilution law and limitations. autoionization of water. pH and pH scale. dissociation equilibria of weak electrolytes. multistep ionic equilibria (ionization of polyprotic acids). hydrolysis and hydrolysis constant. solubility and solubility product principle. common ion effects in ionic equilibrium. buffer solution. buffer capacity and buffer range. pH change in acid base titration (weak and strong). theory of acid base indicator.
20. **Colligative Properties :** Dilute solution. Raoult's law and determination of vapour pressure lowering. laws of elevation of boiling point and depression of freezing point. determination of molecular weight. osmotic pressure. laws of osmotic pressure. determination of osmotic pressure. determination of molecular weight from osmotic pressure. vant Hoff factor. abnomalities in solution due to association and dissociation.
21. **Colloidal Solution :** Colloidal state of matter. lyophilic and lyophobic colloids. preparation and purification of colloids. brief discussion of kinetic. optical and electrical properties of colloids.
22. **Thermodynamics & Thermochemistry :** Some thermodynamic terms. first law of thermodynamics. isothermal but not reversible expansion of an ideal gas. isothermal reversible expansion of an ideal gas. experimental determination of ΔE using bomb calorimeter. enthalpy. experimental determination of ΔH. enthalpy of physical changes (enthalpy of fusion. vaporization. sublimation). enthalpy of chemical changes (enthalpy of formation. combustion. solution. dilution and neutralization). Hess's law of constant heat summation. enthalpy change from bond energy. variation of heat of reaction with temperature (Kirchoff's equation). calorific value of fuel. calorific value of food.

Text Book : For CHEM 311, 321, 311 and 333

1. Lee. *Concise Inorganic Chemistry*. 4th Edition with Chapman & Hall, 1991
2. Cotton. G. Wilkinson & C. Graus. *Basic Inorganic Chemistry*. 3rd Edition. John Willey & Sons (SEA). Pvt. Ltd. 1995.
3. Morrison & R.N.. *Organic Chemistry*. 6th Edition. Prentice - Hall of India Pvt. Ltd. 1994
4. March. *Advanced Organic Chemistry*. 3rd Edition. Willey Eastern Ltd.. India 1994.
5. Maron & C.F. Prutton. *Principles of Physics Chemistry*. 4th Edition. Oxford & IBH Pub. Co.. 1992.

Reference books : For CHEM. 311, 321, 331 and 333

1. Sharpe. *Inorganic Chemistry*. 2nd Edition. ELBS & Longman. Singapore. 1986. (recent edition)
2. D. Madan Satya Prakash. *Modern Inorganic Chemistry*. S. Chand & Company Ltd.. 1994.
3. N. Upadhyaya. *A Text Book of Inorganic Chemistry*. 2nd Edition. Vikash Publishing House Pvt. Ltd. 1995.
4. Lawry and Richardson. *Mechanism and Theory*. Haper and Raw. New York. 1981.
5. Finar. *Organic Chemistry*. Vol.. II. Prentice Hall London. 1955. (available recent edition)
6. C. Norman. *Principles of Organic Synthesis*. 2nd Edition. Chapman and Hill. London. 1978. (recent edition).
7. Warren. *Organic Synthesis*. The Disconnection Approach. Wiley. New York. 1982.
8. House. *Modern Synthesis Reactions*. 2nd Edition. W.A. Benjamin. New York. 1982.
9. L. Kapoor. *Text book of Physical Chemistry*. Macmillan India Ltd.. Vol. I to Vol IV. 1992.
10. Alberty. *Physical Chemistry*. 6th Edition. Willey Eastern Ltd.. New Delhi. 1992.
11. S. Glasstone & D. Lewis. *Elements of Physical Chemistry*. Mcmillan & Co.. Ltd.
12. S. Negi & S.C. Anand. *A Text book of Pysical Chemistry*. Wiley Eastern Ltd. 1991.
13. Silversten. G.L. Bassler & T.C. Morril. *Spectrometric Identification of Organic Compounds*. Wiley. New York. 1981. (Preferably available recent edition).

14. C. Agrawal, *Modern Inorganic Chemistry*, Wiley Eastern. New Delhi. 1981. (available recent edition).
15. Streitweiser & Heathcock. *Introductory Organic Chemistry*, Wiley and Sons. New York. 1981.
16. Solomons. *Organic Chemistry*. 3rd Edition. Wiley. New York. 1984. Eastern Ltd.. New Delhi 1993.
17. A Bansal. *A Text Book of Organic Chemistry*. 2nd Edition. Wiley Eastern Ltd.. New Delhi, 1993.
18. S. Bahl. G.D. Tuli & A Bahl. *Essential of Physical Chemistry* , 3rd Edition. S. Chand & Co., 1994.

(b) Basic Practical Chemistry

Course No. : Chem 312 (major/minor) — Full Marks : 50
Nature of the course : Practical — Pass Marks : 20
Year : I

Course Objectives :

The outcome of this course will be :

- to make students aware of the importance to scientific method of accurate experimental work.
- to develop in students abilities to pe orm experiments having dure regard for safety.
- to develop in students skills of observation and their ability to record and interpret those observations.

Contents :

1. **Volumetric analysis** : Volumetric analysis involving acidimetry and alkalimetry (combination of strong and weak acids and bases). permanganate titration (estimation of iron in Mohr's salt. determination of calcium in calcium carbonate). silver nitrate titration. iodometric titration (potassium dichromate and copper sulphate).
2. **Qualitative analysis of simple inorganic salt mixture containing 2 cations and 2 anions :** Hg^{+}, Pb^{++}, Ag^{++}, Cu^{++}, Hg^{++}, As^{+++}, Sb^{+++}, Sn^{++}, Bi^{+++}, Cd^{++}, Al^{+++}, Zn^{++}, Mn^{++}, Fe^{+++}, Co^{++}, Ni^{++}, Cr^{++}, Ca^{++}, Ba^{++}, Sr^{++}, Mg^{++}, K^{+}, NH_4^{+}, NO_3^{-}, Cl^{-}, Br^{-}, I^{-}, SO_4^{--}, CO_3^{--}, PO_4^{--}.
3. **Purification of organic compounds** : Purification of crude organic compound recrystallyzation (acetanilide. benzoic acid). Determination of purity of organic compound - melting point/mixed melting point (urea. cinnamic acid). Determination of boiling point of an organic compound (aniline. nitrobenzene etc.). Experiment on steam distillation (isolation of limonene from orange peels.). Identification of functional groups (– COOH. –CHO. –CO. –OH. $–NH_2$ - phenol).

4. **Determination of physical properties :** Determination of surface tension of a liquid using stalagnometer. Determination of viscosity using Ostwald viscometer, Preparation of buffer solution from sodium acetate and acetic acid. ammonium chloride and ammonium hydroxide. measurement of pH by pH paper, universal indicator. preparation of starch sol. and to study the dialysis of starch sol. containing sodium chloride through a cellophane or parchment paper. Comparision of the precipitation values of sodium chloride. barium chloride and aluminium chloride for arsenic sulphide sol., Determination of molecular weight of organic compound like acetanilide, napthalne by Rastr's comphor method.

Text Book : For CHEM 312, 322, 332 and 334

1. I. Vogel. A Text Book of Quantitative Inorganic Analysis, Including Elementry Instrumental Analysis. ELBS & Longman, 1969. (Preferably available recent edition)
2. I. Vogel. A Text Book of Qualitative Inorganic Analysis, ELBS & Longman, 1969. (recent edition)
3. L. Shriner. R.C. Fusion & D.Y. Cartin. The Systematic Identification of Organic Compounds. A Laboratory Manual. John Wiley and Sons. Inc. New York. 1986. (Preferable available recent edition)
4. P. Levitt, ed., Findlay's Physical Chemistry. Longman, London, 1973.

Reference Books : For CHEM 312, 322, 332 and 334

1. Gurdeep Raj. *Advanced Practical Inorganic*. 10th Edition.. Gel Publishing House, Meerut. 1994.
2. I. Vogel. *A Text Book of Practical Organic Chemistry. Including Qualitative Organic Analysis*. Longmans. 1958. (Preferably available recent edition).
3. G. Mann and B.C. Saunders. *Practical Organic Chemistry*. Orient Longman., 1986. (Preferably available recent edition)
4. D.P. Shoemaker & C.W. Garland. *Experiments in Physical Chemistry*. McGraw Hill. Kogakusha Ltd. Tokyo. 1967.
5. D. Khosla. A. Gulali & V.C. Garg. *Senior Practical Physical Chemistry*. 5th Edition. R. Chand & Co.. New Delhi. 1987.

(a) Basic Chemistry II

Course No. : Chem 321 (major / minor) — Full Marks : 100

Nature of the course : Theory — Pass Marks : 35

Year : II

Course Objectives :

The outcome of this course will be :

- to explain their knowledge in terms of the relevant principles. concepts, theories. definition patterns and generalization.
- to explain everyday applications and uses of chemistry.

- to present chemical ideas in a clear and logical form.

Group A : Inorganic Chemistry

Refining and purification of metals : Chromatography, ion exchange, solvent extraction, oxidative refining, parting process, zone refining, Mond's process. 5

Comparative study of s- and p- block elements and their important compounds : General group trends, electron configuration, atomic radii, ionization potential, electron affinity, electronegativity, inert pair effect. 20

Chemistry of d- block elements and their compounds : General trends in electronic configurations, ionic and covalent atomic radii, electronegativity, electron affinity, ionization potential, colour and magnetic properties, variable valency, complex formation with reference to 3d - block elements, concept of co-ordination complexes, Werner's theory of co-ordination compounds, comparative study of chemistry of elements of 3d-series (excluding Sc, Ti, V), chemistry of representative compound of 3d - block elements. 14

Preparation, properties, bonding and structure of the following : Oxides and oxyacids of phosphorous, hydrazine, hydroxylamine, hydrazoic acid, hydrogen peroxide, ozone, sodium thiosulphate, peracids of sulphur, potassium permanganate, potassium dichromate. 12

Group B : Organic Chemistry

Cyclic Aliphatic Compounds : Open chain and cyclic compounds, nomenclature, industrial source, preparation, reactions, reactions of small-ring compounds, Baeyer strain theory, stabilities of cycloalkanes, orbital picture, angle strain, factors affecting stability of conformations, conformation of cycloalkanes, equatorial and axial bonds. 6

Aromaticity : Aliphatic and aromatic compounds, structure of benzene, Kekule structure, stability of benzene ring (reactions and heats of hydrogenation and combustion), carbon-carbon bond lengths in benzene, resonance structure of benzene, orbital picture of benzene, representation of the benzene ring, Huckel's (4n +2) rule, nomenclature of benzene derivatives, electrophilic aromatic substitution, effect of substituent groups, determination of orientation, determination of relative reactivity, classification of substituent groups, orientation in disubstituted benzenes, mechanism of nitration, sulphonation, halogenation and Friedel - Craft's reactions, reactivities and orientation, theory of orientation, electron release via resonance, effect of halogenation on electrophilic aromatic substitution. 10

Aldehydes and Ketones : Structure, physical properties, preparation, preparation of ketones by Friedel - Craft acylation, preparation of ketones by use of organocopper compounds, nucleophilic addition, reactions of aldehydes and ketones, oxidation, reduction, addition of cyanide, addition of derivatives of ammonia, addition of alcohols, Cannizaro relation, addition of Grignard reagents, products of Grignard synthesis, acidity of α- hydrogens, reactions involving carbanion, base promoted halogenation of ketones, acid catalyzed halogenation of ketones, Aldol condensation, dehydration of aldol products, use of aldol

condensation in synthesis, crossed aldol condensation, Wittig reaction, Claisen condensation. 11

Carboxylic Acids : Structure, nomenclature, physical properties, salts of caboxylic acids, industrial source, preparation, Grignard synthesis, nitrile synthesis, reactions, ionization of carboxylic acid, acidity of carboxylic acids, structure of carboxylate ions, effect of substituents on acidity, conversion into esters, acid chlorides and amides, reduction to alcohols, dicarboxylic acids, carbanions in organic synthesis, Malonic ester synthesis of carboxylic acids, Acetoacetic ester synthesis of ketones, Decarboxylation of β - keto acids and malonic acids. 10

Amines : Structure, classification, nomenclature, physical properties, industrial source, preparation reduction of nitro compounds, amminolysis of halides, reductive amination, Hoffmann rearrangement, basicity of amines, structure and basicity, effect of substituents on basicity of aromatic amines, ring substitution in aromatic amines, reactions of amines with nitrous acid, diazonium salt, Sandmeyer reaction, synthesis of phenol, diazonium salt (replacement by - H), synthesis using diazonium salts, synthesis of azocompounds. 8

Phenols : Structure, nomenclature, physical properties, salts of phenols, industrial source, preparation, reactions, acidity of phenols, Fries rearrangement, ring substitution, Kolbe's reaction, Riemer-Tiemann reaction, formation of aryl ethers. 5

Group C : Physical Chemistry

Chemical Kinetics : Concept of rate of a chemical reaction, measurement of reaction rate, order and molecularity of a reaction, rate equation (differential and integral form) for zero, first and second order reactions, half life of a reaction, effect of temperature on the reaction rates, activation energy, qualitative treatment of collision theory of bimolecular reactions, activated complex theory, Kinetic study of some reaction mechanism (reaction between O_2 and HBr, I_2 and propanone in acidic medium). 10

Catalysis : Types of catalysis, criteria of catalysis, activation energy and catalysis, poisons, promoters and inhibitors, theories of catalysis : Intermediate compound formation and absorption theories, enzyme catalysis. 4

Photochemistry : Absorption of light, Lambert-Beer's law, Grothus Draper law, Stark Einstein law of photochemical equivalence, quantum yield, reason for high and low quantum yield, phosphorescence, fluorescence, chemiluminescence and thermoluminescence. 4

Conductance : Electrolytic conductance (specific, equivalent and molar conductances), determination of conductance, Kohlrausch's law of independent migration of ions, variation of conductance with dilution of weak and strong electrolytes, transference number and its experimental determination using Hittorfs and moving boundary method, applications of conductance measurement, determination of solubility and solubility product of sparingly soluble salt, degree of dissociation and dissociation constant of acids, conductometric titration 8

Electrochemical Cells : Electrolytic cell and galvanic cells, electronic concept of redox reactions, redox reaction and working of electrochemical cells,

representation of electrochemical cells. half cells. single electrode potential and normal hydrogen electrode. measurement of standard electrode potential, electrochemical series. reference electrodes. measurement of emf of a cell. Nernst's equation. glass electrode. antimony electrode and quinhydrone electrode. potentiometric determination of pH. potentiometric titration (acid base reaction). commercial cells : Leclanche dry cell. lead acid accumulator. fuel cells. 9

Thermodynamics : Molar heat capacities. relation between Cp and Cv. adiabatic expansion of an ideal gas for reversible and irreversible expansion. comparison between isothermal and adiabatic expansion. Joule's - Thompson effect. Inversion temperature. Carnot cycle. thermodynamic efficiency, spontaneous and non-spontaneous changes. second law of thermodynamics. entropy and its mathematical derivation from Carnot cycle. entropy changes. irreversible process. entropy as a measure of randomness. entropy changes and unavailable heat. relation between enthalpy and entropy changes. free energy and work function and their significance. criteria of spontaneity and equilibrium in terms of entropy and free energy. 15

(b) Basic Practical Chemistry II

Course No. : Chem 322 (major /minor) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : II

Course objectives :

The outcome of this course will be :

- to handle and manipulate chemical apparatus and materials safety.
- to record accurately and clearly the results of experiments.
- to draw conclusions and make generalizations from experiments.
- to apply appropriate chemical principle and make generalizations and predictions from chemical facts. observations and experiment data.

Gravimetric Analysis : Quantitative estimation of barium and sulphate ions as barium sulphate. iron as ferric oxide (Mohr salt). 18

Inorganic Preparation : Prussian blue from iron fillings. cuprous chloride. tetra - ammine copper (II) sulphate. potassium trioxalato chromate. chrome alum. 33

Preparative Organic Chemistry : Single step preparation involving the following types : methylation. esterification. acetylation. benzoylation. nitration. reduction. oxidation. and azodyes preparation. These experiments should involve basic organic experiment techniques such as hot filtration. distillation under reduced pressure. filtration under partial vaccum etc. 51

Experiments on Physical Chemistry : Study the kinetics of hydrolysis of methyl acetate in presence of hydrochloric acid at room temperature. study the kinetics reaction between potassium persulphate and potassium iodide by iodine clock method. conductometric titration between strong acid and strong base. potentiometric titration between acetic acid and sodium hydroxide using quinhydrone electrode and to determine dissociation constant of the acid. determination of heat of neutralization of hydrochloric acid with sodium hydroxide using Dewar flask / polystyrene cup as calorimeter. determination of the heat of solution of potassium nitrate using Dewar flask / polystyrene cup as calorimeter. 48

(a) General Chemistry

Course No. : Chem 331 (major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Course Objectives :

The outcome of this course will be :

- to explain everyday applications and uses of chemistry.
- to promote in students the acquisition of knowledge and understanding of chemical patterns and principles.
- to present chemical ideas in a clear and logical form.
- to evaluate the environmental and technological implications of chemistry.

Group A : Inorganic Chemistry

Hydrogen : Isotopes of hydrogen, general study of hydrides and their classification. 5

Noble gases and their compounds : Preparation, properties and structure of xenon fluorides and oxo-compounds (Valence bond treatment, VSEPR treatment, molecular orbital treatment for XeF_2) 5

Detailed study of preparation, properties, bonding and structures of the following : Boric acid, borates, boron nitride, borazines, boron hydrides, metal borohydrides, silicates, silicones, silanes and siloxanes, interhalogen compounds, pseudohalogens, pseudohalides. 18

Chemical Fertilizers : Nitrogen fixation and synthetic fertilizers. 8

Reactions in nonaqueous solvents : Reactions of NH_3, reactions of SO_2 6

Environmental Pollution : An elementary study of environmental pollution (in air and water) arising due to the presence of dust, carbon, CO, CO_2, NO_X, SO_X, H_2S, use of ion exchangers. 8

Group B : Organic Chemistry

Reaction mechanism and methods for determining mechanism : Types of mechanism, types of reaction, thermodynamic and kinetic requirements for reaction, the Baldwin's rules of ring closure, kinetic and thermodynamic control, the Hammond postulate, microscopic reversibility, methods of determining mechanism, identification of products, determination of the presence of an intermediate, the study of catalysis, isotope labeling, stereochemical evidence, rate expression for first and second order reaction, isotope effect. 8

Reactive Intermediates : Stability, structure, generation and fate of carbocation, carbanion, free radical, carbene, nitrene and benzyne, non-classical carbonium ion, neighbouring group participation by π and σ bonds, aromaticity and anti-aromaticity. 14

Spectroscopy and Structure : Determination of structure (spectroscopic methods), the mass spectrum, the electromagnetic spectrum, the infrared spectrum, infared spectra of hydrocarbons and alcohols, the ultraviolet spectrum, the nuclear magnetic resonance (NMR) spectrum, chemical shift, peak area and proton coupling, spin-spin coupling, coupling constant, C-13 NMR (CMR)

spectroscopy. CMR splitting. CMR chemical shift. PMR and CMR of hydrocarbons. alcohols and ethers. 11

Carbohydrates : Introduction. definition and classification. (+) - glucose as an aldohexose. (–) - fructose as a 2 - keto hexose. stereoisomers of (+) - glucose. oxidation (effect of alkali. osazone formation (epimers). lengthening and shortening the carbon chain of aldoses. conversion of an aldose into its epimer. conversion of aldose into ketose and vice versa. configuration of (+) - glucose (the Fischer proof). configuration of aldoses. optical families D and L. tartaric acid. families of aldoses (absolute configuration). open and cyclic structure of glucose. configuration about C-1. methylation. determining ring size. conformation. 11

Heterocyclic Systems : Structure of pyrrole. furan and thiophene. source of pyrrole. furan and thiophene electrophilic substitutions in pyrrole, furan and thiophene (reactivity and orientation). saturated five membered heterocycles. structure of pyridine. source of pyridine compounds. reactions of pyridine. electrophilic substitution in pyridine. nucleophilic substitution in pyridine. basicity of pyridine. reduction of pyridine. 7

Group C : Physical Chemistry

Electrochemistry : Failure of Arrhenius theory in case of strong electrolyte. qualitative treatment of Debye Huckel Onsagar equation. activities and activity coefficients of strong electrolyte. ionic strength. qualitative treatment of Debye Huckel limiting law.. EMF of a cell : Reversible and irreversible cells. types of electrodes (convention regarding sign of emf. measurement of emf of a cell. thermodynamics and emf : ΔH and ΔS from emf. potential and equilibrium constants. thermodynamics of electrode potential. standard potential and equilibrium constants. chemical cells without transference and with transference. concentration cells with and without transference. liquid junction potential (no derivation). principles of photoelectrochemical cells. 20

Phase Equilibrium : Terminology. Gibbs phase rule. one component system : the water system. the sulphur system. two component system : the bismuth - cadmium system. simple eutectic diagram.

Liquid Mixture : Ideal and non ideal liquid mixture. distillation of binary liquids. ratio of distillate to residue. fractional distillation. azeotrope. Solubility of partially miscible liquid pairs. maximum and minimum solution temperatures. Henry's law. distribution law. distribution of solute between two phases. solvent extraction. 15

Surface Chemistry : Physical adsorption and chemical adsorption. adsorption isotherms. Freundlich isotherms. derivation of Langmuir adsorption isotherms. B.E.T. equation and its use in surface area determination. 8

Colloids : Electrical double layer : Helmholtz and diffuse layers. zeta potential. electrophoresis. electroosmosis. precipitation of sol. gold number. Hardy Schutlz law. association of colloids. cleansing action of soap and detergents. emulsion and gels. solution of macromolecules. determination of molecular weight of macromolecules by (a) osmotic pressure (b) viscosity and (c) sedimentation method. 7

(b) General Practical Chemistry I

Course No. : Chem 332 (major) — Full Marks : 50
Nature of the course : Practical — Pass Marks : 20
Year : III

Course Objectives :

The outcome of this course will be :

- to handle and manipulate chemical apparatus and material safely.
- to make accurate observation and measurements, being aware of possible sources of error.
- to plan and organize simple experimental investigations to test hypothesis.
- to perform numerical calculations in which guidance on the methods of solution is provided.

Qualitative analysis of salt mixture containing not more than 6 ionic species (excluding salts insoluble in acids) out of the following : Pb^{++}, Hg^{++}, Ag^{+}, Hg^{+}, Bi^{+++}, Cu^{++}, Cd^{++}, As^{+++}, Sb^{+++}, Sn^{++}, Fe^{++}, Fe^{+++}, Cr^{+++}, Al^{+++}, Co^{++}, Ni^{++}, Mn^{++} Zn^{++}, Ba^{++}, Ca^{++}, Sr^{++}, Mg^{++}, K^{+}, NH_4^{+}, CO_3^{--}, S^{--}, SO_3^{--}, $S_2O_3^{--}$, NO_2^{-}, CH_3COO^{-}, I^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, SO_4^{--}, $C_2O_4^{--}$, PO_4^{---}, BO_3^{---}. — 33

Complexometric titration : Determination Zn^{++}, Mg^{++}, Ca^{++}, and total hardness of water using EDTA. — 18

Qualitative analysis of organic compounds : Systematic qualitative analysis of simple monofunctional organic compounds (aldehyde, ketone, carboxylic acid, carbohydrate, phenol, hydrocarbon, amine, nitro, amide and ammonium salt.) — 51

Experiments on Physical Chemistry : Determination of the transition temperature of hydrated sodium sulphate (Na_2SO_4. $10H_2O$), determination of the critical solution temperature of phenol water system and the composition of the solution at CST, determination of the partition coefficient of iodine in chloroform and water, determination of the equivalent conductance at infinite dilution of strong electrolyte by conductance measurement, determination of ionization constant of acetic acid by pH - measurement and to verify Ostwald's dilution law. — 48

(a) General Chemistry II

Course No. : Chem 333 (major) — Full Marks : 100
Nature of the course : Theory — Pass Marks : 35
Year : III

Course Objectives :

The main outcome of this course will be :

- to develop student's ability to communicate in appropriate ways.
- to encourage student's to apply their chemical knowledge and understanding to familiar and unfamiliar higher studies in chemistry.
- to pursue higher studies in chemistry.

- to explain the social, economic, environmental and technological implications of chemistry.

Group A : Inorganic Chemistry

Coordination Compounds : Isomerism in coordination compounds, IUPAC nomenclature of coordination compounds, factors influencing the formation of complexes (thermodynamic and kinetic stability). 7

Bonding and application of coordination compounds : Valence bond theory, inner and outer orbital complexes, crystal field theory, characterization of complexes by spectroscopic, optical, magnetic, chelates and polynuclear complexes, stereochemistry of complexes with coordination number 4 and 6, substitution reactions & trans effect, application of complexes in analytical and biological fields. 20

Lanthanides and Actinides : Electronic structure, oxidation, states, colour and spectra, magnetic properties, lanthanide contraction. 5

Elementary study of carbonyls and nitrosyls : General method of preparation, bonding, application of 18 electron rule structure of carbonyls. 6

Organometallic Compounds : Non- transition metals : General servey of types, synthetic methods, metal alkyls of group I, II and III elements, Transition metals : transition metals to carbon σ bonds, alkene complexes, haptonomenclature, alkyne complexes, allyl complexes, metallocenes (preparation, properties, structure and elementary approach of bonding with reference to ferrocene). 9

Bioinorganic Chemistry : Introduction, metals in biological system, a study of Fe in biological system. 5

Group B : Organic Chemistry

Name Reactions : Introductory study of glossary of at least 40 name reactions, their simple mechanism and the utilities of the synthetic reagents involved therein under the following headings of reaction types : oxidation - reduction, condensation, substitution, rearrangement, addition & elimination (names are given in the appendix I). 15

Principles of Organic Synthesis : Protecting groups, retrosynthetic analysis, retron and synthon, multistep synthesis. 10

Lipids : Lipids, occurence and composition of fats, hydrolysis of fats, fats as a source of pure acids and alcohols, detergents, unsaturated fats, phosphoglycerides, cell membrane, steroids. 6

Proteins and Nucleic Acid : Protein, structure of amino acids, amino acids as dipolar ions, isoelectric point, configuration of natural amino acids, preparation of amino acids, reactions of amino acids, peptides (geometry of peptide linkage), determination of structure of peptides, synthesis of peptides, proteins (classification and functions), structure of protein, peptide chain, side chain (isoelectric point, electrophoresis), conjugated proteins, secondary structure of protein, nucleoproteins and nucleic acids, the genetic code. 11

Bio-organic Chemistry : Biological oxidation and reduction, (ethanol and acetaldehyde), biological oxidation and reduction (deuterium labeling experiments), stereochemistry of biological oxidation and reduction, organic chemistry of vision, biosynthesis of fatty acids, mechanism of enzyme action (chymotrypsin). 8

Group C : Physical Chemistry

Chemical Energetics : Entropy, entropy change in isolated system, dependence of entropy on temperature, volume and pressure, entropy change in ideal gas, entropy of mixing, entropy change in physical and chemical transformations, third law of thermodynamics, third law and its significance, free energy, free energy change for reaction, Gibbs - Helmholtz equation, properties and significance of ΔG, reaction isotherms, Clapeyron equation, Clausius - Clapeyron equation, thermodynamics of equilibrium constant, K_p and K_c for gaseous system, properties of equilibrium constant, thermodynamic criteria of equilibria. 18

Kinetics : Consecutive reactions, parallel reactions, opposing reaction, effect of temperature on reaction velocity, the energy of activation, the collision theory of bimolecular and unimolecular reactions, chain reactions, transition state theory, kinetics of the following photochemical reactions : (a) hydrogen and chlorine (b) hydrogen and bromine 18

Crystal System : Seven crystal systems and fourteen Bravais lattices, Miller indices, designation of planes and interplanar distances for cubic systems, diffraction of X-rays by crystal, Bragg's equation, crystal structure of sodium chloride and potassium chloride, point defects; Frenkel and Schottky defects (qualitative idea only). 8

Molecular Spectroscopy : Electromagnetic spectrum, Basic ideas, rotation, vibration and electronic spectra of diatomic molecules, Raman spectra. 6

(b) General Practical Chemistry II

Course No. : Chem 334 (major) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : III

Course Objectives :

The main outcome of this course will be :

- to follow instructions for practical work.
- to make accurate observation and measurements being aware of possible sources of error.
- to record accurately and clearly the results of experiments.
- to draw conclusions and make generalizations from experiments.
- to explain practical techniques, procedures and safe laboratory working practices.

Quantitative Estimation : Precipitation titration of silver nitrate in acidic media (Volhard Method), Redox titration involving potassium dichromate (Mohr's salt, determination of iron in haematite). 12

Gravimetric Analysis : Nickel as complex with dimethyl glyoxime, copper as cuprous thiocynate, aluminium as oxinate, lead as lead chromate, magnesium as magnesium ammonium phosphate and pyrophosphate. 33

Paper Chromatography : Qualitative analysis of some inorganic anions and cations by paper chromatography, (two each). 6

Organic Practical : Spectral analysis (spectra of simple organic compounds will be provided and students are required to interpret the given spectra and find out the structures of organic compounds ., Two sets of multistep synthesis (2-3 steps synthesis)., Quantitative analysis of any two : (OH - group, nitrogen, sulphur, glucose, carbonyl group). Isolation of the following natural products (any two) : lactose, caffeine, camphor, essential oil, purification by thin layer chromatography / column chromatography. 51

Physical Chemistry Practicals : Determination of rate constant of the hydrolysis of ethyl acetate by sodium hydroxide., Study of the kinetics of acid catalysed iodination of propanone., Verification of Freundlich adsorption isotherm., Verification of Lambert - Beer's law and to determine the concentration of a solution. Verification of Ostwald dilution law by measuring the conductance of acetic acid at different concentration and to determine the dissociation constant of the acid. 48

Text Books : For all theoretical courses i.e. CHEM 311, 321, 331 and 333

1. J.D. Lee. *Concise Inorganic Chemistry*, 4th Edition. ELBS with Chapman & Hall, 1991
2. F.A. Cotton, G. Wilkinson & C. Gaus, *Basic Inorganic Chemistry*, 3rd Edition, John Wiley & Sons (SEA), Pvt. Ltd., 1995
3. R.T. Morrison & R.N. Boyd. *Organic Chemistry*, 6th Edition. Prentice - Hall of India Pvt. Ltd., 1994
4. J. March, *Advanced Organic Chemistry*, 3rd Edition, Wiley Eastern Ltd. India, 1994
5. S.H. Maron & C.F. Prutton, *Principles of Physical Chemistry*, 4th Edition. Oxford & IBH Pub. Co., 1992

Reference Books : For all the theoretical courses i.e. CHEM 311, 321, 331 and 333

1. A. Sharpe, *Inorganic Chemistry*, 2nd Edition, ELBS & Longman, Singapore. 1986. (recent edition)
2. R.D. Madan, Satya Prakash. *Modern Inorganic Chemistry*, S. Chand & Company Ltd., 1994
3. K.N. Upadhyaya, *A Text Book of Inorganic Chemistry*, 2nd Edition, Vikash Publishing House Pvt. Ltd., 1995.
4. Lawry and Richardson. *Mechanism and Theory in Organic Chemistry*, Haper and Row, New York, 1981
5. I. L. Finar. *Organic Chemistry, Vol.I and Vol. II*, Prentice Hall, London. 1955. (available recent edition)
6. C. Norman, *Principles of Organic Synthesis*, 2nd Edition. Chapman and Hill, London. 1978. (recent edition)
7. Warren, *Organic Synthesis*, The Disconnection Approach. Wiley. New York. 1982

8. House. *Modern Synthesis Reactions*. 2nd Edition. W. A. Benjamin. New York. 1972
9. L. Kapoor. *Text Book of Physical Chemistry*. Macmillan India Ltd. Vol. I to Vol. IV. 1992
10. Alberty. *Physical Chemistry*. 6th Edition. Wiley Eastern Ltd.. New Delhi. 1992.
11. S. Glasstone & D. Lewis. *Elements of Physical Chemistry*. Memillan & Co.. Ltd
12. S. Negi & S.C. Anand. *A Text Book of Physical Chemistry*. Wiley Eastern Ltd.. 1991
13. R.M. Silverstein. G.L. Bassler & T.C. Morril. *Spectrometric Identification of Organic Compounds*. Wiley. New York. 1981. (Preferably available recent edition)
14. C. Agrawal. *Modern Inorganic Chemistry*. Wiley Eastern. New Delhi. 1981. (available recent edition)
15. Streitweiser & Heathcock. *Introductory Organic Chemistry*. Wiley and Sons. New York. 1981
16. Solomons. *Organic Chemistry*. 3rd Edition. Wiley. New York. 1984
17. R.A. Bansal. *A Text book of Organic Chemistry*. 2nd Edition. Wiley Eastern Ltd.. New Delhi. 1993
18. S. Bahl. G.D. Tuli & A. Bahl. *Essential of Physical Chemistry*. 3rd Edition. S. Chand & Co.. 1994

Text Books : For all practical courses i.e. CHEM 312, 322, 332 and 334

1. A.I. Vogel. A Text Book of Quantitative Inorganic Analysis. Including Elementary Instrumental Analysis. ELBS & Longman. 1969. (Preferably available recent edition)
2. A.I. Vogel. A Text Book of Qualitative Inorganic Analysis. ELBS & Longman. 1969. (recent edition)
3. R. L. Shriner. R.C Fusion & D.Y. Cartin. The Systematic Identification of Organic. Compounds. A Laboratory Manual. John Wiley and Sons. Inc.. New York. 1986. (Preferably available recent edition)
4. B.P. Levitt. ed. Findlay's Practical Physical Chemistry. Longman. London. 1973

Reference Books : For all practical courses i.e. CHEM 312, 322, 332 and 334

1. Gurdeep Raj. *Advanced Practical Inorganic*. 10th Edition. Gel Publishing House. Meerut. 1994
2. A.I. Vogel. *A Text book of Practical Organic Chemistry. Including Qualitative Organic Analysis*. Longmans. 1958. (Preferably available recent edition)

3. F.G. Mann and B.C. Saunders. *Practical Organic Chemistry*. Orient Longman. 1986. (recent edition)
4. D.P. Shoemaker & C.W. Garland. *Experiments in Physical Chemistry*. McGraw Hill, Kogakusha Ltd. Tokyo. 1967
5. B.D. Khosla. A. Gulali & V.C. Garg. *Senior Practical Physical Chemistry*. 5th Edition. R. Chand & Co.. New Delhi. 1987

Appendix : I

List of Name Reactions

Condensation reactions

1. Aldol condensation
2. Claisen condensation
3. Dieckmann condensation
4. Darzen's reaction
5. Perkin condensation
6. Wittig reaction

Reduction reactions

1. Birch reduction
2. Clemmensen reduction
3. Wolff - Kishner reduction
4. Cannizzaro reaction
5. Metal hydride reduction
6. Catalytic hydrogenation

Elimination reaction

1. Hofmann degradation
2. E^1, E^2 and E^1 CB reaction

Electrophilic substitution bonds

1. Friedel - Craft's reaction
2. Reimer - Tiemann reaction

Addition to carbon-hetero multiple bonds

1. Mannich reaction
2. Reformatsky reaction

Rearrangement reactions

1. Beckmann rearrangement
2. Claisen rearrangement
3. Cope rearrangement
4. Favorskii rearrangent
5. Hofmann rearrangement
6. Pinacol rearrangement
7. Wagner - Meerwein rearrangement
8. Wittig rearrangement

Oxidation reactions

1. Baeyer - Villiger reaction
2. Oppenauer oxidation
3. Lead tetraacetate oxidation
4. Chromic acid oxidation
5. Permanganate oxidation
6. Peracid oxidation
7. Hydroboration oxidation

Nucleophilic substitution

1. SN^1 and SN^2 reaction
2. Grignard reaction
3. Wittig reaction
4. Malonic ester synthesis
5. Acetoacetic easter synthesis
6. Aromatic nucleophilic substitution

Addition to carbon-carbon multiple

1. Michael reaction
2. Diel's Alder reaction

3. Geology

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	**Total Marks**
First Year	GEO. 311 (Major/Minor)	100	GEO. 312 (Major/Minor)	50	150
Second Year	GEO. 321 (Major/Minor)	100	GEO. 322 (Major/Minor)	50	150
Third Year	GEO. 331 (Major) GEO. 333 (Major)	100 100	GEO. 332 (Major) GEO. 334 (Major)	50 50	300

(a) Physical & Historical Geology, Crystallography and Mineralogy

GEO. 311 (Major/Minor)
Theory

Full Marks : 100
Pass Marks : 35
Year : I

Course Objectives : (Geo 311 & Geo 312)

These courses are designed to provide students theoretical as well as practical knowledge about :

- The Earth including its interior and outer zones
- Isostasy
- Different types of rocks and their formation
- Weathering and mass-wasting
- Ground water and surface water and their Geological activity
- Glacier and glaciation

Contents

1. **Introduction :** The science of Geology, scope, application, method of study, its various branches.
2. **The outer zone of the Earth :** Atmosphere, Hydrosphere, Lithosphere
3. **Isotasy :** Gravity and continental crusts
   Igneous rock and igneous activity : Magma, its crystallisation, composition texture, types of igneous rocks. Forms and intrusive rock bodies, Lava its type and properties, Volcano, Volcanic land forms.
4. **Matamorphic rocks and the continental crust :** Types and texture of metamorphic rocks, factors of metamorphism.
5. **Earthquake and the earth's interior :** Earthquakes and faults, seismic waves, cord mantle.

6. **Sediments and Sedimentary rocks :** Rock cycle. rock weathering. sediments. lithification. sedimentary rocks.
7. **Weathering and mass wasting :** Denotation. soil. initial and sequential land forms. land forms of weathering. types of mass wasting.
8. **Strata and their deformation :** Stratigraphy. rock deformation. kinds of faults. joints. folds.
9. **Ground water and its geological activities :** Surface and surface water, ground water movement. porosity and permeability. Aquifers and Aquicludes. wells. Karst topography.
10. **The geological work of running water :** Rainfall. discharge. drainage system and channel network. stream erosion. transportation and deposition land forms associated with running water.
11. **Glaciers and glaciations :** Formation of glaciers. kinds of glaciers and their description. glacier erosion and transportation. land forms associated with them. Pleistocene glaciation.
12. **Geologic work of wind :** Wind erosion. transport and deposition. land forms.
13. **Geologic work of sea and ocean :** Geologic work of sea and ocean and associated land forms.
14. **Introduction to plate tectonics :** The continental margins. the ocean basin floor. the mid-oceanic ridge. the global plate system, sea floor spreading theories of coral reef development.
15. **Introduction to historical geology :** Scope. aim. method of study. development of historical geology. problem of historical geology. the position of historical geology among other geological sciences.
16. **The origin of Earth and life :** Solar system. evolution of the Earth. development of the atmosphere. hydrosphere and biosphere. theory of origin of life. the first sign of life on Earth. introduction to plant and animal kingdom. fossiles.
17. **Time on rock record :** Unit and measurement of geological time. Geochronology. relative age determination. time stratigraphic units. correlation.
18. **The main tectonic unit of the earth's crust and their evolution :** Principle tectonic units of the present continents. the tectonics on recent oceanic depressions. the tectonic evolution of the earth's crust.
19. **Principles of Paleoecology, Paleogeography, Paleotectonics :** Study of paleo-environments along with the influence of organisms of sediments. the paleogeographic methods of studying epirogenic movement of the crust, the analysis of the geological sections as a method of reconstructing crust movements.

20. **The earliest (Precambrian) history of the earth's crust :** The absolute duration of the precambrian era and the earliest known state of the crust. the shields precambrian rocks and palcography. precambrian glaciations.
21. **Geological history of phanerozoiceon :** Plate position and motion : organic evolution palcogeography and the crystal movement of the Cambrian. Ordovician. Silurian. Devonian. Carboniferous. Permian. Triassic. Jurassic. Cretaceous. Palaeocene. Neogene. and pleistocene.
22. **Introduction to crystallography :** Development of crystallography. geometrical nature of order of crystal. translation vectors. planer and space lattice.
23. **Morphology of crystals :** Point group. symmetry geometrical operation (rotation. reflection. inversion and intonation symmetry notations. Concept of point group and 32 classes. Definition of a crystal face, edge, and solid angle law of constancy of interfacial angles : axial ratios. Parameter system of viciss. Miller indices. Law of rationality of indices. Forty eight forms. Typical crystals showing combination of forms.
24. **Crystal growth and twining :** Growth of crystals from solution and from a melt under controlled conditions. crystal growth in open fractures. solution cavities or vesicles. Twining in crystals. Different types of crystals twins. causes of twining in crystals. twin laws.
25. **Concept of space groups :** Point group and space group. screw axes and glide planes. international space notation.
26. **Introduction to mineralogy :** Definition of mineral. scope of determinative mineralogy. Examples of rock forming (silicate) minerals and ore forming minerals.
27. **Physical Properties of minerals :** Scalar Properties : Colour. lustre and streak. their definition and varieties with examples. specific gravity : Definition with examples. Determination of specific gravity of minerals. Sp.gr. of pure mineral grains by the sink and float method. Fluorescence and Phosphorescence. Magnetic property : Ferromagnetic. Paramagnetic and diamagnetic mineral. Vector properties : Cleavage. parting and fracture. their definitions. mineral example. Hardness : definition. mohsscale of hardness. determination of hardness of minerals. Crystallinity and forms of minerals. Crystalline-crystallized. crystalline. crytocrystalline and amorphous. Habit of mineral elongated. tabular. flattened and equant. Form of crystalline and cryptocrystalline aggregates-types examples and use in identification.
28. **Chemical properties of minerals :** Minerals as a chemical system. Classification minerals. Examples of Native elements. Sulphides. halides. Oxides. sillicates. titillates. phosphates. arsenates and vanadates. nitrates.

borates and uranates, sulphates and chromates, tungstates and molybdates, oxalates and hydrocarbons.

29. **Crystal chemistry of minerals :** Concepts of crystals structure of minerals : dimorphism, polymorphism and pseudomorphism : isomorphism and solid solution.
30. **Introduction to optical mineralogy :** Elements of optics, Optics of isotropic medium - retractive indium. Snell's law critical angle anisotropic media. Polarization and interference of light, Polaroid. Polarizing microscope - construction and use. Magnification and resolving power construction and use of quarter and full wave plates and quartzwedge. Pleochroism and Birefringence. Optical indicatrix - Uniaxial and biaxial indicatrix. Behaviour of light in uniaxial and biaxial crystals. Optic sign. Optical properties of minerals : Form. Cleavage, fracture and parting refractive index and relief, Becke line and its use, Twining colour and pleochrolism, Pleochroic formula of common minerals, Properties under cross polarizers - interference colours, twinning and extinction angle Anomalous interference colours. Michael Levy chart and its use in determining thickness, path difference birefringence of order of interference of colour. Optic sign of antisotropic median, interference figures. Dispersion of optic axes in biaxian crystals.
31. **Brief introduction of :** The goelogy of the Nepal, Punjab, Kumaon and Sikkim-Bhutan Himalayas, geology of the eastern, central, western and far western Nepal. Mineral resources of Nepal.
32. **Minerals genesis and mineral classification :** Formation of minerals in different endogenous and exogenous process, physical and optical character and mode of occurence and important uses of the following minerals : Quartz Feldspar, feldspathoids, mica, amphibole, pyroxine, olivine, garnet, chlorite, epidote, scapolite, andalusite, silllimanite, kyanite, zeolities, zircon, talc, clay, minerals, calcite, apatite, rutile, spiral, pyrite cordierite.

(b) Physical & Historical Geology, Crystallography and Mineralogy

GEO : 312 (major/minor) — Full Marks : 50
Practical — Pass Marks : 20
Year : I

Contents

1. Drawing of contour maps, study of topographic maps, drawing of topographic maps.
2. Study of various geological structures.
3. Study of geological time scale, preparation and study of paleogeographic maps.
4. Drawing & study of mountain chains of the world.

5. Preparation of columner section and their correlation. Study of the geological history from block diagrams and cross-sections, crystallography. Demonstration of space lattice models-galena. fluorite. sphalerite. pyrite. calcite. Study of crystal system, crystallography axes. interfacial angle and measurement with contact goniometer. Study of forty eight crystal forms and symmetry Elements of 32 classes. Construction of Stereographic projection of normal classes of seven crystal systems.
6. **Mineralogy** : Physical properties of minerals : e.g. Fibrous. Columnar. tabular. lamellar, glandular, micaceous. oblates. betroidal. Hardness of minerals- determination hardness using minerals of known hardness. cleavage and crystal structure. Sp. gr - Determination of Sp. gr. of lumps. Colour of the mineral - varieties of quartz, fluorite, calcite. Lustre- Examples of minerals showing vitreous, adamantine, resinous, pearly, silky, metallic lustre.
7. **Streak** : Use of streak plate to obtain streak, examples of minerals yielding different streaks: Fluorescence (f) and phosphorescence (p) : Use of short wave and long wave UV light to study fluorescence and Phosphorescence seen in sheltie, calcite, fluorite and willamette, Magnetic property : minerals attracted by hand magnet - magnetic pyrhotie, magnetite limm etc. Optical mineralogy. Petrological microscope : neat drawing and labelling the parts. Magnification factor and its determination with the help of stage and ocular micrometers.
8. **Demonstration of Optical properties** : Optical accessories : Mica plate. gypsum plate and quartz wedge. their effect on anisotropic minerals. Study of interference figures. optic axes of uniaxial crystals. Determination of optic sign. Dispersion of optic axes. Study of acute bisectrix. obtuse bisectrix. option normal figures of biaxial crystals, determination of optic angle. Determination of birefringence with the help of Michael Levy chart and quartz wedge. Demonstration of Perk compensator plates. Study of optical properties of major silicates : Quartz orthoclase. microcline. labradorite. muscovite. biotite. hornblende, augite. dioposide. oliving. garrnet chloride. epidote. andalusite. kyanite. zircon. clacite. Apatite.

Text Books :

1. Strahler. A.N. Minzt, *Physical Geology*, Harper and Raw, New York. (recent Publication)
2. Berry, L.G. and Mason . B.. *Principles of Historical Mineralogy*.

References :

1. Holmes. A.. *Principles of Physical Geology*. ELBS Publication. 1992.
2. Sanders. T.E.. *Principles of Physical Geology*.John wiley and sons, New year. 1986.

3. Hobbs, Means and Williams. *An outline of structural geology*. John Wiley and sons, New York, 1976.
4. Arogyswanay. R.N.P. *Course on Ministry Geology*. Oxford and IBP Publishers. 1987.

a) Structural, Geology, Petrology, Geology of Nepal and adjoining, region

Course No : Geo 321 (major / minor) Full Marks : 100
Nature of the course : Theory Pass Marks : 35
Year : II

Course Objectives : (Geo. 321 & 322)

These courses are designed to provide students theoretical as well practical knowledge about :

- Scope of structural Geology
- Kinematic and dynamic analysis
- Crystallization silicate melts
- Sterographic projection
- Primary and secondary structures
- Structure and classification of various rocks

Structural geology : Definition, scope of structural geology, Concept of detailed structural analysis : descriptive, kinematics and dynamic analysis. 4

Descriptive analysis : Geological map and cross-section of alien (trend and plunge) and a plane (dip and strike) 4

Introduction to stenographic projection and its application to structural geology. Plotting a plane and the intersection by two planes. Stereographic projection as a statistical tool. 9

Kinematics and dynamic analysis : Strain and stress in two dimensions. Mohr circle for strain and stress. 4

Bedding conformity and unconformity, types of conformity, outcrop characteristics, apparent and true dips. Instrusive contacts, Sill and dykes, Diapirs and salt domes. 5

Primary structures. Their application in structural geology. 3

Fold and its definition : Classification of folds. Cylindrical and non-cylindrical folds. Drag folds. Criteria of recognition of folds in the field. Fault and its definition classification of fault. Strike clip. Normal, reverse, and thrust faults. Criteria of recognition of fault in the field. Joints and their definition, principles of failure by rupture. Classification of joints study of joints in the field. 12

Secondary structures : Cleavage, foliation, and schistosity. Lineation. Their classification and relation with other structures in the field. 4

Nature and scope of petrology differences between petrology. General Classification of rocks : igneous, sedimentary and metamorphic. 1

Form and structures of igneous rocks. Intrusive and their relation to geological structures. Concordant and discordant forms Method of emplacement of igneous rocks-block lava. Ropy lava, amygadaliodal and vesicular structures, flow structures, shell and platy structures. Prismatic and columnar structures. Pyroclastic materials. Textures and microstructures of igneous rocks. 6

Magma : Definition, composition, physico-chemical constitution, primary magma 5

Formation of magma : Rift zones, melting process. Evolution of magma : Differentiation, fractional crystallization, other differentiation mechanisms, Magma mixing and assimilation. 5

Crystallization of silicate melts : Urinary and binary systems. Phase relations and textures., Ternary systems : Simple and complex. The effect of pressure on the melting and crystallization of magma. Classification of igneous rocks : The IUGS classification system, chemical classification. Characteristics of common igneous rocks. 3

Igneous rock at continental margins : The ophiolite suite. The calcalkaline and tholeitic groups, plutonic rocks.

Intracontinal ingneous rocks : gabbroic layered intrusions Anorthosites, Alkali Basalts and Nephelinites, Carbonates Kimberlites and related rocks. 4

Composition and Mineralogy of earth's interior : Seismic data, The geothermal gradient, xenoligh. High pressure experimentation, Mantle petrology, the low-velocity zone. 3

Definition of metamorphism, Limits of metamorphism : Contact metamorphism, burial metamorphism, cataclastic metamorphism, metamorphic rocks, their recognition, distribution and nomenclature. Field observation of metamorphic rocks. Textures and structures of metamorphic rocks. Shape of minerals growth and mutual relation of minerals, growth and mutual relation of minerals crystelloblastic, maculose, gneissose and augen structures. Petrographic description of phyllite, slate, schist, gneiss amphibolite, marble, quartzite, granulite, eclogite. 7

Control of pressure, temperature and composition on metamorphism., Metamorphic processes : Initiation of Metamorphism, Porphyroblast orientation, Metamorphic differentiation, Metamorphic Reactions, the upper limit of Metamorphism. 4

Metamorphic zones : Index minerals, zones in contact metamorphism, isograde : Definition, dependence on temperature and pressures.

Facies : Definition, evolution of concept of metamorphic facies. Relationship of zones, grades and facies. 3

Mineralogical phase rule : Invariant, bivariant reaction, invariant point and their significance (Triple point of Al25.05 and those in metamorphism of calcareous rocks)

Mineral variation related to initial rock composition : Carbonate rocks, mud rocks, felsic igneous rocks maficigneous rocks and tuffs, ultramafic rocks. 10

Time, temperature and deformational relationships, Porphyroblasts and rectonism : Post tectonic porphyroblasts polymetamorphism, Determination of pressure and temperature using total assemblage and changes in mineral composition. 3

Metamorphic rocks : Metamorphic rocks and global tectonics. Metamorphism at transform faults, divergent and convergent junctions. 2

Introduction to sedimentary petrology : Types of sedimentary rocks. Depositional basins. Process involved in formation of sediments and sedimentary

rocks. weathering. corrosion and transportation, deposition. Characteristics of terrigenous. fluviatile. lacustrine, glacial and marine deposits. 3

Textures and structures of sedimentary rocks. Textures with special reference to grain size and sphericity. Texture as indicator of transportation and depositional history of sediments. Structures of sedimentary rocks.: Primary and secondary structures and their significance. Determination of top and bottom of beds. 3

Characteristics of terrigeneous. fluvial. lacustrine and marine sediments. 2

Classfication of sedimentary rocks : Field observation. laboratory studies. ancient and modern environment of mud rocks, sandstones and conglomerates limestones and delostone and other sedimentary rocks like evaporate, bedded chert, bedded phosphate rocks. bedded iron deposits. 5

Diagenesis : Definition Diagenesis of sandstones and limestones. Basic knowledge on compaction. segmentation authigenesis. replacement and recrystellization. 2

Provenance: Extrabasinal and intra-basinal. Meturity of sedimentary environment palcocurrent analysis facies concept. 3

Infroduction to the physiography and tectonic divisions of the Himalayas (with special refefence to Nepal Himalaya) and the adjacent regions. 3

Brief introduction to the geology of the peninsular India with special reference to the archeans. proterozoic gondurances and deccan trap. 6

Introduction to the history of evolution of the Himalaya. 9

b) Structural Geology, Petrology, Geology of Nepal and Adjoining Region

Course No. : Geo 322 (major/minor) Full Marks : 50

Nature of course : Practical Pass Marks : 20

Year : II

Basic concept of field geology. study of methods of representiry physiographic features by hachuring stippling or shading. form lines. layering. contouring etc. Interpretation of topographical forms. Contoured maps. Dip and strike of horizontal. inclined and vertical surfaces. True dip and strike from contoured geological maps. plunge and pitch of linear structures. 2

Outcrop patterns of horizontal bed. vertical beds and inclined beds. Inliers and outliers. True thickness and vertical thickness. Width of outcrop. Relation between true thickness and with of outcrop. 1

Strike. true dip and apparent dip problems measurement of thickness and with of outcrop. Completion of outcrops in geological. Three point problems drawing of profiles and studies of geological maps. Stereographic projection of true and apparent dip. plunge pitch of linear structures. 25

Drawing of the different forms assumed by intrusive igneous rocks with different types of contact between plutons and their wall rock. 3

Study of textures and structures of igneous. sedimentary and metamorphic rocks in hand specimen and under microscope. 8

Systematic megascopic study of the following igneous. sedimentary and metamorphic rocks mica. granite various types of granites pegmatite. syenite.

diorite, gabbro, dolerite, basalt, rhyolite, conglomerate, breccia, shale, limestone, sandstone, schist, amphibolite, marble, quartzite, phyllite, slate. 8

Microscopic study of the following rock types : granites, granodiorite, diorite, Nepheline syenite, pegmatite, gabbro, dolerite, basalt, rhyolite, trochyte durite, Limestone, Sandstone shale, bracua, conglomerate, Schists, gneisses amphibolite, Charnokite, marble and Quartzite, phyllite slate. 25

Drawing of different sedimentary structures. 3

Text Books :

1. Davis, G.H., *Structural Geology of rocks and Regions*, Harper and Row, New York, Recent ed.
2. Ehlers, E.H., and Blatt, H.,*Petrology, Igneous, Sedimentary and Metamorphic Geology of Nepal*, Harper and Row, New York, 1990

(a) Stratigraphy and Sedimentology, Palaeontology & Economic Geol.

Course No. : Geo 331 (Major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Course Objectives : (Geo. 331 & 332)

These courses are designed to provide students theoretical as well practical knowledge about : concept of Stratigraphy, fundamentals of Sedimentation, elementary knowledge on Palaentology, economic minerals, rocks and their origins.

Introduction : Aim, scope and objectives of stratigraphy, development of stratigraphy through time, conceptional backgrounds, stratification, sedimentary cycles & sedimentary forces, inadequacy in stratigraphic record, principles of stratigraphic classification and correlation, international codes and contentions for stratigraphic classification and nomenclature. 12

Method of stratigraph : Principles of lithostratgraphy, lithostratigraphic units, methodology in establishing lithostratigraphic units, basic principles of biostratigraphic units, establishment of biostratigraphy and index fossils of different systems, fundamentals of geochronology, chronological boundaries, type locality, subdivision and fossil content of standard stratigraphic units, fundamentals of magnetostratigraphy, Geomagnetic polarity time scale. 24

Fundamentals of Sedimentation, Sedimentation within different types of continental and marine basins. 10

Introduction : Aim, scope and objectives of palaeontology, fossils, their mode of preservation for life through geological ages, conceptual background on organic evolution, Species, definition, concept and method of nomenclature, Functional Morphology. 10

Invertebrate Fossils : Classification, distribution, evolution and geological history of Phylum Brachiopod, Mollusc (Bivalve, Gastropod, Cephalopoda), Arthopoda (Trilobite) Coelenterate (Anthozoa), Protozoa (foraminfera), Echinodermata (Echinoidea), Hemichordata (Graptoloidea)

Vertebrate Fossils : Geological history through time of the following vertebrate groups : Fishes. Amphibians. Reptiles. Aves and Mammals. Equidae. proboscides and Hominidae Plants fossils : Plant life through time. Introductory idea about Pteridophyta. Pteridospermophyta. Gondwana flora. 40

Introduction, scope, aim, historical background Morphology of ore bodies : a) Isometric. b) pipe - like. d) composite. Classification of mineral deposits. Physical characteristics optical properties and textures of ore minerals. 18

Genesis of mineral deposits : a) magmatic concentration.. b) contact metasomatism. c) hydrothermal. d) sublimation. e) volcanic and submarine exhalative. f) sedimentation. g) evaporation. h) bacteriogenic. i) residual and mechanical concentration. j) oxidation and supergene enrichment and metamorphism 18

Chemical Composition of eco. min. & rocks : Chemical composition important physical properties. mode of occurence. utilization and distribution in Nepal and adjacent areas of the follow-up : ores of lead zinc. copper. aluminium. iron and gold ; magnesite. lime stone. coal. petroleum and some selected gem stones. 18

(b) Stratigraphy and Sedimentology, Palaeontology & Economic Geol.

Course No. : Geo 332 (major) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : III

Study of stratisfication and sedimentary cycles : Study and preparation of stratigraphic columns of some sections of Nepal Himalaya and adjacent areas. 5

Study of morphological feature and identification of important index fossils of the following groups : Brachiopoda. Mollusca (Bivalve. Gastropod. Cephalotioda) Study and identification of important vertebrate fossils found in Nepal. Study and identification of important Gondwana plant fossils. 22

Preparation of mineral maps of Nepal. 6

Study of ores and industrial mineral and rocks in handspecimen : Lepidolite. Halite. Native copper. Chalcocite. Covellite. Chalcopyrite. Malachite. Azurite. Baauzite. Rutile. Limonite. Geothite. Magnetite. Hematite. Siderite. Pyrite. Galena. Orpiment. Realgar. Stibnite. Cassiterite. Sulphure. Psilomelane. Asreno-Pyrite. Native Gold. Sphalerite. Baraite. Limestone. Dolomite. Coal. Graphite. Kaolinite. Gypsum. Fluorite. Corundum. Study of the following ore minerals under the microscope : Galena. Sphalerite. Pyrite. Arsenopyrite. Chalcopyrite. Covellite. Magnetite. Hematite. 42

Text Books :

1. Scjooch. R.M., *Stratigraphy. Principles and Methods*. Harper and Row. New York. Recent ed.
2. Clarkson. E.N.K.. *Invertibrate Palaeontology and Evolution*. Harper and Row. New York. Recent ed.
3. Jansen & Bateman. *Economic Mineral Deposits*. John Wiley and Sons. New York. Recent ed.

(a) Engineering Geology, Exploration Geology and Environmental Geology

Course No. : Geo 333 (major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Course Objectives : (Geo. 333 & 34)

These courses are designed to provide students theoretical as well practical knowledge about :

- overview of engineering Geology
- engineering properties of rocks and soil
- natural resources and their estimation
- exploration of minerals

An overview of engineering geology and engineering practices : Fundamentals of engineering geology investigation : a) Formulation of investigation, b) Data collection. c) Data analysis. d) Evaluation and decision making., Instruments used in engineering geological investigations. 12

Engineering properties of rocks & soils : soil mechanisms. engineering properites of soils. classification of soils. Engineering properties of rocks : a) Rocks strength and deformation b) Discontinuities in rock masses c) Index texts d) Rock mass evaluation e) Classification of rocks. 15

Study of subsurface water ; a) Infiltration and permeability, b) Its influence in construction and control of subsurface water. 4

Exploration methods : a) Mapping. b) Remote sensing. c) Subsurface exploration 7

Construction materials : a) Source. b) Petrographic analysis. c) Aggregate gradation. 5

Natural and risks : a) Evaluation of geologic processes. b) Mitigation of hazards. c) Risk estimation. 5

Introduction : Scope and principles of prospecting criteria : a) structural, tectonic. b) Lithological. c) Stratigraphical. d) Magmatogenic, e) Geomorphologic. f) Geochemical, g) Geophysical 6

Prospecting guides (indication) : a) Outcrops of valuable minerals or productive rocks. b) Dispersion haloes (aureols). c) Ore boulders or floats, d) Rock zone alterations. e) Geophysical anomolies. f) Botanical, g) Paragenetic 12

Prospecting methods and techniques : a) Geological. b) Geophysical. c) Geochemical

Explosive and blasting : Explosive theory of explosions drilling of shot hallose, charging and firing a shot-holes. 3

Exploration methods : mine working. open cast and under ground mining., Mine ventilation. drainage. lighting and support. 6

Drilling : Hand drilling. percussion drilling. rotary drilling. 4

Sampling : Its types. sample spacing in mine openings sampling of exploratory boreholes. 4

Estimation of reserves : Reserves. their classification. Reference data for reserve estimation and estimation of fluid and solid minerals reserves. 4

Ore drassing and beneficiation. 4

Oceans as new areas for exploration of mineral resources. 32

Introduction fundamental concept of environmental geology : Biosphere and concept of geology processes and geological hazard. 2

River flooding : Magnitude and frequency of flood Hazards landslides. slopestability. causes of landslides. Human influence and landslide. prevention and correction of landslides.

Earthquakes : Magnitude. intensity and frequency of earthquakes. man made earthquakes prediction of earthquakes. earthquake hazard reduction. earthquake control.

Volcanoes : Effects of volcanic activity. adjustment to volcanic hazards.

Coastal Hazard : Tropical cyclones tsunamis. coastal erosion. coastal hazard mitigation measures. 27

Hydrogeology and landslide planning : Surface and ground water Hydrology and soil erosion.. The land use plan. soil surveys in relation to land use planning environment friendly land use. 8

Mineral resources and environment minerals and population. environmental impact of exploration processing and smelting of minerals. 3

Energy resources and environment energy crisis. Consumption and production trends of energy environmental effects associated with each type of energy resources. Bioenergy. petroleum. natural gas. hydropower. nuclear. coal solar isothermal tidal and wind energy. Future trends. Pollution : Pollution of air. soil and water. sources of contamination treatment of polluted water. 11

(b) Engineering Geology, Exploration Geology and Environmental Geology

Course No. : Geo 334 (Major) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : III

Determination of various engineering properties of soil : i) unit weight. ii) Specific gravity. iii) Moisture content. iv) Porosity. v) Atterberg limit. vi) Dry strength. vii) Dilatancy. viii) Toughness. 12

Measurement of shear strength 3

Plotting of grain size distribution curves and calculation of various coefficients associated with them. 9

Determination of compressive. shear and tensile strength of rocks. 6

Calculation of rock slope stability using stereographic projections. 12

Calculation of mass strength 6

Preparation of isolethmaps determination of true dip of mineral veins tracing outcrop. mineral vein. etc. construction of folds. 12

Estimation of average grades of minerals from pits. trenches and benches calculation of average assay from core drill samples. Calculation of tonnage factor. 12

Estimation of volume by triangular method. Estimation of volume by polygon method. 12

Estimation of ore reserve by various methods. 12

Text Books :

1. Johnson. R.B. & Degraff. J.B.. *Principles of Engineering Geology*. John Wiley and Sons. New York. Recent ed.
2. Smirnov. A.V.. Miloserdina. G. Eromin. N.. *Short Course of Geological Prospecting & Exploration*. Mir Publisher. Moscow. Recent ed.
3. Keller. E.A.. *Environmental Geology*. Mir Publisher. Moscow. Recent ed.

References for all Courses

1. Holmes. A.. *Principles of Physical Geology*. ELBS Publication. 1992.
2. Sanders. J.E.. *Principles of Physical Geology*. John Wiley and Sons. New York. 1986.
3. Hobbs. Means and Williams. *An Outline of Structural Geology*. John Wiley and Sons. New York. 1976.
4. Arogyaswamy. R.N.P.. *Course on Mining Geology*. Oxford and IBP Publishers. 1987.

4. Mathematics

Introduction

In the three year Bachelor Programme. students offering mathematics as major subject will have to study 8 papers each carrying 75 marks. The duration of examination of each papers will be 3 hours. The distribution of the 8 papers (equivalent to 600 marks) will be the pattern 2 + 2 + 4 i.e.. two papers in each of the first two years and 4 papers in the third year.

The minimum number of periods per week per paper will be 6 (or full 4 hours theory) and 3 (or full 2 hours theory) for tutorial.

All questions will be compulsory and choices. if given. will be of the same unit. Full marks of each paper will be 75 and the pass marks will be 35%.

The yearwise courses distribution will be as follows :

Academic Year	Theory				
	Course No.	Full Mark	Course No.	Full Mark	**Total Marks**
First Year	MATH. 311 (Major/Minor)	75	MATH. 312 (Major/Minor)	75	**150**
Second Year	MATH. 321 (Major/Minor)	75	MATH. 322 (Major/Minor)	75	**150**

Third Year	MATH. 331 (Major)	75	MATH. 333 (Major)	75	300
	MATH. 332 (Major)	75	MATH. 334 or MATH. 335 (Major)	75	

(a) Calculus

Course No : Math 311 (major/minor)
Nature of the Course : Theory

Full Marks : 75
Pass Marks : 35%
Year : I

Course Objectives

The main objectives of this course are :

- To give sound knowledge of Calculus skill and theoritical background in the emerging areas of mathematics.
- To stimulate and sustain interest in and promote enjoyment of Calculus and its application.
- To show that Calculus is a coherent and developing framework of knowledge based on fundamental theories and principles of the structure and process of the mathematics world.

Unit 0. **Review of Elementary Calculus :** Functions, graphs, Evaluation of units Continuity, Discontinuity, Text of continuity and properties of continuous functions, Integration.

Unit 1. **Tangents and Normals :** Tangents and normals, Subtangent, Subnormal and their lengths, Derivative of arc length, Polar equations of subtangent and subnormal, Angle between radius vector and tangent, Length of perpendicular from pole on tangent, Pedal equations and Angle between two curves.

Unit 2. **Higher - order Derivatives and Mean Value Theorems :** Higher order derivatives, Leibnitz theorem, concepts of Rolle's theorem, Lagrange's theorem, Cauchy Mean Value Theorem (without proof) and their applications, Maclaurin's and Taylor's theorems and their application in expanding functions.

Unit 3. **Maxima, Minima and Indeterminate Forms :** Maxima and minima of function of one variable, Concept of local and global maxima and minima, Criterion for maxima and minima, Indeterminate forms, L' Hospital's rule (Only statement).

Unit 4. **Asymtotes and Curve Tracing :** Asymptotes, Types of asymptotes, Asymptotes of algebraic curves, Curve tracing techniques, Standard curve and their tracing.

Unit 5. **Curvature :** Concept of curvature, Chord of Curvature, Curvature at origin, Centre and circle of Curvatures.

Unit 6. **Partial Differentiations and Maxima and Minima of functions of 2 or 3 variable :** Basic ideas of limits and continuity of functions with 2 or 3 variables, Partial Derivatives and geometrical interpretation, Higher order Partial Derivatives, Homogeneous Functions, Euler's theorems, (proof for 2 variables only), Total Differentials, Extremum

values. Stationary points, Criterion for maxima and minima, subsidiary conditions. Largrange's method of undetermined multiplies.

Unit 7. **Integration and Definite Integrals :** Integration concepts, Integration techniques and Standard formulae, Integration of rational fractions and hyperbolic functions. Integration as the limit of a sum. Definite integral and Fundamental theorem of integral calculus (without proof). Properties of Definite integral.

Unit 8. **Beta and Gamma Functions and Reduction Formulae :** Beta and Gamma functions and their properties. Reduction formula.

Unit 9. **Rectification and Quaderature, Volume and Surface of solid of Revolution :** Rectification notion. Length formula. Idea of quadrature and area-formula, volume and surface area of solid of revolution.

Unit 10. **Differential Equations of the first - order and of first degree :** Introduction, Standard form, Variable - separable equations. Homogeneous equations, Equations reducible to homogeneous equations, Non-homogeneous equation of the first order. Exact differential equation, Condition for exactness. Integrating factors and techniques. Linear differential equations and equations reducible to linear forms.

Unit 11. **Differential Equations of the First-Order but not of first degree :** Equations solvable for p. Equations solvable for y. equations solvable for x. Equations for x and y. Equations homogeneous in x and y. Clairaut's equation.

Unit 12. **Linear Differential Equations with Constant Coefficients :** Linear equation with constant coefficients. Linear equations solvable using symbolic operations, symbolic operation techniques Particular integral and complementary function. Homogeneous linear equations. Equations reducible to homogeneous form.

Unit 13. **Application of First order and First degree differential equations :** Formation of problems into differential equation. Initial and boundary conditions, solution technique.

Book Suggested :

1. M.B. Singh and B.C. Bajracharya. : *Differential Calculus*. Sukunda Pustak Bhawan. Kath. (1995).
2. G.D. Pant and G.S. Shrestha. : *Integral Calculus and Different Equations*. Sunita Prakashan. Kath. (1994).
3. D.A. Murray : *Introductory Course in Different Equations*. Orient Longman.
4. T.M. Apostal. : *Calculus Vol. I & II*. Wiley Eastern Ltd. New Delhi. (1986).
5. Das and Mukherjee. : *Differential Calculus*. U.N. Dhar and Sons. Calcutta.
6. Das and Mukherjee. : *Integral Calculus*. U.N. Dhar and Sons. Calcutta.

(b) Analytical Geometry and Vector Analysis

Course No : Math 311 (major/minor) Full Marks : 75
Nature of the course : Theory Pass Marks : 35%
Year : I

Course Objectives

The main objectives of this course is to enable the students

- To develop sound analytical skills and theoretical background in the emerging areas of mathematics.
- To take up higher studies in mathematics.
- To show that Analytical Geometry and Vector Analysis are coherent and developing frameworks of knowledge based on fundamental principles of structure of the mathematical world.

Unit 1. **Transformation of Coordinates :** Transformation. Rotation. Process involving combination of translation and rotation of axes. invariants in orthogonal transformation.

Unit 2. **Conic Sections and their Properties :** Introduction- Conic section as locus of a point and as a section of cone. central conic sections. Ellipse and hyperbola. Derivation their equations in standard forms. Auxiliary circles and eccentric angle. Equations of tangent and normal. Chord of contact. Pole and polar and their properties. Diameter. conjugate diameter and Equi-conjugate diameter. Asymptotes of hyperbola. Relations between the equation of hyperbola. its asymptotes and conjugate hyperbola. Equation of hyperbola referred to the asymptotes as coordinate axes.

Unit 3. **Polar Equation of a Conic :** Polar equation of a conic section with focus being pole. Equation of the chord of conic. Equation to the tangent. normal and chord of contact. Equation of the polar to a conic and equation of the asymptotes.

Unit 4. **General Equation of the Second degree :** General equation of the second degree and the conic representation by them. Nature of the conic. Centre of conic. Equation of the tangent and condition of tangency. Equation of pair of tangents. Director circle. Equation of the normal to a conic. Equation of pole and polar with respect to a conic. Diameter and conjugate diameters. intersection of conics. Asymptotes to a conic.

Unit 5. **Co-ordinators in three Space and Plane :** Review of co-ordinates in space. angle between two lines. general equation of the first degree representing a plane. angle between two planes. plane through three points. plane through the intersection of two planes. condition for representing a pair of planes by the homogeneous equation of the second degree.

Unit 6. **Straight Lines :** Representation of a line as the intersection of two planes. line in symmetric form. line through two points. reduction of the general form to the symmetrical form. perpendicular distance of a point from a line. condition for a line to lie in a plane. general equation of a plane containing a line. coplanar lines and condition for it. Skew

lines. magnitude and equation of the line of shortest distance between two skew lines, intersection of three planes.

Unit 7. **Sphere** : Sphere and equation of a sphere. its representation by the general equation of the second degree, sphere through four given points. plane section of a sphere , intersection of two spheres, sphere with a given diameter. tangent plane and condition of tangency.

Unit 8. **Cone and Cylinder** : Definition and equation of a cone, condition that the general equation of the second degree to represent a cone condition that a cone has three mutually perpendicular generators, tangent lines and tangent plane. condition of tangency, reciprocal cone, enveloping cone and right circular cone, cylinder and enveloping cylinder, circular right cylinder.

Unit 9. **Central Conicoids** : Conicoids and central conicoids. standard equation of central conicoid. intersection of a line with a conicoid, tangent and tangent planes, condition of tangency, director sphere, equation of the normal. cubic curve through the feet of the six normals. general equation of the conicoid through six feet of the normals. polar plane and plane of contact, enveloping cone of the central conicoid and enveloping cylinder of a conicoid section of a conicoid, diametral plane. conjugate diameters and diametral planes of an ellipsoid properties of conjugate semi-diameters.

Unit 10. **Product of three of more vectors** : Multiplication of three vectors. scalar triple products. applications and geometrical meanings of scalar triple product. properties of scalar triple product. condition of conplanarity of these vectors. vector triple product, scalar product of four vectors and vector product of four vectors, reciprocal system of vectors.

Unit 11. **Differentiation of Vectors** : Vector function of a single variable. vector function and its expression in terms of unit vectors, limit and continuity of vector functions, differentiation of a vector function w.r.t. a scalar, partial derivatives of vectors. higher derivatives of a vector w.r.t. a scalar. differentiation of the product of a scalar and a vector: differentiation of scalar product and vector product of two and three vectors.

Unit 12. **Gradient, Divergence and Curl, and Expansion Formulae** : Scalar point function, vector point function, scalar field, vector field. vector operators. gradient scalar field, gradient in polar coordinates, condition for a scalar point function to be constant and conversely, total differential, directional derivitive. divergence of a vector field, solenoidal vector, curl of a vector field, expansion formulae. second order differential operators. expansion of formulae involving first order and second order differential operators.

Book Suggested :

1. Y.R. Sthapit and B.C. Bajracharya. *A Text Book of Three Dimensional Geometry*. Sukunda Pustak Bhawan, Kathmandu.

2. S.L. Loney. : *Elements of Coordinate Geometry*. MacMillan Book Co. N.Y. (1984).
3. J.J. Bell. : *An elementary Treatise of Coordinate Geometry of Three Dimensions*, MacMillan Book Co. N.Y. (1986).
4. M.B. Singh and B.C. Bajracharya. : *A Text Book of Vector Analysis*. Sukuda Pustak Bhawan.
5. S. Narayan : *Analytical Solid Geometry*. S. Chand and Co.
6. Laji Prasad. : *Vector Analysis*. Paramount Publication (1986).

(a) Algebra I

Course No. : Math 321 (major/minor) Full Marks : 75

Nature of the course : Theory Pass Marks : 35%

Year : II

Unit 1. Sets, mapping and properties of integers : Review of sets and set operations, relations and mappings properties of mappings and composite mappings, binary operations, equivalence relations and equivalence classes, properties of integers and prime numbers, divisors and greatest common divisors, prime factors and unique factorization theorem (no proof), congruencies and residue classes. 10

Unit 2. Matrices and Determinants : Matrices and entries, Standard matrices, submatrices, equal matrices, algebra of matrices, Transpose of a matrix, and properties, symmetric, skew-symmetric matrices, matrices of complex entries, Hermitian, Skew-Hermitian matrices, Orthogonal and unitary matrices, determinant of a square matrix, properties of determinants, minors and co-factors, adjoint of a square matrix, inverse of a square matrix and their properties. 8

Unit 3. System of Linear Equations : System of linear equations - homogeneous and non-homogeneous, rank of matrix, reduction to Echelon form, linear dependence and independence, properties of rank, row and rank column rank, rank of product of matrices, consistency conditions, solution of homogeneous and non-homogeneous systems of equations, elementary transformations of a matrix, characteristic equation of a matrix and Cayley-Hamilton theorem (no proof). 10

Unit 4. Groups : Groups and semi-groups and their examples, elementary properties of groups, integral powers of an element, cyclic groups, subgroups and their characterizations, cosets, order of an element, Lagrange's theorem, normal subgroups, quotient group and their properties, homomorphism.. Kernel and image of homomerphism, isomerphism, permutation groups, cyclic permutations, even and odd permutations. 10

Unit 5. Rings and Fields : Rings, special classes of rings, elementary properties of rings, zero-division, division ring, integral domain, field and their properties, homomorphism of rings, ideals and quotient rings, maximal ideal of rings. 8

Unit 6. Vector in n-Space : Point in n-space, algebraic operations in n-space and their properties, scalar product, Norm distance, angle, scalar and vector projections - geometric interpretations, orthogonality. 8

Unit 7. Vector Space and Subspaces : Vector space and subspaces, elementary properties, Linear combinations, linear dependence and independence, basis and

dimension, idea of dual spaces, direct sum, homomorphism and isomorphism, inner product, orthogonality and orthonormality, orthogonal and orthonormal basis. 8

Unit 8. Linear Transformations : Transformations, linear transformations, Kernel and image of linear transformations, algebra of linear transformations, matrix as a linear transformations, eigenvalues and eigenvectors, Caley - Hamilton theorems (no proof). 8

Unit 9. Theory of Polynomial Equations : Polynomials over an integral domain, division algorithm, division of a polynomial, zeros of a polynomial, Rolle's theorem, Properties of equations, Descartes rule of signs, relation between roots and coefficients, application to solution of an equation, symmetric functions of the root, transformation of equations, transformation in general, equation of squared difference of a cubic, multiple roots, sum of powers of roots, reciprocal equations. 10

Unit 10. Cubic and Biquadratic Equations : Algebraic solutions, solution of the cubic, nature of roots of a cubic, nature of roots from Cardan's solution and applications to numerical examples, solution by symmetric functions of roots, solution of the biquadratic and solution by radical.

Book Suggested :

1. I.N. Herstein : *Topics in Algebra*, Vikas Publishing House Pvt. Ltd.
2. R.M. Shrestha & S. Bajracharya : *Linear Algebra with Group & Rings*, Sukunda Pustak Bhavan, Kathmandu.
3. S.Lang : *Linear Algebra*, Addison-wesley Publishing Company.
4. N.S. Gopal Krishan : *University Algebra*, Orient Longman.
5. Chandrika Prasad : *A text Book of Algebra & Theory of Equations*, Pothisala Private Ltd.
6. P.B. Bhattacharya, S.K. Jain & S.R. Nagpaul : *First Course in Linear Algebra*, Wiley Eastern Ltd.
7. P.R. Halmos : *Finite Dimensional Vector Space*, D. Van Nostrand Co., Princeten.
8. B.S. Vatssa : *Theory of Matrices*, Wiley Eastern Ltd.
9. P.B. Bhattacharya, S.K. Jain & S.R. Nagpaul : *Basic Abstract Algebra*, Cambridge, 1986.

(b) Mathematical Analysis I

Course No. : Math 322 (major/minor) Full Marks : 75

Nature of the course : Theory Pass Marks : 35%

Year : II

Unit 1. Basic concepts : Elementary logic, Sets and Set operations, relations and functions, one-to-one and onto mappings, one-to-one correspondence, cardinality of a set. 6

Unit 2. Real numbers System : Field axioms, Order axioms, bounded and unbounded sets, supremum and infimum, completeness axioms, Archemedean property, extended real number systems, countable and uncountable sets. 10

Unit 3. Points set Topology of the Real Line : Neighbourhood. interior points and limit points of a set. open and closed sets and their properties. Bolzano-Weierstrass theorem. closure of a set. dense and derived sets. real line as a topological space. 10

Unit 4. Sequences of Real Numbers : Sequences & Subsequences. Convergent sequences. Bolzano-Weierstrass theorem for sequence. Cauchy sequence. convergence criteria. Operations on convergent sequences. monotonic sequence and convergence. nested intervals theorem. 10

Unit 5. Series of Real Numbers : Series and sequence. convergence & divergence. Cauchy's criteria for convergence. different tests for convergence. alternating series. absolute and conditional convergences. 8

Unit 6. Limit and Continuity : Limit. left hand and right hand limits. properties of limits. intermediate value theorem. continuity of functions. discontinuities. functions continuous on closed intervals. continuity and inverse images of open and closed sets. uniform continuity. 12

Unit 7. Differentiations : Derivative of a real-valued functions of a single variable. differentiability at a point and in an interval. differentiability and continuity, monotonic functions. Rolle's theorem, Lagrange's mean value theorem. Cauchy's mean value theorem and their geometric interpretations. higher order derivatives. Taylor's theorem. Maclaurin's theorem and their infinite series forms. applications of Taylor's theorem in extreme values problems and in indeterminate forms. proof of L'Hospital rule. 12

Unit 8. Riemann Integration : Partition and refinement of partitions. upper and lower integrals. Rimann integrable functions and Riemann integrals. conditions of integrability. properties of Riemann integrals. 10

Unit 9. Fundamental Theorems of Integral Calculus : Primitives. fundamental theorem of calculus. first mean value theorem, generalized first mean value theorem. integration by parts. change of variable in an interval. second mean value theorem. 12

Book Suggested :

1. S.C. Malik & Savita Arora : *Mathematical Analysis (Second Edition)* Wiley Eastern Limited (1993).
2. R.M. Shrestha : *Mathematical Analysis*. Sukunda Pustak Bhandar. Kathmandu. (1995)
3. Shanti Narayan : *Mathematical Analysis*. S.Chand and Co., New Delhi. (1985)

Details of the following courses [to be taught in the third year]

Course V (Math. 331) : Mathmatical Analysis II
Course VI (Math. 332) : Advanced Calculus
Course VII (Math. 333) : Algebra II
Course VIII (Math. 334) : Mechanics
Course IX (Math. 335) : Linear Programming

will be made available as early as possible.

5. Meteorology

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	Total Marks
First Year	MET. 311 (Major/minor) MET. 312 (Major/Minor)	50 50	MET. 313 (Major/Minor)	50	150
Second Year	MET. 321 (Major/Minor) MET. 322 (Major/Minor)	50 50	MET. 323 (Major/Minor)	50	150
Third Year	MET. 331 (Major) MET. 332 (Major)	100 100	MET. 333 (Major)	100	300

(a) Physical Meteorology

MET 311 (Major/Minor)
Nature of the course : Theory

Full Marks : 100
Pass Marks : 35
Year : I

Course Objectives :

This course provides the students a basic knowledge of the quantitative treatment of the energy processes in the atmosphere. The relationship between the basic atmospheric variables including the moisture variables is derived in the form of basic equations. Some of the processes going on in the atmosphere treated quantitatively. A simplified quantitative description of the atmosphere is also treated.

Contents

1. **Introduction of the Atmosphere :** Physical Foundation. Units and Dimension. Characterstics of the atmosphere. composition of the atmosphere. Troposphere.
2. **Equation of State :** Variables of state. Equation of State of an Ideal Gas, Mixture of gases (Dalton's Law).
3. **Principles of Thermodynamic :** Work, Heat. First law of thermodynamic internal Energy and specific heat capacity of an ideal gas. changes in internal energy and its application to the atmosphere. adiabatic process (Potential Temperature). Entropy and second law of Thermodynamics. Numericals.
4. **Moisture Variable :** Vapour pressure. Saturation vapour pressure. Absolute humidity. Relative Humidity. specific humidity. mixing ratio virtual temperature. Dew Point temperature. wet bulb temperature. wet bulb

potential temperature, Equivalent temperature, Equivalent potential temperature, Lifting condensation level, Numericals.

5. **Equation of State of Moist Air :** Change of phase and latent heat, Clausius - Clapeyron Equation, Adiabatic process of saturated air, Numericals.
6. **Thermodynamic Diagrams :** General consideration, The Emagram, The T-phigram
7. **Hydrostatic equilibrium :** Hydrostatic equation, Height computation for upper level , hydrostatics of a special Atmosphere, Homogeneous, Isothermal, Constant Lapes/ rates, Dry adiabatic, Standard atmosphere, Numericals.
8. **Hydrostic Stability :** Stability criteria, Absolute stability, Absolute instability, conditional instability, latent instability, Parcel Method, clice method, entrainment.
9. **AtmosphericOptical Phenomena :** Halo, Rainbow, Visual range Coronas.
10. **Condensation and Precipitation :** Condensation, Evaporation and Sublimation, Size spectrum of Aerosol particles, Solute effect, Ice Nucleation, Growth by Coalescence, Atmospheric Electricity.

Text Books

1. John G. Albright - *Physical Meteorology*, Prentice hall Inc., New York, 1943.

Reference Books

1. H.R. Byers - General Meteorology
2. R.A. Antes, H.A. Panotsky, J.J. Kahir & A Rango - The Atmosphere
3. Compendium of Meteorology (class I and II), Volume I, Part 2
4. Physical Meteorology (WMO Number 364)
5. S.L. Hess - Introduction to Theoretical Meteorology.

b) Climatology

Course No. : MET : 312 (major/minor) Full Marks : 50
Nature of the course : Theory Pass Marks : 17.5
Year : I

Course Objectives :

The aim of the above course is to provide an introduction to climatology for the student of Meterology. In order to familiarize them about the physical causes of the climates and the variation of climate in space and time.

Contents :

1. **Definition and Scope of Climatology :** Purpose of study, difinition of climatology, climate and weather, Elements of climate and statistics to describe them.
2. **Solar radiation and Terrestrial Heat Balance :** The incoming solar radiation in the absence of the atmosphere. Depletion of incoming solar radiation by the earth's atmosphere. Diffuse sky radiation, General Survey of

the Terrestrial Heat Balance. Geographical distribution of solar and out going radiation.

3. **Spatial and Temporal Variation of Temperature over earth :** Temperature at the earth's surface as a function of latitude : the effect of land and sea on the temperature distribution at the earth's surface. the annual variation of temperature. the diurnal variation, the temperature distribution at higher altitudes. Lapes rates of Temperature.
4. **Spatial and Temporal variations of lands and pressure :** Survey of wind and pressure distribution at the earth's surface. The effect of land and sea on the wind and pressure distribution. Monson circulation: The climatic effects of ocean currents. wind and Pressure distribution at higher levels.
5. **Hydrometers :** Annual Precipitation over the earth's surface. the effects of continents and oceans on the distribution of precipitation. Precipitation and Altitude. The annual variation of precipitation. The diurnal variation of precipitation. Snow. Fog. Thunderstorms etc.
6. **Air Masses Cyclones. Fronts etc :** Air masses Definition. source. regions of air masses. Types of air masses. Modification of air masses. Fronts : Definition and classification. Cyclones and anticyclones.
7. **Climatic Classification :** Purpose of climatic classification. various Types e.g. Kopper's & Thornthwaite's climatic classification.
8. **Description of the climatic Type :** The tropical rainy climates. The dry climates. The warm temperate rainy climates. The Snow forest climates. The polar climates.
9. **Regional Climatology of Asia :** Physical Feature. Mean distribution of pressure and wind and Air Masses. Fronts. Tropical cyclones and Anticyclones and climatic regions. Western Disturbances.
10. **Climate of Nepal :** Climate of Nepal.
11. **Climatic Changes :** Climate changes through geological time : Evidence of climate changes. Theories of climate change. impacts of climate changes.
12. **Monsoon :** Different meanings concepts and the origin of Monsoon. Indian South west Monsoon. Role of Tibetan Anticyclone on Monsoon circulation, onset criteria of monsoon and withdrawl.

Text Book

1. Glenn T. Trewartha - *An Introduction to Climate* : McGraw Hill Book Co. Inc.. New York. 1954.

Reference Books

1. E.T. Stringer - *"Techniques of Climatology"* Published by W.H. Freeman & Co. Sanfrancisco.
2. Bernhard Haurwitz and James M. Austin - *Climatology*. McGraw Hill Book Company. Inc. New York 1944.

(c) Meteorological Practical

Course No. : MET 313 (major/minor) Full Marks : 50
Nature of the course : Practical Pass Marks : 20
Year : I

Course Objectives :

The purpose of this course is to familiarize the students about the surface and upper air meteorological instruments : the statistical methods use in climatology determination of water balance and deleneation of climates by different methods.

Contents

1. **Meteorological Practicals :** Network density Norms of precipitation station. meteorological stations installation Criteria for Meteorological stations.
2. **Inspection Techniques :** Fortin's Barometer (to prepare a correction Table), Kew pattern Barometer (to prepare a correction Table) Reduction to sea level (Fortin's and Kew Pattern Barometers). Height different between two stations using Hydrostatic equation. Lag Coefficeint of Thermometer. Altimetry. Asmann psychronmeter and Humidity chart. Analysis solar radiation charts. Preparation of wind roses.
3. **Climatology :** Use of moving averages technique in meteorological data. probability analysis. Climatic classification by both Koppens and Thornthwaites methods. Analysis of evaporation. preparation of weekly and monthly climatological summaries from climatological data.

   Water balance by Thornthwaites method. Preparation of monthly means from land station (Climate) including its general code.

Text Books

1. World Met. Org. No. 8 - *Guide to Meteorological Instrument and observing Practice*. WMO, Geneva. Switzerland. 1993.

Reference Books

1. Ratauack. WMO Publication - *Compendium of Lecture's Notes for Class II Meteorological Personnel*.
2. Her Majesty's Queen Service. London - *Observer's Hand Book*.

(a) Synoptic and Tropical Meteorology

Course No. : Met 321 (major/minor) Full Marks : 50
Nature of the course : Theoretical Pass Marks : 20
Year : II

Course Objectives :

- The purpose of Synoptic Meteorology is to familiarize the students with the techniques of weather analysis and forecasting without which it is impossible to become a weather forecaster.

- The weather in Tropics is different with that of mid latitude. Therefore, the aim of this course is to familiarize the students about the Tropical weather, analysis and forecasting techniques.
- The course contains around observations basis, temperature, rainfall etc. in tropics.

Contents :

Air masses and Fronts : Composition and vertical distribution of the atmosphere : Introduction; Air masses: Main Frontal Zones; Some general properties of fronts 3

Frontal Depressions : Formation of frontal depressions: warm front; cold front; occlusion. Summary of frontal Characteristics. general distribution of weather in frontal depression. Families of Frontal depression. upper winds over frontal depressions. secondary fronts. Flights through frontal depressions. frontolysis and frontogenesis. 9

Other depressions : Causes of western disturbances thermal depressions, orographic depressions. secondary depressions. tropical revolving storms. Tornadoes. Trough of low pressure. etc. 5

Anticyclones : Types of anticyclones. general properties of anticyclones. Cold anticyclones. warm anticyclones. col. Ridge of High pressure. 5

Elements of forecasting : Introduction. Analysis of surface chart; Analysis of upper air chart: Preparation of forecast surface chart: Preparation of forecast upper air chart. Composite forecast chart. Preparation of area. Route and Flight forecasts. Local and Terminal Aerodrome forecasts. Forecasting in the Tropics in general. Various approaches in forecasting. 9

Thunderstorms : Condition favourable for thunderstorms. The cellular structure of thunderstorm. Further characteristics. Flight through Thunderstorm. Electrical phenomena associated with Thunderstorms. 5

Visibility and Fog : Signficance of visibility. Types of fog and its formation, artificial dispersal of fog. 2

Ice Accretion on Aircraft : Introduction. forms of air-frame icing. Factors affecting the form of air frame icing. Air frame icing in relation to cloud forms. Effects of air frame icing on performance. Engine icing. Flight procedures in air frame icing conditions. 5

Some Characteristics of High Altitude Flight : Introduction. Air density and aircraft performance. Jet streams. Clear Air Turbulence (CAT) condensation trails, pressure pattern flying 6

Wind and Pressure : Global distribution (winter and summer) (Equator to Pole) 2

Temperature : Global (seasonal distribution) and Temperature distribution in Nepal 1

Rainfall : Global and local (Distribution of rainfall with special reference to Nepal) 1

Introduction to Tropical Meteorology : Introduction on Tropical Meteorology 1

Primary physical controls of the Tropical circulation : General: the earth's heat energy balance: Tropical general circulation: Primary physical factors- Distribution of land and water, sea surface temperature. Interactions with mid latitude systems 3

The Observational Basis : Present data sources : Surface Data; upper air data; oceanographic data. Meteorological satellite data. Radar data. **Probable Future Data Sources :** Meteorological satellite data: Automatic Meteorological Stations; upper air observations from mobile ships, constant level balloons. 3

Pressure and Winds : Mean sea level Pressure; Diurnal Pressure variations; Large scale pressure changes 3

Winds : General: Resultant, gradient level wind; Resultant 200 MB wind; Mean wind cross sections: Jet streams; Diurnal and local wind effects. 3

Temperature and Water Vapour : Surface Temperature and water vapour. Means Diurnal variations, elevation effects. Upper air temperature and water vapour : means and seasonal changes; mean precipitable water; mean vertical soundings; Diurnal variations; equivalent potential Temperature. 6

Cloudiness : Cloudiness: mean cloud cover; Interannual cloud cover variations: Zonal cloud cover averages; Tropical cloud types; Diurnal cloudiness variation. 1

Rainfall : Mean annual Precipitation: Annual rainfall variability: monthly rainfall variability: Daily rainfall distribution; Rainfall variation with elevation; Meso-scale rainfall distribution: Extreme rainfall amounts: Rainfall associated with Tropical cyclones; Beginning and ending of rainy seasons. 5

Tropical Synoptic Models : Waves : easterly waves, Equatorial waves Vortices : Low Tropospheric cyclones Low tropospheric anticyclones, Mid-Tropospheric and Upper tropospheric circulations. 5

Linear Disturbances : General; Shear lines; clear air turbulence, Asymptotes 1

Tropical Cyclones : Classification and definition of Tropical Disturbances: Global climatology of Tropical cyclones. Tropical storms, their formation, movement and forecasting. Tropical storm characteristics : wind field, temperature field, cloud systems etc. 4

Severe Weather in the Tropics : Thunderstorms : Frequency; Diurnal variation: Duration, Tornadoes, Hail, Extreme winds, Turbulence in lower and higher levels, Icing : General: climatological frequency. Ocean wave phenomena, storm surges. 5

Tropical Analysis : Data collection and Evaluation : Surface and upper air observation Manual analysis Techniques; Recommended analysis levels Frequency and scale of analysis: Stream line/Isotach analysis procedures, Use of aircraft reports; use of climatology; use of satellite data, vertical time cross sections; Thermodynamic diagrams; wind shear and pressure change charts: Rainfall analyses. 5

Tropical Forecasting : Short range Forecasting methods. Prognostic charts; use of Radar; use of stability Indices 3

Monsoons : Introduction; Global monsoons : Differential heating : Land and sea breezes: The heat low (on set of monsoon). Regional Aspects of the Monsoon : Monsoon depressions : Monsoon Trough.. Monsoon climatology : Dates of onset

and retreat of Asian Summer monsoon and Normal winds and Pressure. pattern: Monsoon rainfall The easterly Jet stream: The winter monsoon 5

Text Books

1. R.G. Barry and A.H. Perry - *Synoptic Climatology*. Matheun and Co. Ltd.: London. 1973
2. G.C. Asnani. *Tropical Meteorology Vol. I and II*. 822 Sindh Aundh. Pune. 1993.

Reference Books

1. Byers, H.R. - *Synoptic Meteorology*. New York : McGraw - Hill. 1937.
2. Maj Gary D- *Forecaster's Guide to Tropical Meteorology*
3. *Air Weather Service (MAC) United States Air Force*. 1971 - Atkinson Published.
4. Professor T.N. Krishnamurti. Class I and II Meteorological personnel (WMO) - *Compendium of Meteorology for use.*
5. Herbert Reihl – *Tropical Meteorology*.
6. Her Majesty's Stationary Office - *Handbook of Aviation Meteorology*. London.

(b) Fluid Mechanics and Dynamical Meteorology

Course No. : Met 322 (major/minor) Full Marks : 50

Nature of the course : Theoretical Pass Marks : 20

Year : II

Course Objectives :

Since, Meteorology being a science of atmospheric motion, the study of fluid dynamics is an essential aspect to study the motion of fluid in different physical conditions. Further, this is also useful for the study of subject hydraulics in hydrological science. Keeping these aspects in view, this course has been developed to provide understanding of fluid flow in atmosphere and land surface to the students of meteorology major in Bachelor of Science. T.U.

To provide fundamental knowledge of the dynamical process which determine the spatial and temporal distributions of meteorological variables (e.g. Temperature. Pressure. Radiation. Water vapour etc.). through the utilization of the equation of state. thermodynamic energy equation. Hydrostatic equation. Equations of motions and Continuity equation. The theoretical knowledge will be further clarified by numerical problems in each section.

Contents : **Lecture hours**

Definition and Properties of Fluids : Definition, properties. Classification of fluids, liquid and gases; Fluid mechanics and its branches; fluid mechanics, Hydro-mechanics, hydrostatics, Hydro Kinematics; Hydro dynamics and Hydraulics; Dimensions, units and system of measurement. 5

Kinematics of Fluid Flow : Introduction; methods for describing fluid motion; lines of flow; path line, stream law, stream tube, streak filament line, potential line; General type of fluid flow; steady and unsteady flow; Uniform and non-Uniform flows; Laminar and Turbulent flows; compressible and incompressible flows, Rational and irrational flows; One, Two or three dimensional flow; Equation of continuity for three dimensional flow. Mean velocity of flows;

velocity of fluid particles. Acceleration of flows: convective and local acceleration: Normal Acceleration: Different types of displacement of fluid particles: Translation. rotation, distortion and deformation: equation of stream line : stream function : Physical and mechanical concepts and properties: velocity function: circulation. 14

Basic Equation of Fluid Flow : Introduction: Various form of energies present in fluid flow: Energy Equation : Bernoulli's theorem and its statement: Bernoulli's theorem for liquid : General energy Equation for steady flow and derivation of Bernoulli's equation: Euler's equation of motion and derivation of Bernoulli's equation: Discussions on assumption underlying Bernoulli's equation: Some Practical application of Bernoulli's equation, momentum equation. 14

Some Concepts of Atmospheric Fluid Dynamics : Measurement of acceleration in a rotating coordinate system; Equation of fluid motion in rotating coordinate system: The continuity equation: Common approximation of Atmospheric fluid dynamics : (a) the baratropic fluid. (b) the hydrostatic approximation, (c) the horizontal flow approximation, (d) the geostrophic approximation: the Prudman - Taylor theorem: The dynamics of vorticity: (a) the definition of vorticity: (b) the conservative properties of vorticity, and (c) the dynamics of vorticity in a rotating co-ordinate system. 12

Introduction : Aim, Atmospheric Continuum, hypotheses, units and dimensions, dynamical operations, coordinate systems. 5

Basic Conservation Principle : Introduction, kinematics (velocity and acceleration) Calculation of velocity and position from acceleration, kinematics of a totaling motion, velocity & acceleration (absolute and relative systems) Individual & local time deriviates, Fundamental & apparent forces, Gravitational, Pressure gradient, frictional, Centrifugal, coriolis forces, Equations of motion in Cartesian, spherical and natural, co-ordinates, scale analysis of equations of motion, Numericals. 17

Other Basic Equations : Continuity, Thermodynamic and Hydrostatic equations, Numericals. 6

Application of Basic Equations : Basic equations in pressure co-ordinates, Balanced flow, Cyclostrophic, Inertial flows, Thermal wind, vertical motion, Surface pressure - tendency, Numericals 12

Kinematics of the Wind : Circulation, vorticity, Divergence, Deformation, Relation between Circulation and vorticity, Kelvin's theorem, Bjerkness theorem, Principle of Solenoids, Land and sea breezes, Barotropic and baroclinic atmosphere. 10

General circulation of the Atmosphere : Mean circulation in the Troposphere, Meridional Circulation, Jet streams. 6

Effects of Friction : Introduction to boundary layer meteorology 3

Text Books :

1. S. Eskinazi - *Fluid Mechanics of Thermodynamics of Our Environment*, Academic Press, New York, 1975.
2. Hess - *Introduction to Theoretical Meteorology*, Holt, Rinehart & Winston, New York, 1959.

Reference Books

1. Manohar Lal - *Fluid Mechanics.*
2. Frainics. J.R.D. - *Fluid Mechanics.*
3. Streeter. V.L. - *Fluid Mechanics.*
4. Compendium of Meteorology (Class I & II) - Vol I., Part I *Dynamical Meteorology* (WMO No. 364)
5. J.R. Holton - *An Introduction to Dynamic Meteorology.* Academic Press Inc., New York
6. Pal Arya - *Introduction to Micrometeorology.* Academic Press Inc.
7. Roland B. Stull - *An Introduction to Boundary Layer Meteorology.* kluweh Academy Publishers.
8. Roger G. Barry and Richard J. Chorley - *Atmosphere, Weather and Climate,* Mathuen and Co. Ltd., London.
9. Jagdish Lal - *Hydraulics and Fluid Dynamics.*
10. G.J. Haltimer and F. Martin - *Dynamical and Physical Meteorology.* McGraw. Hill Book Co., New York.

(c) Meteorological Practical

Course No. : Met 323 (major/minor) — Full Marks : 50

Nature of the course : Practical — Pass Marks : 20

Year : II

Course Objectives

The objective is to train the students in synoptic and aviation codes. dynamical computations and familiarization in computers and their use for meteorological purposes.

Contents :	**Lecture hours**
Computation of : Coriolis parameter. Geostrophic wind. Gradient wind. Thermal wind. Divergence. Vorticity. Vertical motion. Deformation	8
Study of report of surface observation from a land station.	8
Study of surface observation from a sea station.	8
Coding and Decoding of surface report from a land station.	8
T-q gram	8
Detailed study of Aviation routine weather report and Aviation selected special weather report. Coding and decoding of METER and SPECI.	6
Study of upper wind report from land station (PILOT).	6
Study of upper level pressure, temperature. humidity and wind report from land station.	6
Plotting of TEMP and PILOT data.	6
Plotting TEMP data on pseudo adiabatic chart.	6
Study of terminal Aerodrome forecast (TAF) Code.	6
Analysis of surface and upper air plotted charts.	12

Introduction to micro computers : Hardware, Input device; Central Processor; Output devices; Software; System Software; Application software 3

Introduction to disk operation system (DOS) : Resident commands; Copy; Dir; Del; Type; MD/CD/RD, External command; Edit; Xcopy; Diskcopy; Format; 3

Program development for meteorological application : FORTRAN statements. Flow Chart, IF.....ELSE.....,
DO.....CONTINUE..... READ.....WRITE FORMAT DIM, DATA etc. 14

Basic programming language : Concept; Flow chart; Command; Rem; Print; if.....ELSE; For.....NEXT; DIM 10

Text Books :

1. WMO No. 261 - *Problems in Dynamic Meteorology*, World Meteorological Organization, Geneva, Switzerland. 1970.
2. WMO No. 364 - *Compendium of Meteorology for use by class I & II Met Personnel Part III Synoptic Meteorology (Vol. I) Vol. II Aeronautical Meteorology*. World Meteorological Organization, Geneva, Switzerland. 1978.

(a) Hydrology

Course No. : Met 331 (major) Full Marks : 100

Nature of the course : Theoretical Pass Marks : 35

Year : III

Course objectives

- Due to rapid growth in the world's population, the importance of water resources is increasing very rapidly. The course is designed to acquaint the students with the development of a nation with water resources as it is equally important for industrial production, generation of hydropower, irrigation and drinking purposes for human beings and animal kingdom. The students will be able to estimate the maximum probable floods that may occur at a given site and its frequency is required for the safe design of reservoirs drains, bridges and culverts, the maximum intensity of storm and its frequency are needed for the design of a drainage project; Estimation of water yield from a basin, its occurrence, quantity and frequency etc., ground water development are the areas for which the hydrology knowledge is essential.
- adopt techniques in measurement of hydrological parameters both by classroom lectures and field experiments.
- Plan and manage reservoirs on the rivers for irrigation and power generation by having a qualitative and quantitative knowledge of the perennial rivers of Nepal like Koshi, Gandaki and Karnali which originate from Himalayas and are fed by vast areas of snow and ice.

Contents : **Lecture hours**

Introduction to Hydrology : Definition and scope. Importance of hydrology. hydrologic cycle. History of hydrology. applications of hydrology. 2

Catchment characteristics : Drainage shape. slope. altitude: hydrometric curve. stream length. catchment area: drainage pattern. density and stream order 3

Precipitation : Forms and types. causes. recording and non-recording rain gauges. errors in measurement. sites: average. depth calculation with different methods and merits and demerits. network density: adjustment of missing data and interpretation. mass curve. hytrograph. depth area duration. 7

Infiltration : Factors affecting infiltration. measurement: infiltration equation. and indices: capacity. infiltration process. 5

Water Losses : Classification of water loses. evaporation process. factors affecting evaporation. estimation. measurement. reduction of evaporation. interception. depression storage. transpiration and factors affecting transpiration. 6

Runoff : Sources of runoff. factors affecting runoff. computation of runoff. rain fall-runoff correlation. runoff characteristics of streams. 5

Hydrographs : Components of hydrograph and seperation: effective rain-fall: unit hydrograph. and theory: assumptions. use and limitation of Unit Hydrograph 7

Ground water : Definition. occurrence. type of acquifers. coefficient of transmissibility and permeability. Davey's law its range validity: and field measurement of permeability. 6

Hydrometry Basics and applications : Definition and scope of hydrometry. History of hydrometry in Nepal. and application of hydrometry in Engineering field 1

Stage Measurements : Site selection. measurement of stage. recording and non-recording gauges. water level recorder : Float and pressure type: Stage gauging with data logger system. crest gauge and its importance. bench mark. vertical and inclined gauge. sectional gauge. flood mark. 7

Site Survey : Equipment. selection of site. longitudinal and cross section survey ; leveling. layout plan preparation. 3

Velocity Measurement : Elementary hydraulics relating to discharge. velocity. slope. cross section area. roughness coefficient site selection: equipment for velocity measurement: floats. current meter. calibration and maintenance of equipment: wading method. cable way measurement. errors. measurement in vertical sections: average velocity calculation. 7

Calculation of Discharge : Area velocity method. arithmetical and graphical methods. dilution method

Indirect Method of Discharge Measurement : Field survey. slope area method. indirect method with structures and culverts. 4

Stage Discharge Relations : Various relations: stage discharge. controls: graphical plots. extrapolation and inter-polation. estimating missing data. 4

Flow Measuring Structure : Uniform and non-uniform flow: wiers. rectangular. trapezoidal and triangular. parshall flumes. 4

Sediment Discharge Measurement : Site selection. Sampling instruments. Measurement of suspended and bed load. 4

Water quality : Analysis for major ions, water pollution. Instruments used, water quality requirements for industry domestic and agriculture. 3

Snow Hydrology : Introduction, Snow and its classification, Distribution of snow, Ripening of snow, properties of Snow. 3

Measurement of Snow, Precipitation gauge : (a) standard and recording rain gauge (b) Seasonal storage precipitation; Snow boards, snow stakes; snow pillow; Determination of water equivalent of snow and instrument used. 7

Snow Survey : Snow course and snow survey; Areal extent of snow cover, Application of remote sensing 7

Snow Melt and Snowmelt runoff Processes : Source of energy for Snowmelt, (a) Radiation, (b) Sublimation, (c) Heat exchange; Snowpack characteristics, (a) Metamorphism of Snow and its type, (b) Stratification of Snowpack; site condition; Rainfall; Estimation of Snowmelt 10

Computation of Runoff from Snowmelt : (a) Seasonal water yield forecasting, (b) Runoff forecasting in river regulation, (c) Design flood due to snow. 7

Glacier Hydrology : Introduction; definition of the terms and source of glaciers; Glacier observations, Glacier inventory; Glacier classification, glacial level, Snow line.

Snow accumulation on glacier : (a) Snow observation and measurement technique (b) Accumulation Zone - Determination of previous year's net Snow accumulation, (c) The glacier ablation zone 10

Glacier Characteristics : Glacier mass balance and glacier variation; Glacier movement, erosion and sediment production. 7

Glacier Lake and it's Outburst Flood (GLOF) : (a) stability of glacier lake and mechanism of outburst from glacier lake (b) Glacier lakes of Nepal (c) Sedimentation in a glacier lake (d) Methods of Presentation of GLOF 7

Text Books

1. Ven Te Chow, Chief Ed. - *Handbook of Applied Hydrology*, McGraw Hill Book Co., New York.
2. M. Gunnel and M.J. Clark - *Glacio Fluvial Sediment Transport*, John Wiley and Sons, New York.

Reference Books

1. Linsley et.al. - *Applied Hydrology*, Tata McGraw Hill, New Delhi
2. Hersehy - *Hydrometry Principles and Practicalities*, Wiley
3. WMO Number 168- *Guide to Hydrological Practicalities Vol. I.*
4. Rantz et. al. - *Measurement and Computation of Stream flow Vol. 2*, Paper 217; U.S. Govt. Printing office, Washington D.C., 20402.
5. Meinzer - *Hydrology*.
6. किरण शंकर- *जल विज्ञान*
7. Linsley et al. Raghunathan - *Hydrology for Engineers*, McGraw Hill, New York, 1975.
9. Todd - *Ground Water Hydrology*, John Wiley
10. Bruce and R.H. Clark - *Introduction to Hydrometeorology*, Pergument Press

11. S.I. Solomon and I. Cordery - *Compendium of Meteorology*, NOC II, Par 5, Hydrometeorology W.M.O. No. 364
12. John Store and W.P. Cross - *Elements of Applied Hydrology*, The Ronald Press Co. New York.
13. Nemer - *Engineering Hydrology*, Tata McGraw Hill, New Delhi
14. Corps of Engineers - *Snow Hydrology*.
15. Peterson - *Physics of Glacier*.

(b) Applied Meteorology

Course No. : Met 332 (major)
Nature of the course : Theoretical

Full Marks : 100
Pass Marks : 35
Year : III

Course objectives :

- Air pollution meteorology is concerned with the fate of atmospheric pollutants once they are emitted into the atmosphere and address natural releases, deliberate industrial emissions and accidental pills.
- If the environment was a static entity, estimates of pollutants would be sufficient to define future trend. However the natural environment is undergoing continual evolution and it is important to identify existing trend so that pollutants can be accounted for in predicting likely future air quality. Keeping this in view, this course has been developed to provide clearly understanding to the students how atmospheric constituents is effected by continuous, dynamic change with vast quantities being added to or removed from the atmosphere by various natural and industrial processes and in developing ways of predictions the pollutants. Also predictions are addressed through the impact of pollutant on the environment in defining air -quality indices that act as a guide to both natural and induced changes.
- Understanding the physical principles of meteorological parameters such as radiation, temperature, precipitation, etc. together with the understanding of life processes of plants and animals in relation to meteorological variables, is of primary importance in the process of food supply. By understanding the relationship between weather and crop yield, it is possible to predict crop yield in advance. It may also provide information about the climatic potential of an area and hence it can be used to maximize its potential. Artificial modification of climate inside a greenhouse to introduce new varieties of agriculture is another important field of modern agro-meteorology. The prime objectives of the course are to highlight these aspects.

Air Pollution : Introduction 1

The atmospheric boundary layer : Solar radiation; terrestrial radiation, Soil temperature, Air stability; Local wind structure; the logarithmic profile : the

Ekman Spiral, turbulence: statistical methods: Boundary - layer scaling. 6

Pollutants and their Properties : Sources and emission of air pollutants: Residence time and reaction rates: sulphur compound: Nitrogen and carbon compounds: Organic Compounds : Aerosols and their properties. 7

Environmental Monitoring and Impact : Network design: meteorological monitoring: Pollutant monitoring: Pollutant effects on plants, human beings and materials. Pollutant indices. 7

Dispersion of Pollutants : Turbulent gradient transport, statistical theories of turbulent diffusion. Gaussian plume model and its applications 4

Air Pollution Climatology : Spatial and transport variations of meteorological parameters including inversions mixing depths, ventillation coefficient etc. 3

Meaning of Agricultural Meteorology : Back ground: Introductory plant physiology and Animal Physiology: Natural plants and wild life: Influence of weather on agriculture: Long-term and short-term effects and growth. Land use strategy and Agro-climatology. 9

Climatological Factors affecting Agriculture : Radiation: Temperature: Moisture: Wind etc. 3

Agricultural Meteorology Plant growth : Seed germination: Pollination: Crop development and Growth: Crop pests and diseases 5

Agricultural Meteorology and Soil : Soil condition and drainage: Fetilizers: Mulches 4

Agricultural Climate : Rice, Wheat, Corn, Soyabean, Tomato, Apple, Sugarcane, Tea and Coffee 5

Weather and Plant Diseases : Weather and pathogens: weather and the host: Forecasting disease development 5

Text Books :

1. Boubel, Richard W. & Others - *Fundamentals of Air Pollution*, 3rd ed., Academic Press, New York, 1994.
2. Smith, Lionel P. - *Methods in Agricultural Meteorology*.

Reference Books :

1. Perkin, C. Henry - *Air Pollution*.
2. Davidson & Bryant - *Air Pollution Physical and Chemical Fundamentals*.
3. Tom Lysons & Bill Scott - *Principle of Air Pollution Meteorology*.
4. Ed. David H. Slade - *Meteorology and Atomic Energy*.
5. Stern - *"Air Pollution"* (Ed.), Academic Press, New York.
6. Chang - *Agriculture Meteorology*
7. Landsberg - General Climatology
8. *Guide to Agricultural Meteorological Practices*, Lo. Mo. 134, WMO, Geneva
9. Vitkerich - *Agricultural Meteorology*, Israil Programme for Scientific Translation Jerusalem
10. Slatyer - *Plant - Water relationships*, Academic Press, New York

11. William P. Lawry - *Weather and Life.* An Introduction to Biometeorology. Academic Press Inc.

(c) Hydrology and Surveying Practical

Course No. : Met 333 (major) Full Marks : 100

Nature of the course : Practical Pass Marks : 35

Year : III

Course Objectives

- The students will be able to : analyse rainfall, depth area duration etc. plot on given maps, graphically represent collected data, interpolate data for prediction, measure various parameters, survey using various techniques and instruments, use contour maps etc., apply remote sensing techniques to land use, glaciers, land features, drainage systems, cloud patterns and types.

Contents : **Lecture hours**

Surveys : Basics 1 : River profile. 2. Cross section profile. 3. Velocity measurement by (i) float (ii) Currentmeter. 4. Discharge calculation 15

Rainfall analysis :

Practical Number 1 : Double mass curve analysis 3

Practical Number 2 : Isohectal and thiessen polygon plotting on a map. 6

Practical Number 3 : Calculation of mean precipitation depth by isohectal. Thiessen and A.M. Methods 6

Practical Number 4 : Depth area duration analysis 6

Practical Number 5 : Missing data interpretation 6

Infiltration :

Practical Number 4 : Ring infiltrometer data analysis 6

Runoff Different methods of base flow separation. Unit hydrograph analysis with given data 6

Statistical analysis : Regression analysis. Optimization of number of rain gauges. Statistical analysis for recurrence interval (return period) of storm (Simple methods like Californian etc.) 4

Hydrometry

Discharge calculation : Cross section profile with given data. Cross section area with given data. Measurement of velocity with current meter data. Measurement of discharge. Stage-discharge velocity, Graphical and logarithmic extension. Survey with given data. Bearing and coordinates of location points. 6

10

Surveying :

Practical Number 1 : Fundamental concepts and principle of surveying.

Practical Number 2 : Sources of error and types of errors for surveying.

Practical Number 3 : Different methods of linear measurement chaining on uneven or sloping ground and errors in chaining, tape corrections

Practical Number 4 : Basic problems in chaining and plotting a chain survey.

Practical Number 5 : Introduction of bearing and angles. The theory of magnetic compass

Practical Number 6 : Working operation of plane table surveying and errors in plane tabling.

Practical Number 7 : Theodolite, use of a theodolite. Measurement of horizontal and vertical angles and source of errors in theodolite work.

Practical Number 8 : Method of leveling, theory of direct leveling (spot leveling), errors in leveling

Practical Number 9 : Reduction of levels be done by rise and fall and height of collimation method.

Practical Number 10 : Use of contour maps, contour interval, characteristics of contours and interpolation of contours.

Remote Sensing Practicals : (a) Introduction to remote sensing and its importance. (b) Application of stereoscope to determine the land features. (c) Identification of glacier area. (d) To delineate land use pattern (e) To delineate drainage system. (f) Study of cloud types with the help of instrument. 6 × 3

Text Books :

1. R. Varshey - *Engineering Hydrology*. Chand Printing Co., Roorkie
2. Thomas M. Lillesand and Ralph W. Kiefer - *Remote Sensing and Image Interpretation*. John Wiley and Sons Inc.

Reference Books :

1. J. Nemec - *Engineering Hydrology*. McGraw Hill. New Delhi
2. Lineley et al. - *Applied Hydrology*. Tata

6. Microbiology

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	Total Marks
First Year	MB. 311 (Major/Minor)	100	MB. 312 (Major/Minor)	50	150
Second Year	MB. 321 (Major/Minor)	100	MB. 322 (Major/Minor)	50	150
Third Year	MB. 331 (Major) MB. 333 (Major)	100 100	MB. 332 (major) MB. 334 (Major)	50 50	300

(a) General Microbiology

Course No. : MB 311 (Major/Minor) Full Marks : 100
Nature of the course : Theory Pass Marks :35
Year : I

Course Objectives :

The main objectives of the course are to give the students general knowledge and practical skill about

- The concept of the microbial world

- The nomenclature of microbiology
- The fundamental techniques of handling microbes and
- The characteristics. Physiology. generities and ecology of mirobes.

Contents

1. **Chronological development of microbiology and discovery :** Introduction. Microorganisations as a cell. General history of Microbiology and Microorganisms. Microbial diversity. Discovery of Microorganisms. Spontaneous generation. Germ theory of diseases.
2. **Correlate Microbiology with different areas :** Discipline of Microbiology. Introduction. Medical and public health microbiology. Agricultural microbiology. Food Microbiology. Mirobial biotechnology. industrial and environmental microbiology.
3. **Nomenclature of microorganisms :** Classification and Nomenclature.
4. **Physiology of bacteria :** Introduction. Morphological characteristics and the fine structure of bacteria. Nutrition. reproduction and cultivation.
5. **Fungus :** Fungi. Classifications. Structure. Growth and reproduction. fungi of medical importance.
6. **Introductory Parastitology :** Protozoan. Structure and reproduction. Nematodes. structure and its role in agriculture.
7. **Microbial techniques :** Bacteria. Introduction. Types of microscope. Types of culture medium. Types of microorganisms including anaerobic Bacteria.
8. **Handling Micro-organisms :** Aseptic techniques during the handling of microorganisms. Isolation and identification of microorganisms (Bacteria, Fungi and Viruses). Enumeration and counting of micro-organisms.
9. **Methods of sterilization :** Introduction. Principles of sterilization. Control of micro-organisms by temperature (high and low temperature). Irradiation. Ultrasonic. Filteration. Chemical agents.
10. **Physiological characteristics of microorganisms :** Introduction. Growth of microorganisms (growth curve). factors affecting the growth of microorganisms. Essential nutrient. Including carbon. nitrogen. mineral and other sources of vitamin. Temperature. Water activity. Salinity. pH. Gases. CEC.
11. **Biochemical properties of microorganisms :** Nutritional Types. photolithotrophic. chemolithotrophic. photorganotrophic. chemo-organotrophic. Microbial Energetic. carbon metabolisms (general concept of glycolysis and TCA cycle). ATP generation. Fermentative pathways.
12. **Microbial genetics :** Introduction. Prokaryotic genome. Genetic code. Plasmids. Recombination of gene. Mutation. Auxotropic mutation.
13. **Ecological factors in the microbial world :** Introduction. Ecological concept. Microbial interactions and symbiotic relationship. Normal

microbial flora of animals and plants. Microbial flora of aquatic and terrestrial environment.

(b) General Microbiology

Course No. : MB 312 (Major/Minor)
Nature of the course : Practical

Full Marks : 50
Pass Marks : 20
Year : I

Contents

1. **To identify role of microscope and operate it scientifically :** Introduction of microscope. Type of microscope. Use of microscope in microbiology. numerical aperature. resolving power.
2. **To list the application of equipment in microbiology for sterilization :** Structure and method of working of : Hot air oven, Autoclave. Inculator, UV-safety hood. Steam sterilizer.
3. **To prepare and use different stains :** Doner stain. Gram's stain, Methylene blue stain. Ziehl Neelson stain. Nigrosin stain.
4. **To perform the biochemical tests and make use of them :** Bio-Oxidation : Sugar fermentation. MR tests. VP test. catalase test, oxidase text. Nitrate test. Hydrolysis tests. starch hydrolysis. fat hydrolysis. Tryptophane hydrolysis.
5. **To prepare various culture media :** Basic media. Synthetic media. Differential media. Enriched media. Enrichment media.
6. **To identify the bacteria :** Introduction. Methods and approach to identify the bacteria.
7. **To obtain the pure culture :** Growth and reproduction. Plate culture. Streaking Plate. V Tube Technique. Serial dilution method. (Pour Plate technique). Quantitative estimation of growth.
8. **To detect the factors affecting microbial growth :** Temperature. Atmospheric pressure. Hydrogen ion Concentration (pH). Miscellaneous physical requirement i.e. light and salt.
9. **To identify various medical and agriculture importance of fungi elements :** Introduction. Classification : Morphology. Collection of sample. Culture techniques. identification.
10. **To measure the Bacterial growth :** Determination of cells : Breed method. counting chamber. proportional count method. Plate count. Membrane filter count. Turbidity measurements.
11. **To calculate the size of microorganisms :** Micrometry technique.
12. **To detect the oligodynamic effect of metal and the effect of UV. light on bacterial growth :** Effect of metal on bacterial growth. Effect of U.V. light on growth.

To distinguish the growth characteristics of anaerobes. Introduction of anaerobic bacteria and growth characteristics. Methods of cultivation. antibiotics and growth inhibition.

Text Book (MB 101 & 102) :

1. Harold. J.B. Microbiological Application : A Laboratory Manual is general Microbiology. W.C. Broom Com. Publishers (1979).
2. Brock. T.D. Smith. T.W., Modigan M.T., The Biology of Microorganism. Prentice Hall 1970.

Reference Books :

1. Atlas. R.N., Microbiology : Fundamental and application. Mcmillan. Co. 1984.
2. Michael. J.P., J.P.E.C.S. Chan N.R. Kriej. Microbiology. Tata McGraw Hill (5th Ed.). 1993.

(a) Microbial, Biochemistry and Biotechnology

Course No. : MB 321 (major/minor) — Full Marks : 100

Nature of the course : Theory — Pass Marks : 35

Year : II

Course Objectives (MB 321 & 322)

The main objectives of this course are :

- to give the students basic knowledge and practical skills related to
- living cell and its functions.
- macromolecules of livings
- concept of biotechnology and genetic engineering.

Contents :

Living cell and understanding of its biochemical functions : Introduction to biochemistry : Origin of biochemistry and its relationship with other sciences. Biochemical explanation of living things. The elements of life: Chemical elements present in living organisms. Organic compounds found in living cells. Water : the solvent for life. Cell biomembranes - structure and functions. 14

Macromolecules of living cells : Molecular components of micro-organisms. Carbohydrates : introduction. functions. classification. structure. important properties. Lipids : introduction. functions. classification. properties and reaction. Proteins. aminoacids and enzymes : name and functions. structure and properties. Nucleic acid. structure and definition. types of nucleic acids : synthesis of nucleic acids. functions of nucleic acids. 18

Methods of microbial metabolism : Concept of exergonic and endergonic reactions. Heterotrophic and autotrophic metabolism. Role of ATP intermediary metabolism. Heterotrophic generation of ATP in various pathways. Lipid metabolism. 16

Microbial genetics : Different types of genetic materials. structure. transcription and translation. regulation of gene expressions. genetic code. 20

Concept of biotechnology : Definition and history. Scope and importance. Risk and hazards of biotechnology 18

Fermentation process : Introduction. Solid state Fermentation. Submerged state fermentation. Fermentation industries. beer. ethanol. acetic acids. Fermentor designs. 14

Agricultural microbial biotechnology : Introduction. Biofertilizer and composting. Plant tissue culture. Micropagation and disease free plants. General concept of cell fusion and embryo transfer. Mushroom culture. 8

Biotechnology in dairy industry : Cheese production. Others milk products. sour milk. dry powder milk. 10

Methods in genetic engineering : Introduction. Technique of gene manipulation. Outline of gene cloning. Gene cloning procedure. Achievement and prospect of genetic engineering. 12

Enzyme technology in various areas : Introduction. Source of enzymes. Selection of source of enzymes. Advantage of microbial enzymes. 16

(b) Microbial, Biochemistry and Biotechnology

Course No. : MB 322 (major/minor) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : II

Contents :

To prepare the solutions of different concentrations : Molar solutions. Normal solutions. ppm (part per million) solutions. 3

To calculate the value of various solution : Measurement of pH by pH meter and indicators (papers). Preparation of acetate. phosphate and citrate buffer of different pH. 3

To perform the qualitative and quantitative estimate of various tyes of carbohydrates : Benedict test (for reducing sugars). Hydrolysis test (for di and polysaccharides). Iodine test for starch. Quantitative estimation of reducing sugars by DNS (3.5 dinitrosalicylic acid method). 3

To estimate the lipid types : Determination of the acid value of fat. Saponification value of fat. The iodine number of fat. Estimation of blood cholesterol. 3

To estimate the protein : Ninhydrin reaction. Biuret reaction. Xanthoproteic reaction. Caesin test in milk. test for tyrosine. tryptophan and arginine. test for sulphur containing amino acids. Heat coagulation test for egg albumin. Quantitative estimation of amino acids by using ninhydrin reactions. 3

To analyse the different enzymes qualities : Amylase. sucrose. Carboxylase. protease. Lipase. Phosphatase. lactase. 3

To use the different instruments and techniques for biochemical analysis : Separation of amino acids by paper electrophoresis. Identification of sugars by thin layer chromatography (TLC). Separation of lipid by thin layer chromatography (TLC). Separation of amino acids by paper chromatography. 3

To detect the pathogenic and symbiotics micro organisms from various plants and their products : Diagnosis of citrus virus by ELISA. Rhizobium inoculation

in different leguminous plants, Production of potato seedling by tissue culture technique. Isolation of mycorrhiza from different plants. 3

To apply fermentation technology : Isolation of Methanogenic bacteria from rumen, Study of fermentation yield, by substrate variation method, Food and Beverage industries. 6

Text Book (MB 321 & 322) :

1. Wood, E.J. and Rickerring, W.R., *Introducing Biochemistry and Biotechnology*. ELB Publication (Latest Publication).

Reference Books :

1. Rao, K. Ragunathan. *Textbook of Biochemistry (3rd Ed.)*. Prentice Hall of India, 1986.
2. Rao, R.A. v. SS. *A Text Book of Biochemistry*, UBSPD Co. 1993

(a) Agriculture and Food Microbiology

Course No. : MB 331 (major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Course Objectives (MB 331 & 332)

The objectives of the course are

- to give the students basic knowledge of theory and practical skills related to :
- different types of soil and their constituents
- the role of micro-organisms in soil fertility
- the role of various mineral cycles of nature
- various microbes found in different kinds of food.

Formation of soil : Physical factors. Chemical factors. Biological factors. 6

Soil and its constitutions : Mineral matters. Organic matters. Soil solution. Gases. 8

Discrimination of micro-organisms and their roles : Bacteria. Fungi. Actinomycetes. Protozoa. Blue-green algae (cyanobacteria) 10

Rhizospheric and phyllospheric microorganisms : Introduction. Role of crop production. Factors influencing their growth and activities. 12

Role of different microorganisms : Introduction. Nitrogen cycle, ammonification, nitrification, denitrification. Carbon cycle, organic matter decomposition, recycling of organic wastes. Phosphorous solubilisation mineralization, inorganic phosphorous, organic phosphorous, Sulphur cycle, mineralization, microbial assimilation of Sulphur, oxidation of sulphur, reduction of inorganic sulphur compounds. 19

Anaerobic decomposition and mechanism of methane production and application : Anaerobic decomposition of organic compounds. Mechanism of methane production. Digested slurry as manure. 10

Micro-organisms in various foods : Bacteria. Molds. Yeasts. Primary sources of micro-organisms in food contamination. 14

Techniques used for the determination of micro-organisms in food : Techniques of demonstration of micro-organisms in food. Sampling methods (various food industries. dairy market. meat market). Culture. 10

Factors affecting the microbial growth (intrinsic and extrinsic) : Intrinsic parameters. Extrinsic parameters. 6

Food handling & spoilage : Different types of food handling in industries and market. Spoilage of : Fruits and vegetables. Fresh and processed meat and poultry product. Egg and egg products. Milk and milk products. Canned foods. Flour cereals and bakery products. Fermented foods. Soft drinks. 22

Food preservations : Chemical. Irradiation. Low temperature. High temperature. Drying.

Foods quality evaluation : Quality standard of milk. Quality standard of bakeries. Quality standard of meat and eggs., Quality control of food. 10

Role of micro-organisms in food poisoning : Gram positive cocci *(Staphylococcus spp.)*, Gram positive spore formers *(Clostridium spp.)*, Gram negative bacteria *(Salmonella spp.)*. 10

(b) Agriculture and Food Microbiology

Course No. : MB 332 (major) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : III

Microorganisms present in soil : Total viable number of bacteria. Fungi, Actinomycetes in diff. kinds of soil. 3

Burried slide technique for microbial flora of soil : Different types of micro organisms in soil. Identification of microbes by using various techniques. 3

Azotobacter : Introduction. Morphological Structure. Culture of Azotobacter. 3

Rhizobium : Morphological Structure. Cultural properties. Methods of isolation and identification. 3

Cellulolysis Produced by organisms : Demonstration of cellulolysis. Use of cellulolysis. 3

Mircro organisms from Biofertilizers : Isolation and identification of Organisms responsible for formation of fertilizers. 3

Distincition of various organisms present in soil : Demonstration of winograskys column. Uses of column in differentiation of microbial ecology. 6

Discrimination of various organisms from soil samples : To show the distribution of organisms, their methods of isolation and antibiotic activity. 3

Cyanobacteria : Isolation. growth characteristics. Identification. 3

Phosphorus Solubilisers : Methods of culture. Identification of solubilisers. 3

Count of micro-organisms in different foods : Methods of isolation and counting technique of bacteria from various foods. 3

Dairy products milk, cheese & ice-cream : Culture of organisms. Detection and demonstration of micro organisms.

Reduction test in milk : MBRT test 3

Presence of micro-organisms in meat and meat products : Isolition and identification of types of organism in meat and meat products. 3

Microorganisms present in fruits : Culture of micro organism in fruits (their types). Methods of identification.

Text Books (MB 331 & 322) :

1. Jay, J.H., *Modern Food Microbiology (3rd Ed.)* CBS. Pub. & Distributors, Delhi. 1987
2. Martin Alexender, *Introduction to Soil Microbiology*, Academic Press. 1961.

Reference Books :

1. Rangaswami, G., Bagyaraj, P.T., *Agricultural Microbiology (2nd Ed.)*, Prentice Hall of India, 1993.

(c) Medical and Environmental Microbiology

Course No. : MB 333 (major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Course Objectives (MB 333 & 334)

The main objectives of the course is to give knowledge on :

- the microbial world in the human body
- the methods of transmission of microbes
- the process of immunizations and laboratory biosaftey
- microbes and its environments

Contents :

Historical background of medical microbiology : Historical aspects of medical microbiology and various diseases process. 4

Bacterial flora of the human body : Study of microorganisms from skin Gastrointestinal tract. Respiratory tract. Commansals. Symbiotic. Opportunistic. 10

Methods of transmission of diseases : Explanation of : Epidemic. Endemic. Pandemic 8

Types of infection : Mechanism of infection. Host parasite interaction. 6

Immunity process : Types of immunity. Immunoglobulins and their types. Antigen Antibody reactions. Auto immune disease. Hyper sensitivity. Acquired immune deficiency syndrome (AIDS). 27

Safety measures in clinical laboratory : Principles of laboratories safety. Decontamination and disposal of infected materials. 4

Importance of antibiotic and chemotherapeutic agents in clinical microbiology : Types of antibiotics. Chemotherapeutic agents. Mode of actions. 6

Methods of specimen collection, transportation of medical samples or specimen : Cerebrospinal fluid. Blood sputum. urine and other body fluids. Discharges and Pus. 6

Method of collections of viral samples : Introduction. Types of viral samples. Maintenance of temperature and transportation. Identification and interpretation. 6

Common pathogenic viruses : Mumps, Measles and Polio. Influenza. Rabies. Human immune deficiency virus. Viral culture. 8

Sample collection and lab diagnosis of nicotinic infections : Samples. Nasal Swab. Skin scrapping. Other samples. 9

Medically important fungi : Introduction, Classification, Morphology. Basis of growth. 9

Microbial ecology : Microbial association of soil. water and air. 6

Aquatic microbiology : Introduction. Types of water, Characteristics of water. 6

The water quality basis : Water quality criteria. Source of water pollution. Water pollution control. Water treatment. Control of water-borne diseases. 12

Industrial effluent : Introduction. Industrial pollution. Domestic sewage and microbiology of sewage. Methods for the treatment of industrial effluent and Sewage. 12

Microbial air pollution : Introduction. Methods of measuring micro-organisms in air (indoor and outdoor). Air-borne diseases. Air-pollution control. 9

(d) Medical and Environmental Microbiology

Course No. : MB 334 (major) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : III

Contents :

To interpret safety precautions in medical micro-biological laboratories: Demonstrate safety precautions to be taken in the laboratories. 3

To prepare the reagents for staining : Preparation of reagents for staining Gram's staining. Ziehl Neelson, Albert stain. 3

To illustrate different staining procedure : Gram's staining. etc. 3

To categories different cultural media : Preparation of media. Nutrient Agar. Blood Agar. Mac Conkey Agar. 3

To illustrate the inoculation and biochemical tests of bacterial culture : M.R. Test.. V.P. Test. Citrate test. Urease test. SIM test. Indole test. 3

To discriminate different types of bacteria from biochemical tests : Sugar test, Nitrogen test, Interpretation of the result after biochemical test. 6

To operate enzymatic test of the bacteria : To perfrom important enzymatic tests. coagulase test. Catalase test. Oxidase test. 6

To explain serological test on virus : ELISA test. Hemagglutination test. 3

To operate Nicotinic infection samples : Sample collection. skin scrapping. nail clipping. sputum. 6

To examine the fungal elements : Detection of fungal elements :. KOH preparation. Iodine preparation. India ink preparation. Lactophenol and cotton blue preparation. 6

To predict fungal culture media : Preparation of media : Sabouraud dextose agar. Potato dextrose agar. Malt extract agar. 6

To operate bacteriological examination of drinking water : MPN methods. MF methods. 6

To predict microbial and biochemical parameters of sewage : Perfrom microbial count. DO and BOD test. 6

To demonstrate water treatment station : Field visit to water treatment station. 3

To categorize the types of air pollution : Study microbes in Air. Class room. Laboratory. Public House. Factories. etc. 9

Text Book (MB 333 & 334) :

1. Monica. Chusbrough. Medical Laboratory Manual for Tropical Countries Vol. 2. ELBS London. 1984.
2. Michael J.P.. E.C.S. Chan and N.R. Krieg. Microbiology. 5th edition Tata McGraw Hill. Delhi. 1993.

Reference Book :

1. Grewwood. D.. Slack R.C.B.. Peutherer. J.F.. *Medical Microbiology* ELBS. With dunclude Livingstone.

7. Physics

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	Total Marks
First Year	Phy. 311 (Major /Minor)	100	Phy : 312 (Major/Minor)	50	150
Second Year	Phy. 321 (Major/Minor)	100	Phy. 322 (Major/Minor)	50	150
Third Year	Phy. 331 (Major) Phy. 332 (Major)	100 100	Phy. 333 (Major)	100	300

(a) Machanics I, Thermodynamics, Statistical Physics, Electricity and Magnetism

Course No. : Phy. 311 (Major/Minor) Full Marks : 100
Nature of the Course : Theory Pass Marks : 35
Year : I

Course Objectives :

At the end this course the students should be able:

- To acquire sufficient basic knowledge in Physics:
- To apply this knowledge base for studying major courses in Physics:
- To solve mathematical problems in related topics:

– To deduce mathematical equations and formulas.

MECHANICS I :

1. **Probability and Statistical Analysis of Data :** Concept of Probability. distribution function (Binomial. Normal and Possion). Systematic and random errors. Laws and errors. Standard errors. least square fit. Chi square. I and T tests. interpolation. numerical value.
2. **Momentum and Elastic Collisions :** Principles of linear and angular momentum. elastic and inelastic collision. Centre of mass of a system of particles.
3. **Gravitational Field and Potential :** Kepler's Law of planetary motion. gravitational field and potential. Gauss and Possion equations for gravitational field, gravitational self- energy. rocks-single and multistage. reduced mass, central forces.
4. **Rotation of Rigid Bodies :** Equation of motion for a rigid body. theorems of moment of inertia. M.I. of rectangular. cylindrical and circular lamina. spherical shell and solid sphere. energy of rotation.
5. **Oscillatory Motion :** Small oscillation in a potential well. harmonic oscillation equation and general solution. example of simple harmonic oscillation. spring and mass system. simple and compound pendulum. torsional pendulum bifilar oscillations. Helmholtz resonator. oscillation of two masses connected by a spring. normal modes. N coupled oscillators. damped and forced harmonic oscillator. power dissipation. quality factors. transient and steady states. power absorption.
6. **Wave Motion :** Particle velocity and wave velocity. equation of plane progressive wave. differential equation of wave motion. energy of progressive wave. transverse wave on string. longitudinal wave in rods and gasses. energy of stationary waves.
7. **Elastic Properties :** Inter–relation between elastic constants. coefficient of rigidity of a cylinder. bending moments. shearing forces. cantilever. supported beam.
8. **Fluid Mechanics :** Kinematics of moving fluid. Equation of continuity. Euler's equation. Bermoulli's theorem. Viscous fluids. stream line and turbulent flow. Poiseulle's law. and its application. Reynold's number.

THERMODYNAMICS :

9. **Thermodynamic Fundamental Concepts :** Thermodynamic systems. thermal and thermodynamic-equilibrium. equation of state. thermodynamics

processes. external and internal work. internal energy. quassi–statics. isothermal. adiabatic. isobaric and isochoric processes.

10. **Laws of Thermodynamics and their Application :** Zeroth law. first law of thermodynamics. second law of thermodynamics. Carnot's theorem. absolute scale of temperature. entropy changes in reversible and irreversible processes. principle of increase of entropy. entropy and second law. third law of thermodynamics and its applications.
11. **Thermodynamic Relations :** First and Second latent heat equation. Triple point. Thermodynamics potentials. Hemholtz's function. enthalpy. Gibb's function. Maxwell's thermodynamics relation. phase transition. Clausius Clapeyron equation.
12. **Concept of Ideal and Real Gases :** Concept of ideal and real gases. Joule expansion. Joule's law for perfect gas. Van der-Waal's equation. critical constant of Van der-Waal's gas. Joule- Thomson expansion porous plug experiment. constancy of enthalpy. adiabatic expansion.
13. **Production of Law Temperature :** Thermodynamics of refrigeration. refrigeration cycle. efficiency. cooling in joule-Thomson expansion. regenerative cooling. cascade cooling. Boyle's temperature. temperature of inversion. critical temperature and its application.
14. **Transport Phenomenon :** Molecular collisions. collision cross-section. molecular diameter. mean free path transport phenomenon. transport of momentum.energy and mass. Brownian motion. Einstein's theory of Brownian motion.
15. **Black Body Radiation :** Total energy density. spectral energy density. emissive power. absorptive power. Kirchoff's Law. Pressure of radiation. pressure of diffuse radiation. Stefan-Bolzmann's law. spectrum of black body radiation. Wien's displacement Law. Plank's Radiation Law. Rayleigh-Jean's Law.

STATISTICAL PHYSICS :

16. **Classical Statistical Physics :** Phase - space. microstate and macrostate. ensemble. constraints and accessible state. Zone thermodynamic probability. fundamental postulates of statistical mechanics. division of phase space into cells. entropy and probability. Boltzmann's Canonical Distribution law. Maxwell's Distribution law of velocities. Maxwell's Boltzmann statistics. Law of equipartition of energy.
17. **Quantum Statistical Physics :** Introduction. Bose-Einstein Statistics. Fermi-Dirac statistics gas in metals. Fermi level and energy.

ELECTRICITY AND MAGNETISM :

18. **Elementary Vector Analysis :** Gradieht. Divergence and curl of a vector in Cartesian. Polar and Cylindrical coordinates. Gauss's Stoke's and Green's theorems. Laplacian in polar coordinate system.
19. **Electrostatic Potential and Field :** Coulmob's law. the electric field. electric flux. Gauss's law and its applications. Equipotehtial surface. potential due to charge distribution. Poissons and Laplace's equations. Work done for a moving charge. Electrostatic energy. Electrical images. Potential and field due to an electric dipole and force on a charged sphere.
20. **Electrostatic Fields in Dielectric :** Polar and non-polar molecules, electric polarization. the displacement vector. Gauss's law for dielectric media. Force and energy in dielectric systems. Boundary conditions of D and E at the interface. Claussis Mossotti relation. Langevin Dehye Formula.
21. **Magnetic Fields due to Currents :** Sources of magnetic induction field. Biot and Savart's law and its applications. Lorentz force. Ampere's circuital law. magnetic vector and scalar potential, the magnetic dipole. surface current density.
22. **Magnetic Properties and Fields :** Magnetic dipole moment of current loop and angular momentum. magnetization. Langevin's theory of para and diamagnetism ferro magnetism. magnetic domain theory . magnetic susceptibility and permeability. ferrities.
23. **Interaction between Currents :** Current and distribution of current. Field and interaction of moving charges. force between parallel currents.
24. **Electromagnetic Induction :** Faraday's Law. self and mutual induction. search coil. Grassot's fluxmeter. earth inductor. energy stored in magnetic field transformer. its use and applications.
25. **LCR circuit Transients :** LCR circuits with AC and DC sources. phase diagrams. impedance. resonance. the quality factor. power factor.
26. **Maxwell's E.M. Equation :** The displacement current. Maxwell's equations and their use in propagation of electromagnetic wave. derivation of Gauss's theorems. Faraday's - Lenz bais law Biot and Savart's law, Ampere's circuital laws. energy of a charged particle in an electromagnetic field. general idea about reflection and transmission of electromagnetic waves at the interface between two media.

Text Book :

1. Mathur. D.S. : *Mechanics*. S. Chand and Co. Ltd. New Delhi. 1993.
2. Single S.S. Agrawal. J.P. and Prakash S.. : *Heat and Thermodynamics*. Pragati Prakashan. Meerut. 1990.
3. Reitz. J.R.. Melford. F.J. and Christy. R.W. : *Foundations of Electromagnetics*. Narosa Publishing House. New Delhi.

Reference :

1. Smith C.J. : *General Properties of Matter*. Radha Publishing House, Calcutta. Indian Edition. 1985.
2. Sears F.W. and Zemansky. : *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, Narosa Publishing House. New Delhi (Preprint 1993).
3. Smith. C.J., : *Electricity and Magnetism*. Radha CBS Publishers. New Delhi.
4. Reif. F., : *Fundamentals of Statistical and Thermal Physics*. McGraw Hill Publishing.
5. Huang, K., : *Statistical Physics*. Wiley Eastern.
6. Khandelwal D.P. : and Pande. A.K. : *Thermodynamics and Statistical Physics*. Himalayan Publishing House. Bombay.
7. Brijlal and N. Subrahmanyam. : *Heat and Thermodynamics*, S. Chand and Company Ltd., New Delhi.
8. Kittel and Koremer. : Thermal Physics, CBS Publisher, New Delhi.

(b) Physics Laboratory I

Course No : Phy 312 (Major/Minor)
Nature of the course : Practical

Full Marks : 50
Pass Marks : 20
Year : I

Course Objectives :

At the end of this practical course the students will be able :

- To relate theoretical concepts to practical skills.
- To perform laboratory work
- To perform major laboratory courses
- To set experiments related to physics
- To design laboratory experiments
- To draw conclusions from laboratory work
- To develop proper laboratory skills
- To interpret laboratory work results.

Experiments :

1. **Mechanics Experiments :** Determinations of moment of inertia of flywheel. – Determination of 'g' using bar pendulum/Kater's pendulum. – Determination of 'Y' by bending beam method. – Determination of surface tension of liquid by capillary rise method/ Jaeger method. – Determination of modulus of rigidity of wire by torsional pendulum/Maxwell's vibration needle. – Determination of coefficient of viscosity by Poiseulli's method.
2. **Thermodynamic Experiment Constant :** Determination of Stefan's constant. – Determination of the ratio of C_p and C_v by Clement and Desorme's method.
3. **Electricity and Magnetism Experiments :** Measurement of the sensitivity and constant of Ballistic galvanometer. - Measurement of high resistance by the method of leakage. - Measurement of low resistance by Carey Foster

bridge. - Determination of power factor of coil. - Determination of magnetic field using search coil. - Determination of dip using earth inductor. - Estimation of efficiency of transformer. - Measurement of impedance of inductor/capacitor circuit. - Measurement of impedance of LCR series circuit. - Measurement of capacitance by Ballistic galvanometer.

Text Book :

1. Arora. C.L. : *B.Sc. Practical*. S. Chand and Co.

PHYSICS : LIST OF EQUIPMENTS

Mechanics Experiments :

Phy. 312

1. **Moment of Inertia :** Flywheel. stop watch. venire callipers. weight box. threads. meter scale.
2. **Value of 'g' :** Bar pendulum. Stop watch. Kater Pendulum.
3. **Determination of 'Y' :** Bending Beam. Weights. Leclanche. Leclanche cell. galvanometer. venire callipers. connecting wires.
4. **Surface Tension :** Surface : Travelling Microscope. capillary tube. beaker, iron stand.
5. **Surface Tension (Jaeger Method) :** Jaeger apparatus. thermometer. glass tube. travelling microscope.
6. **Modulus of Rigidity (Torsion Pendulum) :** Teris pendulum apparatus weights.
7. **Modulus of Rigidity (Maxwell needle) :** Maxwell needle apparatus. screw gauge. physical balance. meter scale. stop watch.
8. **Coefficient of Viscosity (Poiseulli's Method) :** Poiseulli's apparatus.

Heat :

1. **Stefan's constant :** Stefans's Constant apparatus set.
2. **Determination of C_p and C_v :** Set of Cp and C_v measuring apparatus.
3. **Lee and Chalton's Method :** Set of bad conductor for conductivity measurement.

Electricity and Magnetism :

1. **Sensitivity and constant of Ballistic Galvanometer :** Ballistic Galvanometer. lamp and scale. iron stand, resistance boxes. standard cell. tapping key.
2. **High Resistance (leaking method) :** High resistance Galvanometer. high resistance, cells capacitor. key.
3. **High Resistance Carey Foster Bridge :** Copper strips. galvanometer. Meter bridge. ball low Transistor.
4. **Power Factor of coil :** A-C Ammeter (2 sets). A-C Voltmeter (2 sets). Rheostat (2 sets) fan. cells 1 Ω 2 Ω resistors.
5. **Magnetic field by search coil :** Electro magnet. Fluxmeter with search coil.

6. **Dip measurement by earth inductor :** Earth inductor. Ballistic galvanometer.
7. **Efficiency of Transformer :** Transformer. ammeter and voltmeter.
8. **Impedance of inductor / capacitor :** Inductors. capacitors. resistances. multimeters.
9. **Impedance of LCR series circuit :** Oscilloscope. signal Generator. resistances. capacitor. inductor. ammeters. voltameters.
10. **Capacitance by Ballistic galvanometers :** Ballistic Galvanometer. capacitors.

(a) Physics (Optics, Atomic and Nuclear Physics, Electronics)

Course No. : Phy. 321 (major/minor) Full Marks : 100

Nature of the course : theory **Year : II**

Course Objectives :

At the end of this course the students will be able :

- to acquire sufficient basic knowledge on such topics in physics as optics Atomic and Nuclear Physics and electronics
- to apply their knowledge to learning major courses
- to solve mathematical problems related to the topics
- to deduce mathematical relations and formulas.

Contents : **Lecture hours**

OPTICS :

Wave Nature of Light : Nature of light. Huygen's wave theory and its application for propagation of waves. 2

Aberrations at Spherical Surfaces : Refraction through spherical surfaces from Huygen's wave theory. chromatic aberrations: astigmatism. Coma. Curvature distortion and their elimination. Ramsden's and Huygen's eyepieces. 7

Interference : Condition for obtaining interference. spatial and temporal coherence. interference by division of wave front. Fresnel's biprism. Lloyd's mirror. Division of amplitude: thin and wedge films. Newton's rings. Michelson interferometer. Fabry Perot interferometer. Intensity distribution. Antireflection gratings. 11

Diffraction : Huygen's principle. Fresnel and Fraunhoffer diffraction. Fresnel's diffraction : Zone plate. Circular aperture. straight edge. straight wire. disc. Fraunhoffer's diffraction : Diffraction through a single and double slit. Circular aperture and disc. Dispersive and resolving power of grating. microscope and telescope. 12

Polarization : Unpolarized. plane. circular and elliptically polarized light. Double refraction. Crystal polarizer. Malus law. Brewster's law. polarization by

reflection and scattering. Double refraction and Huygen's explanation. Production and analysis of polarized light. optical activity Laurent's half shade polarimeter and its applications. 8

Dispersion and Scattering : Normal and anomalous dispersion. scattering of light. 2

Lasers : Spontaneous and induced emission. conditions for laser action. population inversion. optical punping. Ruby and He-Ne lasers and application. 4

Holography : Basic technique of holography. theory of holography. applications. 4

ATOMIC AND NUCLEAR PHYSICS I :

Nuclear structure : General background of structure of atom and nucleus. Rutherford scattering its conclusions. limitations of Rutherford model of atom. need for quantum idea. 4

Bohr's Atomic Theory : Bohr's hydrogen atom. energy level diagram and spectra of hydrogen atom. Franck-Hertz experiment and limitation of Bohr's model. 4

Sommerfeld's Atomic Model : Sommerfield non-relativistic atom. space quantisation. vector atom model. spectral terms arising from LS coupling and s. p. d. f. notation. Stern-Gerlach experiment. Pauli's exclusion principle. 5

Fine Structure Spectrum : Fine structure of Hydrogen lines. doublet structure of alkali spectrum. single and triple series of alkaline earth atoms. 4

Zeeman Effect : Normal and anomalour Zeeman effect for one electron system. 4

Characteristic X-ray Spectrum : Characteristic X-ray. X-ray Spectrometer. Fine structure of X-ray transitions. Mosley's law and its application. 4

Constituents of the nucleus : Proton-electron hypothesis and its failure. Proton-neutron hypothesis. Qualitative facts about. mass. charge. density. magnetic and electric properties of the nucleus. packing fraction. mass defect. binding energy. and its main feature. 6

Radioactivity : Basis of the theory of radioactive disintegration. half-life. mean life. successive radioactive transformations. equilibrium. natural radioactive series. units of radioactivity. Qualitative discussion of alpha. beta and gamma ray spectra. absorption of α particles. range. straggling and stopping power. theory of α decay. Neutrino hypothesis of β-decay. qualitative discussion of the theory of β - decay. 7

Interaction of Nuclear radiation with matter : Interaction of γ-rays with matter. absorption. photoelectric effect. compton scattering. pair production. measurement of γ-ray energies internal conversion. 6

Nuclear Detectors : Ionization chamber. G.M. Counter. scintillation counter. nuclear emulsion. Bubble chamber.

Accelerators : Cyclotron, synchrotron, synchrocyclotron, Betatron, Linear accelarator. 3

ELECTRONICS :

Circuit Analysis : Superposition theorem, Thevenin's and Norton's theorem and their applications, maximum power transfer theorem. 5

Characteristics of Diodes : Semiconductor, Different types of diodes, energy band in semiconductors, band gap, Diode characteristics, application of juction diode as half and full wave rectifier, bridge rectifier, filter (R - C filter), Zener diode as voltage regulator. 7

Bipolar Junction Transistors : PNP and NPN transistors, transistor characteristics in different modes, α and β of transistor, input and output characteristics of CB, CE and CC amplifiers, transistor biasing, Amplifier gain calculation, AC-input impedance of different configuration Q-point, Optimum Q-point, bias stabilization, stability factor. 12

FET and UJT : Field effect transistors, characteristics of FET, Unijunction transistor and its characteristics, FET as an amplyfying device with infinite input impedance, UJT as a relaxation oscillator. 5

Amplifiers : R-C amplifier, frequency response, power amplifier, overall voltage gain. 5

Operational Amplifiers : Principle of differential amplifiers, and operational amplifiers, transfer characteristics, inverting and non-inverting mode, common mode rejection ratio (CMRR). 4

Oscillators : Introduction of feedback and their types, negative feedback, positive feedback and Oscillators, Barkhausen criterion, working principle of Hartley, Colpitts and phase shift Oscillators, multivibrators. 6

Logic gates and Digital Electronic : Decimal and binary numbers and their interconversion, arithmetic and binary numbers, Boolean algebra and de-Morgan's theorem, AND, OR, NAND, NOR, NOT, X-OR and XNOR gates, Synthesis of gates to realise a Boolien equation, NAND gate as basic building block, RS, JK, D flip-flops, Half adders and full adders. 6

Text Books :

1. Subramanyamn, N. and Brij, L. : *Text Book of Optics*, S. Chand and Co., Ltd. 1994.
2. Wahr, Richard and Adir : *Physics of the Atom*, Addison Wesley.
3. Malvino, A.P. : *Electronic Principles*, Tata McGraw Hill publishing Co. Ltd. India.
4. Murugesan R : *Modern Physics*, S.Chand & Co. Ltd., New Delhi.

References :

1. Jenkins and White : *Fundamental of Optics.* McGraw Hill Hook Co. Ltd. Ny., 1957.
2. Theraja, B.L. : *Basic Electronics.* S.Chand & Co. Ltd. New Delhi.

(b) Physics Laboratory II

Course No. : Phy. 322 (major/minor) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : II

Course Objectives :

At the end of this practical course the students will be able :

- to relate theoretical concepts to practical skills.
- to perform prescribed practical works.
- to perform the major laboratory course.
- to set experiments related to the course.
- to design laboratory experiments.
- to draw conclusions from laboratory work.
- to develop proper laboratory skills.
- to interpret data from laboratory work.

Experiments : (150 hrs.)

Optics Experiments : Wave length determination by Newton's Rings method. Estimation of wavelength using Fresnal biprism.. Wavelength determination using Michelson interferometer.. Wavelength determination from diffraction due to a sharp edge.. Determination of width of a slit by diffraction method.. Wavelength determination using plane diffraction grating.. Estimation of resolving power of prism.. Determination of resolving power of plane transmission grating.. Determination of refractive index of prism for light of different wavelengths.. Determination of specific rotation of sugar solution using Laurentz Half-shade polarimeter.

Electronics Experiments : Verification of network theorems of Maximum power transfer/Thevin's/Norton.. Study of characteristics of junction and zener diode.. Study of characteristics of Bipolar transistors.. Calibration of CRO for the measurement of voltage and frequency.. Study of rectification characteristics of DC power supply.

Electricity and Magnetism Experiments : Series and parallel resonant circuits.. Time constants or RL, CR and LCR circuits.. Measurement of capacitance by AC Bridge (de-Sauty Method).. Measurement of inductance by Mawell's inductance-capacitance Bridge.

Text Books :

1. Arora, C.L.. *B.Sc. Practical.* S. Chand and Co.

(a) Solid State Physics, Nuclear Physics, Mechanics

Course No : Phy : 331 (major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Course Objectives :

At the end of this course the students will be able :

- to acquire comprehensive and indepth knowledge on major topics of physics.
- to solve mathematical problems related to the course topics.
- to deduce mathematical equations and formulas.
- to pursue higher courses in physics.

Solid State Physics :

Types and structure of crystals : The crystalline types of solid, amorphous and glassy, liquid states, lattice and lattice traslational vector, the basis and crystal structure, primitive lattice cells, fundamental lattices, two and three dimensional lattices, Miller indices, simple crystal structure. 8

Crystal structure from Diffraction : Electron, neutron and X-ray diffraction techniques for studying crystal structure, Laue method, Brillouin Zone, reciprocal lattice and conversion to different lattices. 4

Bonding in crystals : Equilibrium lattice constant, different types of bonding and lattice energy. 5

Defects in Crystals : Lattice vacancies, colour-centres, alloy, slip, types of dislocation, Burger's vector, dislocation and crystal growth. 5

Lattice Dynamics : Lattice vibration lattice specific heat, phonon spectrum, Dulong and Petits relation, Einsteins theory, Debye's theory. 5

Free Electron Theory : Free electron theory of metals, density of states, Fermi energy, electron specific heat, relaxation time, mean free path, mobility, thermal conductivity, electrical conductivity, Wiedmann - Franz law Hall effect. 5

Band Structure of Crystals : Concept of energy band in solids, valence and conduction band, distinction between conductor, insulator and semi conductors on the basis of band theory. 6

Properties of Semiconductors : Types of semiconductor (Extrinsic and intrinsic) and carrier concentration, mobility life time product, photo voltaic cell and its applications. 6

Super Conductors : Introduction to super conducting behaviour of materials, zero resistivity, critical temperature, Meissner effect. 4

Magnetism : Classical theories of magnetism, Approach to quantum theory of magnetism. 2

Nuclear Physics II :

Nuclear Forces : Nuclear binding energy and saturation of nuclear forces, nuclear stability, charge independence of nuclear forces, Two nucleon system deuteron problem. 8

Nuclear Reactions : Nuclear transmitation and discovery of neutrons. characterisation and Types of nuclear reactions. conservation theorems. Q-value. threshold energy cross-section of nuclear reactions. 8

Nuclear Reactors : Fission. multiplication factor. critical size. power of a nuclear reactor. classification of nuclear fusion reactors. Research and power reactors. Proton-Proton. chain. carbon-nitrogen cycle. controlled thermo nuclear reactions. 10

Nuclear Models : Assumption of liquid drop model of nucleus. semi-emperical mass formulas and significance of various terms. condition of nuclear stability. Expetimental evidence for nuclear magic numbers. elementary accounts of nuclear shell model. energy level scheme and explanations of magic numbers. prediction of shell model. 12

Cosmic ray and elementary particles : Discovery and properties of cosmic rays. elementary particles. Meson theory of Nuclear forces. classification of particles. types of interaction. Quantum number. Conservation laws. isospin. parity. parity violation in decay. charge conservation. symmetry. strangeness. hypercharge. Introduction to quarks and qualitative description of quark model. Interaction of quarks and leptons. 12

Mechanics II :

Motion in Central Field : Motion in Central force field. motion in arbitrary potential field. equation of orbits. Kepler's Laws of planetary motion. 8

Elastic and Inelastic Collision : Collision of particles. collision in laboratory and centre of mass systems. cross section. collision Rutherford scattering. 8

Lagrangian Formulation and Applications : Lagrangian formulation. constraints. generalized co-ordinates. D' Alembert's principles. Lagrange's equations. Kinetic energy. Laws of conservation of energy. cyclic co-ordinates. 8

Inertial frames : Moving co-ordinate system. translating and rotating co-ordinate systems. Coriolis force. Focault's pendulum. 6

Motion of Rigid Bodies : Motion of rigid body. Euler's theorem. angular momentum and kinetic energy. the inertiatensor. Euler's equation of motion. torque free motion. Eulerian angle. symmetrical top. 10

Relativity : Gallilean invariance. inertial frames of reference. Gallilean transformations non-inertial frames and fictious forces Michelson - Morley experiment. Lorentz transformation. length contraction. time dilation. transformation and addition of velocities. variation of mass with velocity. mass energy relation. relation between momentum and energy. transformation of energy and momentum. 10

Text Books :

1. Godstein. H. : *Classical Mechanics*. Narosa Pub. House. (Reprint). New Delhi. 1993.
2. Kittel : *Introduction to Solid State Physics*. John Wiley
3. Kaplan I. : *Nuclear Physics*
4. Mathur. D.S.. *Mechanics*. S. Chand and Co.
5. Kittel C. : *Solid State Physics* - Wiley Eastern.
6. Srivastava B.N. : *Basic Nuclear Physics*. Pragati Prakashan Merrut. India.

7. Murugesan R. : *Modern Physics*, S. Chand & Co. Ltd., New Delhi.

References :

1. Wagman. Y.R. : *Classical Mechanics*. Prentice Hall of India Pvt. Ltd., New Delhi. 1990.
2. G. Tak Wale and P.S. Puranik : *Introduction of Classical Mechanics*.
3. C. Rana and P.S. Joag : *Classical Mechanics*
4. Greeewood. *Classical Dynamics*.
5. Resnick : *Special Theory of Relativity*.
6. D.S. Mann & Mukhejke, *Relativity Mechanics and Statistical Physics*.
7. Kompanyets A.S. : *Theoretical Physics*.
8. R.L. Singhal : *Solid State Physics*. Pub. Kear Nath Ram Nath Co. Meerut.
9. Kachhava : *Solid State Physics*. Tata McGraw Hill Publishing Company Ltd.
10. Keer : *Principle of the Solid State*. Wiley Eastern Ltd.
11. Saxena Gupta & Saxena : *Fundamental of Solid State Physics*. Pragati Prakashan.
12. H.L. Hall : *Solid State Physics*. E.L.B.S.

(a) Physics (Quantum Mechanics, Mathematical Physics)

Course No. : Phy. 332 (major) — Full Makrs : 100

Nature of the course : Theory — Pass Marks : 35

Year : III

Course Objectives

At the end of this course the students should be able :

- to acquire sufficient indepth knowledge needed for major physics.
- to solve mathematical problems related to the course.
- to deduce mathematical equations and formulas.

Quantum Mechanics :

Introductory Wave Mechanics : Inadequacy of classical mechanics. Davisson - Germer experiment. de Broglie waves. group and phase velocity. uncertainty principle and its applications. 10

Quantum Mechanical Wave Propagation : Equation of wave propagation. time dependent and time independent Schrodinger equation. normalization of wave function. expectation values of dynamical quantities. Ehrenfest theorem. 13

Operator, Formalism in Quantum Mechanics : Operator. eigenvalues and non-commuting operators. Hermitian Operators. orthogonal functions. and orthogonality momentum operator. expansion in eigen functions. parity operator equation of motion. box normalization. angular momemtum operator. 15

Barrier Penetration : Free particle. particle in a box. potential step and particle wave function. finite and infinite potential barrier. reflection and transmission coefficients tunnelling effect. 12

Harmonic Oscillator and Applications : Linear harmonic oscillator. Hermite polynomials oscillator wave function. even and odd parity states. energy of harmonic oscillator. zero point energy. rigid rotator. 10

Quantum Mechanical Solutions : Schrodinger equation for spherically symmetric potential. spherical harmonics. degeneracy. angular momentum Laguerre polynomials solution of Schrodinger equation for hydrogen atom. probable densities of electrons and shapes of orbitals. transition probabilities and selection rules. 15

Mathematical Physics :

Vector Analysis : Review of vector algebra. unit vector. basis vector. components. vector field. dot. cross and triple product. reciprocal set of vectors. vector differentiation. gradient. divergence and curl.

Vector integration. Gauss. Stoke's and Green Theorents. unit vectors in curvilinear system. are length and volume element in curvilinear system. gradient. divergence. curl and Laplacian in curvilinear system. orthogonal curvilinear system with examples of cylindrical and spherical systems. 12

Tensor Analysis : Tensors in physics. moment of inertia and stress tensors. General co-ordinate transformation. contravariant and covariant vectors. contravariant. covariant and mixed tensors. Kroneckar delta. addition. multiplication and contraction. 6

Operators in Linear Vector Space : Definition. linear independence. dimension. basis. inner product. orthogonal basis. orthogonalization. linear transformation. matrix algebra. Hermitian. Unitary and orthogonal matrices. inverse coordinate transformation. similarity transformation. eigenvalue and eigenvector. diagonalization trace. 11

Fourier Analysis and Applications : Review of functions of real variables. limit. continuity. differentiation. integration. infinite series and convergence. Fouries series. Direchlet conditions. even and odd functions. square. triangular and sawtooth waves. output of a full wave rectifier. summing of Fourier series. Gibbs. phenomenon. applications. 11

Integral Transforms : Fourier transforms of functions and their derivations. convolution theorem. Parseval's relation. Laplace transforms of elementary functions. derivatives. integrals. unit step function and periodic functions. Laplace inverse transform. solution of initial value problems. 11

Differential Equations with special functions : Review of methods of solving second order differential equations. linear independence and Worknsian. second order equations with variable coefficients. power series method. Hermite. Lagendre. Laguerre and Bessel equations and solutions.

Partial Differential Equations : Stretched string and d' Alembert's solution. wave and heat conduction equations in one. two and three dimensions. Laplace equation in cartesian. cylindrical and spherical coordinate systems and solutions. 12

Text Books :

1. Powell and Crase Mann B. : *Quantum Mechanics*. Narosa Publishing House. New Delhi. 1994.

2. Charlie Harper : *Introduction to Mathematical Physics*. Prentice Hall of India Pvt. Ltd., 1990.

References :

1. Mathews, P.H. & Venkatesan S. : *A Text book of Quantum Mechanics*. Tata McGraw Hill Publishing Co. New Delhi.
2. Gupta, B.D. : *Mathematical Physics*. Vikas Pub. House Pvt. Ltd., New Delhi. 1994. (Re-print)
3. Rajput, B.S. : *Elementary Mathematical Physics*. Pragati Prakashan Meerut. 1994.
4. Mathew and Walker : *Methods of Mathematical Physics*.
5. Arfken : *Mathematical Methods for Physics*. Academic Press.
6. Margenau and Murphy, G.M, : *Mathematical for Physicist and Chemist*. Van Norstand.
7. Pipes L.A. : *Mathematics for Scientists and Engineers*.
8. A. Hinchey : *Vectors and Tensors*. Wiley Eastern.
9. W. Joshi : *Matrices and Tensors in Physics*. Wiley Eastern.

(c) Physics Laboratory III

Course No. : Phy. 333 (major) — Full Marks : 100

Nature of the course : Practical — Pass Marks : 35

Year : III

Experiments : (100 hrs.)

Atomic and Nuclear Experiments : Estimation of charge of electron by Millikan's method.. Estimation of e/m of an electron.. Estimation of Planck's constant using photo-electric effect.. Study the characteristics of Geiger counter and find its dead time.. Determination of linear absorption coefficient of β/γ rays through matter.

Solid State Physics Expts : To find the resistivity of semiconductor using four probe method.. Estimation of band gap of semiconductor using leakage current method.. Study Hall effect.

Electronics Expts. : Study the characteristics of regulated power supply using Zener diode, transistor and integrated circuit.. Study the characteristics of phase-shift oscillator.. Experiments with multivibrator.. Study logic gates (OR, AND, NAND, NOR, XOR).. Experiments to study characteristics of FET and UJT.. Experiment involving characteristics of operational amplifiers.

Experimental Project :

Project may involve fabrication, characterisation of application of electronics, solid state physics, Nuclear physics etc.

Or,

Computer programming, may involve least squares fitting of a straight line, statistical analysis of data, curve fitting of Poisson or other distributions, Estimation of probability, Chi-square Value, Fitting of Histogram to data etc.

Or,

Additional regular experiments can be given in place of minor project/computer programming if facilities are not available for the latter.

Text Books :

1. Worsnop and Flint, *Physics Practicals*

8. Statistics

Statistics, which is mostly understood by a layman as a set of data has developed from its premitive form as "Political Arthmetic" to most sophisticated scientific method for describing any phenomena whether natural or man-made: making inferences on the cause and consequences of the phenomenon and making prediction and projections. Thus the study of Statistics has been "a must" for the study of each and every academic discipline. The extent of the statistical knowledge to be imparted however various according to the nature of the discipline. Accordingly Statistics is taught in almost all subjects as integrated course. On the other hand, statistics has also developed as a seperate discipline on its own by developing more and more new techniques and theories. Thus statistics is taught in academic circles as a vertical course and also as integrated course to help other discipline.

The present course is designed to meet the demands of both vertical and integrated Statistics courses.

A silent features of the course offered in three years B.Sc./B.A. Statistics is shown as :

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	**Total Marks**
First Year	STAT. 311 (Major/Minor)	100	STAT. 312 (Major/Minor)	50	**150**
Second Year	STAT. 321 (Major/Minor)	100	STAT. 322 (Major/Minor)	50	**150**
Third Year	STAT. 331 (Major) STAT. 332 (Major)	100 100	STAT. 333 (Major)	100	**300**

Of above courses, courses offered at first year and second year are meant for both vertical and integrated programmes in statistics teaching, whereas courses offered at third year are exclusively for vertical program of Statistics teaching.

(a) Descriptive Statistics & Introdution Probability

Course No. : STAT 311
Nature of the course : Theory

Full Marks : 100
Pass Marks : 35
Year : I

Objective of the course :

General :

- To develop and sustain interest among students in learning of Statistics and motivate them to apply Statistics in their day to day life and enjoy the result.
- To promote awareness and understanding among the students the application of Statistics in social, economic, management and technical sciences.
- To show that Statistics is the mathematical description of a phenomenon.

Specific

- To introduce basic statistical ideas and methods so that the students may develop sense of appreciation for the subject.
- To introduce concepts of probability and its related theorems.
- To develop a base line knowledge for high level learning of Statistics.

Unit 1 : Descriptive Statistics

1.1 **Nature of Statistical Data :** Quantitative and qualitative data, scales : Nominal, Ordinal, interval and Ratio scales, Cross section and Time series data, Discrete and Continuous data.

1.2 **Sources of Data :** Different Sources of data : Primary and secondary sources, Sources of Primary data - Censuses, Sample Surveys and Observations, Sources of Secondary Data including official Publications.

1.3 **Data Presentation :** Presentation of data by tables and diagrams according to one, two and three factors of classification. Presentation of continuous data, Graphical representation of frequency distribution by Histogram, Frequency polygon and cumulative frequency distribution (inclusive and exclusive method) and Ogives.

1.4 **Fundamental Statistical Measure :** Concepts of moments, Moments of different orders, their relationship, Measures of Central tendency, Dispersion, Skewness and Kurtosis for both grouped and ungrouped data, Use of Shepherd's correction and Charlies check for grouped data.

1.5 **Relation between two variables :** Scatter diagram, correlation, Spearman's Rank correlation, Kendal Tau Ratio.

1.6 **Regression and Least Square Methods :** Principles of least square and fitting of 1st, 2nd and 3rd degree polynomials and exponential curves, Regression upto 3 variables, Error in regression and properties of residuals, Multiple and partial correlations upto 3 variables.

1.7 **Analysis of Categorical Data :** Fundamentals set of Frequencies, Consistency of Data, Conditions for consistency, Independence and association of attributes, Various measures of association.

Unit 2 : Introduction to Probability

2.1 **Events :** Fundamentals of set theory, random experiments. trials definition of events. various types of events. set operation of events. sample point and sample space.

2.2 **Concepts of Probability :** Definition of Probability - Classical and relative frequency. Richard Von Mises and Kolmogorov's approaches to probability. Merits and demerits of these approaches (only a general idea is to be given).

2.3 **Some Fundamental Theorems in Probability :** Additive and Multiplicative laws of probability. Conditional probability extending to Bayes theorem. Geometrical probability.

2.4 **Random Variable :** Definition of Random Variable (Discrete and continues). Expectation and related Theorems. Probability mass function (p.m.f) & probability density function (p.d.f.) cumulative distribution function (c.d.f.), measures of location. dispersion. moments. skewness & for a given distribution function. Concepts of Moment generating Function (m.g.f.) and Probability generating Function (p.g.f.).

2.5 **Univariate distributions and their Properties :**

Discrete :

Concepts, Conditions and derivation of distribution functions, moments and fundamental statistical measures. properties and application of Univariate distribution such as Bionomial. Poisson. Geometric. Hyper-geometric and Negative Binomial Distributions.

Continuous :

Concepts of Normal distribution. Derivation of its distribution function. Normal distribution as a limiting case of Binomial and poission distribution. Properties of Normal Distribution. concepts of Uniform. Cauchy. Gamma. Beta Distributions. Weibull Distribution. log Normal distributions. their distribution functions. measures of their moments. their important properties and applications.

Text Books :

1. Yule G.V. and Kendall M.G.. *"An Introduction to the Theory of Statistics"*. Charles Griffins & Co. London.
2. Shankarnarayan G.. : *"Elementary Theory of Mathematical Statistics"*. Oxford.

(b) Statistical Computation I

Course No. : STAT 312 — Full Marks : 50
Nature of the course : Practical — Pass Marks : 20
Year : I

Objectives :

General :

To develop and sustain student's interest in computation Statistics and motivate them to enjoy its application.

To develop among the students the skill of processing and interpreting data for formulation and generalizations.

Specific :

To impart training to students in Statistical Computation and to develop in them capabilities to apply Statistical theories in Practical Problems.

To develop Statistical computational skills and knowledge in the areas prescribed in stat 312

Unit 1 : Computation of Statistical Measures :

1.1 **Computation of Elementary Statistical Measures :** Construction of frequency tables and its graphical representation for continuous and discrete data. computation of measures of central tendency from raw data. Computation of measures of central tendency from grouped data. Computation of measures of dispersion. skewness and kurtosis.

1.2 **Least Square Fittings :** Least square fitting of polynomial upto 3 degree (2 problems) Least square fitting of exponential curve. Construction of bivariate frequency table for bivariate observations (2 problems - discrete & continuous)

1.3 **Computation of Regression & Correlation Coefficient :** Fitting of linear regression and computation of correlation coefficients from unclassified data. Fitting of linear regression and computation of correlation coefficients from data classified in a two way table. Fitting least square multiple regression for three variables.

1.4 **Computation of Multiple & Partial Correlation :** Computation of multiple and partial correlation for three variables.

1.5 **Fitting of standard Distributions :** Fitting of Binomial, Poisson, Normal, Hypergeometric & Negative binomial distribution. Numerical problems based on standard univeriate distribution.

1.6 **Measures of Association :** Computation of measures of association.

Unit 2 : Computation of Probabilities : **Periods 60**

2.1 Numerical Exercise on set operations

2.2 Nemerical Exercise on Theory of Probability & related theorems

2.3 Nemerical Exercise on expectation & related theorems.

(a) Probability Theory and Statistical Methods

Course No. : Stat. 321 (major minor) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : II

Objectives :

General :

- To impart statistical knowledge an intermediate level.
- To produce man power in statistics that can be geared towards the country's requirements at various levels of postings.
- To impart essential knowledge of Probability Theory and distributions

- To give basic statistical theories on parametric estimation, hypothesis testing and Non-parametric testings.

Contents :

Unit 1 : Probability Theory : Number of Periods : 75

1.1 **Probability Distributions** : Truncated distributions (Binomial and Poisson).

1.2 **Bivariate Distributions** : Discrete & Continuous type: c. d. f., p.m.f.: Marginal and conditional distributions: Independence of random variables. Function of one and two dimensional random variables: Jacobean of transformation: Distribution of sums, products and quotients of two random variables. Expectation and their properties: Conditional expectation (Simple case only).

1.3 **Some important theorems in Probability** : Chebyshev inequality and its applications: Concept of convergence in probability: Weak law of large number: Central limit theorem (Statement and application only).

Unit 2 : Statistical Methods : Number of periods : 75

2.1 **Statistical Methods** : Sampling from a distribution : Definition of Random Sample: Statistics and its sampling distribution: Standard error of sample mean, sample proportion and sample moments: Sampling distribution of mean of random sample from Normal Population and sum of squares of standard normal deviates: Independence of sample mean and sample variance in random sampling from a Normal distribution (statement only). χ^2, t, F distribution and their properties (Central distribution only).

2.2 **Theory of Estimation** : Point estimation for a Parameter: Requirements of a good estimator : unbiasedness, consisteney, efficieney and sufficiency (definition only): Cramer Rao inequality: Maximum likelihood estimators and statement of their properties: Moment estimators: Construction of confidence interval estimators.

2.3 **Test of Significance** : Null and alternative hypothesis: Type I and Type II errors: Level of significance: Critical value: Critical and acceptance region: Small sample test for the mean and variance of Univariate Normal Distribution: Testing of equality of two means and two variances of two Normal distributions: Paired t-test, related confidence intervals: Test of significance of simple correlation, multiple and partial correlation: Test for linearity of regression. Large Sample test and interval estimation of a

mean and a proportion: Difference of two means and two proportions: Fishers Z transformations and their uses: Chi-square test for (i) goodness of fit (ii) homogeneity (iii) independence of attributes in a contingency table.

2.4 **Nonparametric Tests :** Definition of order Statistics upto 2nd order: Run test: Sign test: Wilcoxon Matched pairs signed ranks test: Mann whitney U test: Median test; Kolmogorov-Smirnov test (one sample case): Cochran's Q test: Kruskal Wallis one way ANOVA test: Friedman two way ANOVA test.

Text Books :

1. Yule G.V. and Kendall M.G.. *"Elementary Theory of Mathematical Statistics"*, Charles Griffins & Co., London.
2. Hogg R.V. and Tanis E.A.. *"Probability and Statistical Inference"*. McMillan, New York.

(b) Statistical Computation II

Course No. : Stat. 322 (major/minor) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : II

Objectives :

General

- To provide knowledge and understanding of the principles and applications of computational statistics.
- To impart the skills pertaining to processing and interpretation data: formulation and generalization.

Specific :

- To impart training to students in statistical computation involved in application of parametric and Non-parametric tests.
- To develop capabilities to handle problems from various fields that need parametric confidence interval and application of statistical hypothesis testing.

Unit 1 : Fitting Distribution and Statistical tests : No. of periods : 120

1.1. **Fitting Standard Distributions :** Fitting Truncated Binomial distribution. Poisson distribution and Bivariate Normal distribution.

1.2. **Test of Means and Variance :** Test of single mean and single variance and their confidence intervals for large and small samples; Test of equality of two variances and confidence intervals for ratio of two variances: Test of difference between two means when variances are known or unknown for large and small samples: Test of difference

between two means when variances are known or unknown : related confidence intervals: Paired t-test.

1.3. **Test of Correlation and Regression :** Test of significance of correlation coefficient and use of Z-transformation: Test of linearity of regression.

1.4. **Test of Proportions :** Test of significance for single and two proportions: Test of homogeneity of proportions.

Unit 2 : Non Parametric Test : No. of Periods : 40

2.1. Numerical exercise related to non-parametric courses prescribed in Stat. 321.

(a) Sample Surveys and Design of Experiments

Course No. : Stat. 331 (major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Objectives :

General

- To introduce advanced techniques of data collection and analysis such as sample surveys and design of experiments.
- To produce man power in statistics that can be geared towards the country's requirements at various level of posting.

Specific :

- To provide basic concepts of sample surveys, Experimental Designs and also to provide basic knowledge of analysis of variance for one way and two way classified data.
- To give computational skills in analysis of designs such as CRD, RBD, LSD, Greco Latin square Design: Factorial designs such as 2^2, 2^3 and 3^2 designs and analysis of covariance.

Unit 1 : Design of Experiment : No. of Periods : 90

1.1. **Analysis of Variance :** Concepts of linear in ANOVA: Statement of Cochran theorem: Analysis of one way, two way classification (l & m observations per cell) in fixed effect model.

1.2. **Simple Basic Designs :** Need for design of experiments: Fundamental principles of designs: CRD, RBD, LSD, Graeco Latin Square Designs and their analysis: Orthogonality of classification in two way layouts: Advantages of orthogonality relations: Simple illustrations: Missing plot techniques for RBD and LSD (one observation missing only).

1.3. **Analysis of Covariance :** Analysis of Covariance for one way layout with one concomitant variable for CRBD.

1.4. **Factorial Designs :** 2^2, 2^3, 3^2 designs: Main effects and interactions: Confounding in 2^3 factorial design.

Unit 2 : Sample Surveys : No. of Periods : 60

2.1. **Concepts of Sample Surveys :** Concepts of population and sample: Needs of sampling: Censuses and sample surveys: Basic concepts in sampling: Organisational aspects of sample surveys: Questionnaire design: Sample selection and sample size: Sampling and non-sampling errors.

2.2. **Some Basic Sample Survey Methods :** Simple Random Sampling with and without replacement: Stratified random sampling. Ratio and Regression methods of estimation under simple and stratified random sampling: PPS (with replacement) : estimation of population total and its variance: Systematic Sampling.

Text Books :

1. Cochran W.G., *Sampling Techniques*. Wiley Eastern, New York.
2. Kempthorane O., *Design and Analysis of Experiments*. Wiley Eastern, New York.

(b) Applied Statistics

Course No. : Stat. 332 (major)
Nature of the course : Theory

Full Marks : 100
Pass Marks : 35
Year : III

Objectives :

General :

- To make the students aware of Statistical Technique of applied nature usually used by economist, demographer, quality control engineers and applied scientists.

Specific :

- To impart to the students substantial knowledge of demographic measures and computing these measures.
- To enable them to handle basic tools used in Economic Statistics such as Index Numbers, Time series, Quality control and Natural income as well as to give them the concepts of Nepalease Official Statistics.

Unit 1 : Demography : No. of Periods : 75

1.1. **Some Demographic Data :** Sources of demographic data : Census, Vital registration, Hospital records: Demographic sample surveys of Nepal with special reference to their objectives, methods and important results.

1.2. **Age Sex Composition :** Evaluation of Age and Sex data and Errors in age reporting: Whipple's index: UN's age Sex Accuracy Index:

Population pyramid and age dependency ratio: Adjustment or smoothing of age distribution (methods of simple parabola only).

1.3. **Measurement of Mortality and Life Tables :** CDR: ASDR: Standardized death rates (direct, indirect methods): Comparative mortality index and life table death rate. Complete life table - its functions and relation between its various functions; Abridged life tables and their construction by Reed-Merrel and Greville's methods.

1.4. **Measurement of Fertility :** CBR, GFR, ASBR, TFR and CWR: Standardized birth rates-direct, indirect and UN's Age Sex adjusted birth rate; Replacement index and intrinsic rate of population growth: population projection.

1.5. **Population Models :** Simple linear model; Compound interest model: Simple exponential model; Polynomial model upto third degrees; Logistic models, use of these models in population projections: Population projection by component method.

Unit 2 : Econoqic Statistics : No. of Periods : 75

2.1. **Index Number :** Index numbers - definitions and application of index numbers; Price relatives and quantity or volume relatives; Link and chain relatives; Problems involved in computation of index numbers: Use of averages, simple and weighted aggregate methods: Laspeyer, Paasche, Fisher, Dorbin-Bowley and Marshall-Edgeworth Index numbers: Time, factor reversal and circular tests of index numbers: Cost of living index number and its construction and Real wages and their constructions.

2.2. **Time Series Analysis :** Economic time series - its different components: Additive and Multiplicative models: Determination of trends : Moving average; Exponential smoothing; Analysis of seasonal fluctuations: Construction of seasonal indices; Forecasting by using time series methods.

2.3. **Statistical Quality Control :** Importance of Statistical methods in industrial research and practice; Specification of items and lot qualities: Types of inspection: Determination of tolerance limits: General theory of control charts; Causes of variation in quality control limits; Sub grouping; Summary of out of control criteria: Charts for attributes - NP chart, P-chart, C-chart, U-chart, charts for variables - X and R charts.

2.4. **Nepalease Official Statistics :** Coverage. Sources & Limitation of Official Statistics in Nepal related to Population. Agriculture. Labour and Industries.

2.5. **National Income :** Concepts of National Income and its construction with special reference to Nepal.

Books :

1. Barday. *Demographic Techniques*. John Wiley and Sons. New York.
2. Singh M.L. and Saymi S.B.. *Introduction to Mathematical Demography*. B.D. Manandhar. Kathmandu.
3. Gioon A.M.. Gupta M.K. and Dasgupta B.. *Fundamentals of Statistics Vol. 2*. World Press. Calcutta. India.

(c) Statistical Computation III

Course No. : Stat. 333 (major) Full Marks : 100

Nature of the course : Practical Pass Marks : 40

Year : III

Objectives :

General :

- To develop sustain students in interest in Statistical computation for problems of applied nature.
- To provide adequate knowledge and understanding of the principles and application of statistical computation which contribute to the quality of life in a technologically based society.

Specific :

- To give students an understanding of advanced Statistical techniques for applied fields.
- To train them in computer handling for Statistical analysis.

Contents :

Unit 1 : Statistical Computation Techniques in Experimental design :

No. of Periods : 60

1.1. **Analysis of Variance :** One way analysis of variance: Two way analysis of variance.

1.2. **Various Design of Data Analysis :** Completely Randomized Design: Randomized Block Design: Latin Square Design: Greaco-Latin Square Design.

1.3. **Missing Plot Techniques and Analysis :** Missing Plot in RBD: Missing plot in LSD: Analysis using 2^2 factorial design: Analysis using 2^3 factorial design: Analysis using 3^2 factorial design: Analysis using 2^3 factorial design with confounding of treatments.

1.4. Analysis of Covariance : Analysis of covariance for RBD with single covariate.

Unit 2 : Statistical Techniques in Sample Surveys : No. of Periods : 60

2.1. Questionnaire Design and Sample Survey : Questionnaire preparation for sample surveys: Use of random numbers in sample selection.

2.2. Sampling : Determination of sample size: Analysis of sample data using simple random sampling: Analysis of sample data using stratified sampling: Analysis of sample data using systematic sampling. Ratio and Regression method of estimation of population totals: Estimation of population total and its variance in PPS sampling.

Unit 3 : Demographic Techniques : No. of Periods : 80

3.1. Measure of Mortality & Fertility : Computation of measures of age sex component: Computation of Mortality Measures: Computation of Fertility Measures: Construction of Life-Tables.

3.2 Population Projection : Population projection using mathematical models: Population projection using demographic models: Computation of population replacement indices.

Unit 4 : Economic Statistics : No. of Periods : 80

4.1. Index Number : Construction of index numbers using different methods: Test of consistency of index numbers: Construction of cost of living index number: Computation of cost of real wage using index number.

4.2. Determination of Trends : Determination of Trend by different methods: Computation of Seasonal Indices: Time series forecasts: Construction of X-chart: Construction of R-chart: Construction of P-chart: Construction of C-chart.

Unit 5 : Application of Computer in Statistical Analysis :

No. of Periods : 40

5.1. Basic knowledge in Computer operation.

5.2. Preparation of Tables and graphs.

5.3. Computation of basic statistical measures by using computer. (Mean. standard deviation. Moments. Correlation coefficients and regression Coefficients)

5.4. Concepts of Computer Programming.

5.5. Model buildings and testing the models by different methods.

Text Books :

1. Cochran W.G.. *Sampling Techniques*. Wiley Eastern. New York.

2. Kempthorne O., *Design and Analysis of Experiment*. Wiley Eastern. New York.
3. Singh M.L. and Saymi S.B., *Introduction to Mathematical Demography*. B.D. Manandhar. Kathmandu.
4. Goon A.M., Gupta M.K. and Dasgupta B., *Fundamentals of Statistics Vol. 2*. World Press. Calcutta. India.

References : For all Courses

1. Hoel P.G., *An Introduction to Mathematical Statistics*. Asia Publishing House. New Delhi. India.
2. Wilks S.S., *Mathematical Statistics*. John Wiley & Sons. New York.
3. Des Raj. *Sampling Design*. Tata. McGraw Hill. India.
4. Federer W.T., *Experimental Design*. Oxford and IBH. New Delhi.
5. Schaeffer L., Mendehall W., Loynen Ott., *Elementary Survey Sampling*. PWS KENT Pub.
6. Gnedenko B.V., *The Theory of Probability*. Mir Pub., Moscow.
7. Snedecor and Cochran W., *Statistical Methods*. Lowa State University Press.
8. Anderson T.W., & Clove S.L., *An Introduction to Statistical Analysis of Data*. Hought on Mibbin & Co.
9. Chung K.L., *Elementary Probability Theory with Stochastic Processes*. Springier International Student Education.
10. Rohatgi V.K., *An Introduction to Probability Theory and Statistical Inference*. Wiley Eastern. New York.
11. Kenny S.F. & Keeping E.S., *Mathematical Statistics, Vol. I. II*. Van Nostrand.
12. Montgomery D.C., *Design and Analysis of Experiments*. John Wiley Co., New York.
13. Saigel S., *Von Parametric Statistics*. John Wiley Co., New York.
14. Mendemhall W., Weckaly D. and Schaeffer L., *Mathematical Statistics with Application*. Boston PWS Kent Publications. USA.
15. Myers R.H., *Classical and Modern Regression with Applications*. Boston Kent Publications. USA.
16. Bhat U., *Introduction to Stochastic Processes*. John Wiley Co., New York.
17. Mood A.M., Greville F.A., & Boes D.C., *Introduction to the Theory of Statistics*. McGraw Hill Publication. U.K.
18. Hogg R.V. and Craige A.T., *Introduction to Mathematical Statistics*. Collier MacMillan Co., New York.
19. Singh M.L., *Understanding Research Methodology*. Kathmandu. Nepal.

9. Zoology

Academic Year	Theory		Practical		
	Course No.	Full Mark	Course No.	Full Mark	Total Marks
First Year	ZOL. 311 (Major/Minor)	100	ZOL. 312 (Major/Minor)	50	150
Second Year	ZOL. 321 (Major/Minor)	100	ZOL. 322 (Major/Minor)	50	150
Third Year	ZOL. 331 (Major) ZOL. 332 (Major)	100 100	ZOL. 333 (Major)	100	300

(a) Non - Chordata

Course No. : ZOL. 311 (Major/Minor) — Full Marks : 100
Nature of the Course : Theory — Pass Marks : 35
Year : I

Course Objectives :

At the end of the course the students will be able :

- To take interest in pursuing further about the details and applications of lower non-chordates.
- To distinguish between unicellular and multicellular species.
- To describe the division of labour in the lower organised animals.
- To explain the structures and characteristics of different parasites.
- To identify and study the bewildening variety of insects found on earth.
- To participate team work even in small animals.
- To distinguish between various shelled animals and study their habitats.

Contents — **Lecture hours**

Group A : A Lower Non-Chordata

Detailed study of following animals types :

1. **Protozoa** : *Amoeba* and *Plasmodium* - Distinguishing characters. Classification upto orders and brief ecological notes. Habit, habitat and economic importances of *Entamoeba, Trypanosoma, Giardia, Monocystis, Vorticella, Opalina, Balantidium, Nyctotherus* and *Noctiluca.* 10
2. **Metazoa** : Introduction to metazoa, origin of metazoa. 1
3. **Porifera** : General structure of *Sycon.* Canal System and Skeleton. Distinguishing characters. Classifications upto orders with ecological notes (Habit, Habitat and economic importance) on *Grantia, Spongilla, Euplectella* and *Hyalonema.* 10

4. **Coelenterata** : Detailed study of *Obelia*. Polymorphism in Hydrozoa. Introduction to corals Classification upto orders. Distinguishing characters with ecological notes on *Hydra, Sertularia, Plumularia, Tubularia, Bougainvillea, Porpita, Velella, Physalia, Rhizostoma, Millepora, Aurelia, Alcyonium, Tubipora, Zoanthus, Metridium and corals (Madrepora, Favia, Fungia, Astrangea).* 14

5. **Platyhelminthes** : Detailed study of Fasciola hepatica and Taenia solium. Distinguishing characters and classification upto orders with ecological notes on *Digesia, Schistosoma, Echinoccocus, Planaria.* 14

6. **Aschelminthes** : Detailed study of *Ascaris lumbricoides* and *Wuchereria bancrofti* (Filaria). Economic importances of Helminthes. Distinguishing characters and classification upto orders with ecological note on *Oxyuris.* 10

7. **Annelida** : External Character and general anatomy of *Hirudinaria* (leech). Distinguishing characters and classification upto orders with ecological notes on *Pheretima, Polynoe, Eunice, Arenicola, Aphrodite, Amphitrite, Chaetopterus, Tubifex, Pontobdella.* 8

Group B : Higher Non-Chordata and Protochordata

1. **Arthropoda** : External characters and Organ system of cockroach and prawn. Mouth parts of insects : (a) Chewing and biting. (b)Piercing and sucking type. (c) Sponging type. (c) Chewing and lapping type. (e) Siphoning type. Economic importance of insects. Social life in insects (honey bee and termite). Distinguishing characters and classification upto orders with ecological notes (habit, habitat and economic importance) on *Peripatus, Lobster, Cancer, Sacculina, Eupagurus (hermit crab), bug, beetle, Lepas, Balanus, Apus, Lepisma, Gryllus, Mantis, Cicada, Forficula, Dragon fly, Julus (Millipede), Scolpendra, Scorpion, Moth, Spider and Limulus.* 22

2. **Mollusca** : Organ System of *Pila* and *Unio*. Economic importance of Mollusca. Distinguishing characters and classification upto orders with ecological notes on *Chiton, Anodonta, Ostrea, Solen, Pecten, Haliotis, Patella, Aplysia, Doris, Limax, Loligo, Sepia, Octopus, Nautilus* and *Dentalium.* 20

3. **Echinodermata** : External features and water vascular system in starfish. Affinities of Echinodermata. Distinguishing characters and classification

upto orders with ecological notes on *Echinus*, *Cucumaria*, *Ophiuroidea* and *Antedon*. 10

4. **Protochordata** : Systematic position, distribution, ecology, general anatomy and affinities of *Balanoglossus*, *Herdmania* and *Branchiostoma* Development of *Herdmania*. Classification upto orders with brief ecological notes on *Pyrosoma*, *Doliolum*, *Salpa* and *Oikopleura*. 2

Text Books

1. Kotpal (retd.), R.L., *Modern Text Book of Zoology. Invertebrates*, 6th edition, Rastogi Publication, Meerut India. 1992.

Reference Books

1. Dhami & Dhami, *Invertebrate Zoology*, R. Chand & Co. New Delhi. 1989.
2. Majupuria, T.C. *Invertebrates Zoology*, S. Nagin & Co, India.
3. Prasad, S.N., *Life of Invertebrates*, Vikas Publishing House Pvt. Ltd., New Delhi. 1992.

(b) Lower & Higher Non-Chordata, Protochordata

Course No : ZOL : 312 (major/minor) Full Marks : 50
Nature of Course : Practical Pass Marks : 20
Year : I

Course Objectives :

At the end of this course, the students will be able :

- To identify the different representatives of different Phyla.
- To identify and study different pathogenic animals which cause diseases.
- To identify and explain the structures of different organs of invertebrates.

Study of representative example of different phyla (mentioned in theory papers) upto order from museum specimen/slides.

Study of slides : Binary fission and conjugation in *Paramecium*, L.S. & T.S. of *Sycon*, Sporocyst, Redia, Carcaria, Scolex, and Proglottids of *Taenia*, T.S. of *Fasciola* (Different regions), T.S. of *Ascaris*, T.S. of *Nereis*, T.S. of star fish arm, T.S. of (*Branchiostomata*) *Amphioxus* (Various regions), Spicules and pharyn of *Herdmania* and Pharyns of *Amphioxus*. Mounting of coelenterates by shocking borax carmine.

Dissections of following animals : Leech - General anatomy, excretory and reproductive organs. Prawn - Appendages, digestive organs and nervous system. Cockroach - General anatomy, Digestive, nervous and reproductive systems. *Pila* - General Anatomy and nervous system. *Unio* - General anatomy and Nervous System.

Mouting : Temporary - Osphradium and Radula of *Pila*, Jaw of Leech. Permanent slide preparation - Mouth parts of insects (a) Cockroach, (b) Mosquito, (c) Honey bee, (d) Butterfly, (e) Housefly.

Whole mounts of the following : (Permanent Slides) - *Daphnia, Cyclops, Cypris*, Mosquito larva and Pedicellaria of star fish.

Practical note books, permanent slides and collection of animals to be submitted at the time of examination.

Text Books

1. Verma P.S., A Manual of Practical Invertebrate Zoology, S. Chand & Co. India.

Reference Books

1. Wersę, P.B., *Science of Biology*, McGraw Hill Co. India.
2. Lal, S.S., *A Text Book of Practical Zoology Invertebrate.*

(a) Chordata, Cell and Tissue Biology

Course No. : Zol. 321 (major/minor) Full Marks : 100
Nature of the course : Theory Pass Marks : 35
Year : II

Course Objectives :

On completion of this course the students will be able :

- To distinguish chordates and non-chordates.
- To describe anatomy of fishes, amphibians, reptiles, birds and mammals.
- To explain characteristics of certain groups of chordates.
- To explain the differences in composition of various tissues which form the basis of their functions.
- To relate the structure functioning different systems of the body.
- To explain how different functions of the body are regulated.
- To describe the structure and chemistry of basic units of life.

Contents : **Lecture hours**

Group A : Chordata

Cyclostomata : External characters of *Petromyzon and Myxine*. Distinguishing characters and classification upto orders. 2

Pisces : External characters and functional anatomy of *Scoliodon*. Economic importance of fishes. Distinguishing characters and classification upto order. Ecological notes, habit and habitat and economic importance of : *Chondricthyes : Zygaena, Pristis, Trygon, Rhinobatus* and *Chimaera. Actinopterygii :- Polypterus, Acipencer, Lepidosteus, Mystus, Tetradon, Echeneis and Solea. Dipnoi : Protopterus.* 16

Amphibia : External characters and organ system of frog. Origin and parental care in amphibia. Distinguishing characters and classifications upto orders and ecological notes on : *Necturus, Amphiuma, Ambystoma* and its Axolotl larva, *Triton, Salamandra, Hyla and Rachophorus.* 14

Reptiles : External characters and functional anatomy of *Uromastix*. Identification of poisonous and non-poisonous snakes. Biting mechanisms in snakes. Distinguishing characters and classification upto orders and ecological notes on : *Chelone, Testudo, Hemidactylus, Calotes, Draco, Varanus,*

Phrynosoma, Chameleon, Typhlops, Python, Bungarus, Naja, Viper, Hydrophis, Crocodyus, Gavilis and *Alligator*. 16

Aves : Functional anatomy of *Columba livia*. Bird migration. Pheasants of Nepal. Distinguishing characters and classification upto orders with ecological notes on : *Ardea, Milvus, Pavo, Tyto, Eudynamis* and *Casuarius*. 15

Mammalia : Functional Anatomy of Rabbit. Distinguishing characters and classifications upto orders. Characters and affinities of Prototheria, Metatheria and Eutheria. 10

Ecological notes on : *Ornithorhynchus, Echidna, Didelphys, Kangaroo, Panthera leo, Manis* (Pangolin or Spiny ant-eater), *Herpestes* (Mongoose), *Pteropus* (fruit and small bat). 7

Group B : Cell and Tissue Biology

Histological study : Histological structure of skin, stomach, intestine, liver, pancreas, lung, kidney, spinal cord, ovary and testes of Amphibia and Mammalia. 10

Physiology of mammalia with reference to man :

Digestion : Composition, function and regulation of salivary, gastric, pancreatic, bile and intestinal fluids. Absorption, Nutrition (Balance diet including vitamins and minerals).

Respiration : Transport of Oxygen and Carbon dioxide, Bhor effect. ***Blood :*** Composition and functions of blood and lymph. Structure and functions of haemoglobin. ***Heart :*** Origin, conduction and regulation of heartbeat. Blood pressure.

Excretion : Physiology of urine formation. ***Nerve Impulse :*** Origin and conduction of nerve impulse, synapse and myoneural functions. 20

Endocrinology : Structure and function of mammalian endocrine glands with particular reference to pituitary, thyroid, parathyroid, pancreas, adrenal and gonads. 8

Cell Biology : Cell structure and cell theory. *Enzymes :* Classification, structure, and functions of enzymes and co-enzymes. *Organelles :* Plasma membrane, endoplasmic reticulum, ribosome, lysosome, golgi-complex, mitochondria, centrioles and basal granules, cilia and flagella. *Nucleus :* nuclear membrane, nucleolus and chromatin. Cell Division. Structure, type and function of chromosome, polytene and lampbrush chromosomes. Linkages, crossing over. 20

Genetics : Gene and gene concept, interaction of gene. Gene mutation. Sex determination and sex linked inheritance. Structure of nucleic acids. Structure and function of RNA and DNA. DNA replication, genetic code. 12

Text Books

1. Dhami & Dhami. *A Text Book of Zoology Vol. II & III*. Pradeep Publication, New Delhi. 1968.
2. Verma, P.S., *A Manual of Practical Zoology (Vertebrate)*. S. Chand & Co., New Delhi. 1978.

3. Kotpal (retd.). R.L.. *Modern Text Book of Zoology. Vertebrates*. 6th Edition. Rastogi Publication, Meerut. India. 1992.
4. Rastogi. S.C.. *Text Book of Physiology*. Wiley Eastern Ltd.
5. Verma. P.S. and Agrawal. V.K., *Cell Biology Evolution and Ecology*. S. Chand & Co., New Delhi. 1978.

Reference Books

1. Rastogi. V.Nath. K. Nath. R., *Invertebrate Zoology*. Delhi.
2. Majupuria. T.C., *Introduction to Chordates*. Pradeep Publication. New Delhi. 1968.
3. Dhami & Dhami. *Vertebrate Zoology*. S. Chand & Co.. New Delhi. 1978.

(b) Chordata, Cell and Tissue Biology

Course No. : 322 (major/minor) Full Marks : 50

Nature of the course : Practical Pass Marks : 20

Year : II

Course Objectives :

At the end of this course the students will be able :

- To identify and explain the structure of different organs in a body.
- To relate the shape and structure with the skeleton.
- To identify and study different animals in details.

Dissections : *Scoliodon* - Afferent and Efferent branch arteries. Cranial nerves. Internal ear. General anatomy. digestive. reproductive. artery and venous system of : *Calotes*, *Columba*. Rat/Rabbit (depending on availability)

Study of permanent slides : Sections of skin. stomach. intestine. liver. pancreas. lung. kidney. spinal cord. ovary and testis of frog and mammal.

Study of skeleton of : *Scoliodon*. frog. *varanus*. pigeon or fowl. and rabbit.

Study of chick cells : Study of different types of cells. Study of cytoplasmic organelles through permanent slides. Permanent slides of mitosis and meiosis cell division.

Study of Museum specimen. Classification and characters mentioned in theory papers. Physiology - Study of the action of salivary amylase on starch.

Preparation of permanent slides : Placoid scales. Ampulla of Lorengini. Pecten of birds, striped and unstriped muscle.

Text Books :

1. Verma. P.S.. *A Manual of Practical Zoology (Vertebrate)*. S. Chand & Co.. New Delhi. 1968.

(a) Ecology, Fish and Aquaculture

Course No. : Zol. 331 (major) Full Marks : 100

Nature of the course : Theory : Pass Marks : 35

Year : III

Course Objectives :

At the end of the course, the students will be able :

- To show the development in all groups follows the same basic pattern.
- To demonstrate the interdependence of animals and their interactions with the environment.
- To show familiarity with different kinds of habitats and their preservation.
- To demonstrate knowledge of the dynamic history of life.
- To list factors which contribute to fish production.
- To create environment for fish aquaculture.

Contents : No. of Periods

Group A : Ecology

Developmental Biology : Gametogenesis. Fertilization and Parthenogenesis. Thpes of animal eggs. Patterns of cleavage and gastrulation. Germ layers and their derivatives, and homologies. Cell cleavage and fate maps. Development of *Amphioxus*. Chick and mammals. Type of placenta and their functions. 22

Ecology : Components of ecosystem. Ecosystem energetics (Energy flow through trophic levels, food webs and food pyramids). Ecosystem managements. Biochemical cycles (Nitrogen, Carbon and Phosphorus). Population : Population density, natality, mortality, immigration, emigration, pyramid, sex-ratio, dispersal and population growth including potential, human population and its impacts on eco-degradation. *Pollution* :- Water, air, npise and their control measures. Wild life management in Nepal. Introduction to Biodiversity. Endangered species in Nepal. Conservation of endangered species. Wild life sanctuaries and their representative fauna. 30

Short history of evolutionary thought. Evidences in favour of evolution. Darwinism and neo-Darwinism. Evolution of horse. 8

Zoo-geography : Brief account of Zoo-geography realms. Oriental fauna - its boundaries and important fauna. 5

Animal behaviour : Learning and innate behaviour, territorial, relationship, and mating behaviour. 6

Group B : Fish and Aquaculture

Fish and Aquaculture : *Fishes of Nepal* :- Occurrence, distribution and morphology of *Labeo, Cirrhina, Catla, Mystis,* Channa *(Ophiocephalus), Schizothorax.* Diagonostic characters and distribution of Dipnoi. Scales and fins in fishes. Migration in fishes. Aquarium and its maintenance. Economic importances of fishes. 17

Hill Stream fishes in Nepal : Sound-producing organs. General introduction to aquaculture/pond culture in Nepal. Water resources of Nepal :- rivers, lakes,

ponds and reservoirs. Construction and preparation of ponds in general. Induced breeding of cultivated fishes. 17

Exotic Fishes in Nepal : Abiotic factors in water : Physical factors : Temperature. Light and water current. Chemical factors : pH. Dissolved Oxygen. Carbon dioxide. Alkalinity. Nutrients (Phosphates and nitrates). Biotic factors in water :- Plankton. Fish diseases. 17

Text Books :

1. Khanna, S.S., *An Introduction to Fishes*. S. Chand & Co., New Delhi. 1966.
2. Dhami & Dhami. *A Text Book of Zoology Vol III*. Pradeep Publication. New Delhi. 1968.

Reference Books :

1. Nichel Sky, G.V., *The Ecology of Fishes*, Cademic Press, London, 1965.
2. Shrestha, J., *Fishes of Nepal*.
3. Sharma, C.K., *Water Resources of Nepal*.
4. Campbell, N.A., *Biology*, Benamin Cumming, USA.
5. Shrestha, T.K., *Resource Ecology of the Himalayan Water*, 1990.
6. Shrestha, T.K., *Fish Catching in Nepal*, 1995.
7. Shrestha, T.K. and Jha, D.K., *Introduction to Fish Culture*, 1990.

(b) Medical Zoology, Applied Entomology

Course No. : Zol. 322 (major) Full Marks : 100

Nature of the course : Theory Pass Marks : 35

Year : III

Course Objectives :

At the end of this course, the students will able :

- To state disease causing agents.
- To describe immune system and resistance in the body.
- To enlist method to find out the causes of diseases.
- To describe the importance of insects to mankind.
- To explain various measures to control these insects.
- To create understanding and appreciate of wild life.
- To explain the necessity of presenting wild life.

Contents :

Group A : Medical Zoology

Introduction to parasitology : Terminology.

Pathogenic microbes : Viruses, Ricketsia, Spirochetes and Bacteria.

Protozoan parasites : Brief account of life histories, mode of infection, pathogenecity, prophylax and treatment of pathogens with reference to human parasitic protozoa :- *Trypanosoma*, *Leishmania*, *Giardia*, *Plasmodium*, *Entamoeba* and *Trichomonas*. 17

Helminths : *Fasciolopsis, Schistosoma, Echinococcus, Trichinella.* Phyto and entomopathogenic nematodes :- *Meltidogyne* and *Heterorhabditis.* Arthropods as direct agents of disease and discomforts and vectors of human diseases :- *Anopheles* (Malaria). *Culex pipiens* (Filariasis). *Culex* (Encephalitis). Ctenocephalides (dog flea). *Xenopsylla* (plague flea). *Pediculus* (epidemic typhus). Distribution, biology and control of the above mentioned vectors. 18

Short Informations about : Histopathological changes in related organs with diseases such as cirrhosis, nephrosis, tumors and cancer. Occurrence and eradication of epidemic diseases such as typhoid, cholera, smallpox, meningitis, tuberculosis and zoonotic diseases : Rabies and Echinococcus. Brief account of human defense mechanism : The Immune system, origin and role of immune system. **Antibodies** : Structure, function, immunoglobulins, antigens, vaccines, T-lymphocytes, Cellular immune response, compatibility antigen, Cellular interactions in immunity - monophagus, T-helper and T-Suppress cells, the AIDS virus. 20

Group B : Applied Entomology

Classifications of insects upto order. Elementary knowledge of collection, preservation and culture of insects. Bionomics of the insect pests : Cotton - *Earias vitella*, (pedtinophoro) gossypiella. 15

Crop Pests : Wheat : *Sesamia inferens*, Paddy - *Tryporyza incertulus, Leptocarisa acuta.* Pulses - *Heliothis armigera.* Cash crop pests : Sugercane - *Scirpophaga nivella, Pyrilla serpusilla.* Vegetable Pests :- *Raphidopalpa foveicollis, Leucinodes arbonalis.* Stored grain Pests : Rice - *Sitophilus oryzae, corcyra cephalonica.* Wheat - *Trogoderma granarium.* Pulses - *Callasobruchus chinensis.* 20

Safe Storage of food grains : Introduction. Damage by insect pests. Requirement of safe storage. Types of storage. Storage for different periods : (a) Transit (b) short-term (c) long-term storage structure and godowns. Transit storage structure. Short term storage structure. Long term storage structure. *Household pests* :- Fleas, mosquitoes, Bedbugs, human lice, sandflies, houseflies, cockroaches and white ants. Economic importances of above insects. Out lines of sericulture, apiculture, lac culture. *Principle of insect control* :- Mechanical, cultural, chemical, biological, sterile male technique, genetic, quarantine - integrated approach to pest management. 20

Group C : Wild Life Management

Wild Life and its management : Wild Life. National Parks and Reserves of Nepal. Wild Life distribution in ecological zones. Wild life values. Economic exploitation and its impact in nature. Endangered animals of Nepal. Definition of endangers. Vulnerable rare and threatened animals. Conservation of Wild Life in Nepal. Importance of wild life management. Predator - Prey relationship and competition. 40

Text Book :

1. Fenemure. P.G.. *Applied Entomology*. Willy Eastern Co.. New York.
2. R.C. Sobti. *Text Book of Medical Zoology*. Central Publication. Allahbad 1966.
3. Majupuria. T.C.. *Wild Life and Management*.
4. Shrestha. T.K.. *Wild Life of Nepal*. 1981.

Reference Books :

1. Chandler and Read. *A Text book of Zoology*. Willey Eastern. New York 1967.
2. Grore. A.J. and Newell. G.E.. *Animal Biology*. University Tutorial Press. Ltd.. UK.

(c) Zoology Specialisation

Course No. : Zol. 333 (major) Full Marks : 400
Nature of the course : Practical Pass Marks : 35
Year : III

Course Objectives :

At the end of this course. the students will be able :

- To maintain aquariums.
- To carry out experiments related to evolutionary biology. Zoo- geography.
- To understand animal behaviour.
- To understand some pathological changes in tissues caused by small parasites.
- To understand wild life and its management.

Development biology : Stages of gametogenesis : structure of egg and sperm. Section of whole mounts of : early developmental stages of chicks. *Amphioxus* and mammals.

Evolution. Zoo-geography and behaviour. Zoo-geographical studies with the help of maps.

Statical Methods : Sampling. data collection. data analysis. measurement of density. student's t-test. Chi-square test.

Medical Zoology : Preparation of blood film. Blood group analysis. ABO and study of permanent slides of plasmodium (microfilaria). Preparation of permanent stained mounts of rectal ciliates of frog. Study of permanent slides and specimens of parasitic protozoans. helminthes and arthropades mentioned in the theory course. Collection. preservation and identification of parasites from the vertebrates. Study of permanent slides showing histopathological changes in liver and kidney in relation to cirrhosis and nephrosis. Pathological examination of sputum. blood, urine and stool. Blood : erythocytes.

Applied Entomology : Collection and preservation of insects. Classification of insects upto order. Identification and life-histories of economically important insects listed in the theory course. Study of mouth parts. legs and antennae. Study of damage caused by insects. Rearing and culture of any one insects of economic importance. Insecticide dusting and important equipments. Bee culture techniques.

Wild Life and its management : Survey of wild animal species in an area by study of animal signs such as food cutting. claw marks. foot-prints. nests. food remains. pellets etc.. and a social behaviour. Study of wild animals by marking technique such as banding. ringing etc. Study of habits and habitats of birds by use of binoculars in the field. Field survey of animal populations of an area by setting trapping. Measuring the populations and listing the species in order of abundance.

Fish aquaculture collection and preservation of fish : Identification and classification of fishes listed in the syllabus. Study of maturity stages. Estimation of fertility in *Heteropneustes fossilis. Labeo rohita, Catla catla.* Demonstration of artificial induction of spawning with fish pituitary extract. Demonstration and

preparation and maintenance of aquarium. Physico-chemical analysis of following parameters from ponds : Temperature. pH. Dissolved Oxygen. Free carbon dioxide. Alkalinity and Hardness. Identification of the following specimens of phytoplakton. zooplankton and aquatic insects : Phytoplanktons - *Synadra, Fragilaria, Navicula, Cycletella, Pimularia, Oscillatoria, Microcystes, Anabaena, Scenedesmus, Pedirsprum.* Zooplanktons - Nauplius larva, *Daphnia, Cyclops, Simiephalus, Bosmina, Asplanchna, Karatella, Philodina, Branchiones.* Aquatic insects.

Text Books :

1. Verma. P.S., *A Manual and Practical Zoology*. S. Chand & Co., New Delhi. 1978.

Reference Books :

1. Werse. P.B., *Science and Biology*, McGraw Hill. London.

10. MATHEMATICS

a) Mathematical Analysis II

Course No. : Math. 331 — Full Marks : 75

Nature of the course : Theory (Compulsory) — Pass Marks : 35%

Year : III

Unit 0 : Review of analysis I — 15hr.

1. *Infinite Series and Infinite Products* : Sequence of real numbers. Limit superior. Limit inferior. Infinite series. Inserting and removing parenthesis. Rearrangement of series. Riemann's theorem on conditional convergent series. Subseries. Double sequences. Double series and rearrangement theorem for it. Sufficient condition for iterated series. Multiplication of series and Merten's theorem. 11 hr.

2. *Sequences and Series of Functions* : Pointwise convergence. Uniform convergence. Cauchy condition for uniform convergence. Tests for uniform convergence. Uniform convergence and continuity. Uniform convergence

and Riemann integration. Uniform convergence and differentiation, Power series, Multiplication of power series. Taylor's series generated by functions. 11 hr.

3. *Improper Integrals* : Convergence, Divergence, Application of Fundamental Theorem of calculus. Simple properties. Conditions and tests for convergence. Absolute convergence. Abel's test and Dirichlet's test.8 hr.

4. *Point Set Topology* : Euclidean space R^n, Open balls and open sets in R^n. Closed sets and Adherent points. Bolzono - Weierstrass theorem. Cantor intersection theorem. Metric spaces. Point set topology in metric spaces.11 hr.

5. *Compactness* : Lindelof covering theorem. Heine - Borel convering theorem. Compactness in R^n. Compact subsets of a metric space. 8 hr.

6. *Limits and Continuity* : Convergent sequence in a metric space. Cauchy sequences. Complete metric spaces. Limit of a function. Continuous functions. Continuity of composite functions. Continuity and inverse images of open or closed sets. Functions continuous on compact sets. Topological mappings (homomorphism). Bolzano's theorem and intermediate value theorem. Uniform continuity. Uniform continuity and compact sets. 11 hr.

7. *Multivariable Differential Calculus* : Directional derivatives. Directional derivative and continuity. Total derivative. Total derivative expressed in terms of partial derivatives. Matrix of linear function. Jacobian matrix. Chain rule and its matrix form. Mean Value theorem. Sufficient conditions for differentiability and for equality of mixed partial derivatives. Taylor's formula for functions from R^n to R^1 11 hr.

8. *Functions, of Bounded Variation* : Properties of monotonic functions. functions of bounded variation. Total variation. its additive property. Total variation on [a. x] as a function of x. Functions of bounded variation expressed as the difference of increasing functions. Continuous functions of bounded variation. 8 hr.

9. *Riemann - Stieltjes Integration* : Riemann - Stieltjes integrals. Linear properties, Integration by parts. Change of variable. Reduction to a Riemann integral. Step-functions as integrations. Reduction to a finite sum. Increasing integrators. Upper and lower integrals. Riemann's condition. Comparison theorems. Integrators of bounded variation. 14 hr.

10. *Riemann - Stieltjes Integration (continued)* : Neccesary and sufficient conditions for existence of Riemann - Stieltjes integrals. Mean Value theorem. Integral as a function of the interval. Second Fundamental theorem. Second Mean Value theorem. Riemann - Stieltjes integrals depending on a parameter. Differentiation under the integral sign. Interchanging the order of integrations. 10 hr.

Book Suggested :

1. Apostal : *Mathematical Analysis*, Addison - Wesley Naroso Publishing House.
2. Robert G. Bartle : *The Elements of Real Analysis*, John Wiley and Sons.
3. David V. Widder : *Advanced Calculus*, Prentice Hall.

b) Advanced Calculus

Course No. : Math. 332 — Full Marks : 75
Nature of the course : Theory (Compulsory) — Pass Marks : 35%
Year : III

Units :

1. *Curves in Space* : Tangent line. Principle normal and binormal at a point on a space curve. Osculating plane. Normal plane and rectifying plane at a point on a curve. Torsion. curvature. Radius of curvature. Serret-Frenet formula. Circle of curvature. Properties of locus of center of curvature. 15 hr.

2. *Exact Differential Equations* : Exact differential equations. Condition for exactness. Integration of an exact equations. Equations of the form $y^{(n)} = f(x)$. Solutions of equations not containing x or y directly and of equations containing x or y derivatives. 12 hr.

3. *Second Order Linear Differential Equations* : Solutions of homogeneous and non-homogeneous equations. Transformations of equations by removing first derivative. by changing dependent variable and independent variable, and Method of variation of parameter. 12 hr.

4. *Simultaneous and Total Differential Equations* : Simultaneous equations of the first order and of the first degree. Simultaneous equations of second order and of first degree. Single integrable differential equations. Condition of integrability. single non-integrable differential equations. 12 hr.

5. *Partial Differential Equations of First Order* : Singular integral, General integral. Integral of linear equations. Lagrange's solutions. Solution of equations of four standard forms. Charpit method. 10 hr.

6. *Partial Differential Equations of Second Order* : Homogeneous and non-homogeneous equations with constant coefficients. Monge's equations. 10hr.

7. *Vector Integration* : Line. surface and Volume integrals. 10 hr

8. *Integral Tranformation Theory* : Green's theorem in the plane. Gauss's divergence theorem and Stoke's theorem. 10 hr.

9. *Functions of Complex Variable* : Limit and continuity. Derivatives and differentials. Cauchy - Riemann equations. Sufficient conditions. Analytic functions. Harmonic functions. 12 hr.

10. *Fourier Series* : Trignometric series. Fourier series. Fundamental theorem. Fourier - cosine series and sine-series. Unigueness theorem. Fourier series of orthogonal functions. Convergence of Fourier series. 12 hr.

Book Suggested :

1. Weather Bern : *Differential Geometry.*
2. Murray. Daniel A. : *Differential Equations.*
3. Churchill and Brown : *Complex Variable and its Applications.*
4. G.D. Pant and G.S. Shrestha : *Integral Calculus and Differential Equations.*
5. M.B. Singh and B.C. Bajracharya : *Text Book of Vector Analysis.*
6. L. Prasad : *Vector Analysis*
7. Badri Luxmi Vaidya : *Vector Analysis*
8. Apostal. T.M. : *Mathematical Analysis.*

c) Algebra III

Course No. : Math. 333 Full Marks : 75

Nature of the course : Theory (Compulsory) Pass Marks : 35%*

Year : III

Unit

1. *Vector Spaces and Linear Maps* : Vector spaces and suspaces. Basis. Dimension. Sum and Direct sum. Linear maps. Dimensions of kernel and image. 10 hr.
2. *Matrices and Linear Maps* : Matrix algebra (general treatment). Matrix as a linear map. Representation of a linear map by matrix. Effect of change of basis on matrix representation and coordinates of a vector. 8 hr.

3. *Scalar Products on Vector Spaces* : Scalar and Hermitian products. Positive definiteness. Orthogonality. Schwarz and Bessel inequalities. Gram - Schmidt Orthogonalization. Orthogonal complement. Applications to linear equations. Billinear maps and matrices. General orthogonal basis. the dual spaces. 15 hr.

4. *Billinear Forms and Standard Operators* : Billinear forms. Quadratic forms. Symmetric. Hermitian and Unitary operators. Sylvester's theorem. 12 hr.

5. *Polynomials and Matrices* : Polynomials of matrices and Linear maps. Eigen vectors and Eigen values. Characteristic polynomial. Minimal polynomial. Decomposition of a vector space w.r.t. a linear map. Jordan normal form (no proof). 12 hr.

6. *Triangulation of Matrices and Linear Maps* : Existence of triangulation. Hamilton - Cayley theorem. Diagonalisation of unitary maps. 8 hr.

7. *Groups* : Review of groups. subgroups. quotient groups and homomorphisms. Homomorphism theorems. Automorphisms and inner automorphism. Permutation groups. Representation of groups by matrices. Cayley's theorem. Conjugacy and conjugate classes. Normalizer and Centralizer. Class equations and applications. Cauchy's theorem. External and Internal direct products. Sylow's theorems (no proof). 20 hr.

8. *Rings* : Rings. Ideal. Homomorphisms. the field of quotient of an integral domain. Divisors and greatest common devisors. Prime elements. Units. Euclidean rings. Unique factorization theorem. Gaussian integers. Polynomial rings. Polynomial over rational fields. 15 hr.

9. *Fields* : Finite and Infinite fields. Field extensions. Finite and Algebraic extensions. Roots of polynomials, Splitting fields. Uniqueness (No proof). Derivative and multiple roots. 15 hr.

Book Suggested :

1. I.N. Herstein : *Topics in Algebra*, Vikash Publication.
2. S. Lang : *Linear Algebra*. Addison - Wesley Publication.
3. N.S. Gopal Krishnan : *University Algebra*. Orient Longman.
4. K. Hoffman and R. Kunz : *Linear Algebra*, Prentice Hall.
5. P.B. Bhattacharya et all : *First Course in Linear Algebra*. Wiley Eastern.

d) Mechanics

Course No. : Math : 334 Full Marks : 75

Nature of the Course : Theory (Optional) Pass Marks : 35%

Year : III

Statics :

Units :

1. *Coplanar Forces* : Resultant of coplanar forces. Equation to the resultant. Equivalent force and couple. General condition of equilibrium. 15 hr.
2. *Virtual Work* : Work done by the resultant. Virtual displacement. Virtual work. Principles of virtual work for a system of coplanar forces acting on a particle and for a system of coplanar forces acting at different points of a rigid body (without proof). 15 hr.

3 *Catenary* : Definition. Equation of the common catenary in the intrinsic and Cartesian forms. Properties of common catenary. approximations to the common catenary. Sag of a tightly stretched wire. 15 hr

4. *Center of Gravity* : Center of mass. Center of gravity. Center of gravity by integration. Center of gravity of an arc. Center of gravity of a plane area. Center of gravity of a solid of revolution. Center of gravity of a surface of revolution. Center of gravity of the sum or difference of two bodies. 15 hr.

Dynamics :

5. *Rectilinear Motion* : Simple harmonic motion. Motion under inverse square law. Motion under laws of forces. 10 hr.

6. *Kinematics in Two Dimensions* : Motion in plane - velocity and acceleration. Radial and transverse components of velocity and acceleration. Angular velocity and acceleration. Tangential and normal components of acceleration. 15 hr.

7. *Constrained Motion* : Conical pendulum. Motion on a smooth curve in a vertical plane (circle and cyloid). 10 hr.

8. *Central Orbits* : Motion of a particle in a plane with an acceleration which is always directed to a fixed point in the plane and applications. 10 hr.

9. *Moments and Products of Inertia* : Definition. Motion of inertia in some simple case. Theorem of parallel axis, Moments of inertia about any axis. Momental ellipsoid. 10 hr

Book Suggested :

1. R.S. Verma : *Text Book on Statics*, Pothishala. Pvt. Ltd. Allahabad

2. H. Ray : *Text Book on Dynamics*, S. Chand and Co. Delhi.

e) Linear Programming

Course No. : Math. 335 Full Marks : 75

Nature of the course : Theory (Optional) Pass Marks : 35%

Year : III

Units :

1. *Linear Programming* : Introduction to linear programming problems. Examples, Mathematical formulation of L.P.. Applications and limitations of L.P. 6 hr.

2. *Geometry in R^n and Graphic Solution of L.P.* : Vectors in n-space. n-dimensional Euclidean space. Vector inequalities. Hyper - plane. Half-spaces. Line and line segment. Half-line. convex set. Convex combination. Extreme point of a convex set. Convest hull of a set. Convex polytope. Convex polyhedron. Statement of Fundamental theorem of L.P.P.. Solution of L.P. by graphical method. 10hr.

3. *Simplex Method* : General linear programming problem. Slack and surplus variables. Standard form of L.P.P.. Basic solutions. Basic feasible solutions. Optinal basic feasible solution of L.P.P., Characteristic solutions of L.P.P.. Relation between extreme points of the set of feasible solutions and basic feasible solutions of L.P.P. (including proofs). Fundamental theorem of standard L.P.P.. Fundamental properties of solutions to an L.P.P. (without proofs). Optimality critérion (without proofs). Simplex Table an. Computational procedure of the simplex method for L.P.P.. Artificial variable technique. Method of penalties (Big M - method). Two phase method and degeneracy. 17 hr.

4. *Duality Problems* : Duality in L.P.P.. Symmetric and unsymmetric primal dual problems. Algorithm for primal dual construction. Fundamental

theorems of duality and complementary slackness theorem. Reading solutions to the dual from the simplex table and conversely. 13 hr.

5. *Transportation Problems* : Introduction. Examples of transportation problem (T.P.). matrix form of T.P.. Transportation table. Methods of obtaining a first feasible solution (North west corner rule. Lowest cost entry and Vogel's approximation method). Modi-method (u - v method) of solving T.P.. Degeneracy in the T.P.. Unbalanced transportation problems. 13 hr.

6. *Assignment problems and Routine Problems* : Introduction. Need and utility. Solution of assignment problems. Unbalanced assignment problem. Travelling - Salesman (Routine) problem and its solution. 10 hr.

7. *Sequencing Problem (S.P.)* : Introduction, scope and significance of S.P.. problems with n jobs and 2 machines, Problem with n jobs and 3 machines. Problem with n jobs and m machines. Optimal sequencing algorithm. Graphical solution of S.P. 10 hr.

8. *Game Theory* : Basic concept of game theory. Zero sum and non-zero sum game. Two persons zero sum games. Minimax and maximin criterion. A two persons zero-sum game with mixed strategies. Dominated strategies and principle of dominiance Graphical method for the solution of $(2 \times n)$ and $(m \times 2)$ games. Transformation of a rectangular matrix game into a linear programming problems. 13 hr.

9. *Non-Linear Programming Problem* : Introduction. Multivariable optimization - without constraints. with equality constraints and inequality constraints (upto three and two constraints) Criterion for extremum using Hessian matrix. Solution by the methods of Lagrange's multipliers. Kuhn - Tucker conditions. Graphical solution method. 10 hr.

10. *Difference Equations* : Finite difference. Difference formula. Difference table shift operator E. Relation between operator E and difference operator. Factorial function. Anti-difference. Different equations. Various types of linear difference equations. Homogeneous linear difference equations with constant coefficient. Solution of linear first order difference equations and linear second order difference equation with constant coefficients. Particular solutions to non-homogeneous linear difference equations (method of undetermined coefficient and operators method). 13hr.

Book Suggested :

1. P.K. Gupta and Man Mohan : *Linear Programming and Game Theory*. Sultan Chand and Sons (Revised Edition).

2. G. Hadley : *Linear Programming*. Narosa Publishing House (1990)

3. R.K. Gupta : *Linear Programming*.

4. S.I. Gase : *Linear Programming*.

5. M. Upadhyaya : *Linear Programming*.

6. P.K. Gupta. Man Mohan and Kanti Sworup : *Operational Research*. Subtan Chand and Sons. Revised and Enlarged Edition.

7. Tana. Hamdy. A. : *Operational Research*.

8. H.C. Saxena : *Finite Difference Calculus & Numerical Analysis*. S.C. Chand.

f) Mathematical Statistics*

Course No. : Math. 336 Full Marks : 75

Nature of Course : Theory (Optional) Pass Marks : 35%

Year : III

(Those students who have offered statistics in 1st and 2nd year will not be permitted to take up this courses.)*

Units :

1. *Presentation of Data :* Tables and diagrams, Construction of table with one or more classifications. Diagrammatic representation (various type of graphs). Graphical representation of frequency distribution. Cummulative frequency distribution and time. Categorisation of data.

2. *Measures of Location and Central Tendency :* Measures of location. Central tendency. Dispersion moments. Skewness and Kurtosis for grouped and ungrouped data. Shiphard's correction for grouped data. Scatter diagram. 8 hr.

3. *Regression and Correlation :* Concepts of regression. Linear regression and its properties. Error in regression. Properties of residuals. Principles of least - squares (1st-3rd degree and exponential curves.) Correlation - definition and properties. Rank correlation and skewness correlation formulae. Intra-class correlation coefficient and various correlation coefficients. 20 hr.

4. *Probability and Types of Probability :* Definition and properties. Classical and relative approach to probability. van mises. Cramer and Kologorov approaches. Merits and demerits of each of the approaches. Types of probability - Space. trail and sample. Events and their type. Conditional

probability and its properties. Geometric probability. Bay's theorem and its application. 20 hr.

5. *Random Variables* : Variables and continuous variables. Properties of each type of variables with illustrations. Mgf and Pgf. Cummulative distribution function of random variable. Mathematical expectation. Expectation of random variables and its properties. Measures of location. Measures of dispersiomoment. Skewness and Kurtosis. 20 hr.

6. *Probability Distributions* : Standard univariate distribution and its properties. Truncated distribution. Descrete distribution - Introduction. Binomial distribution. Poisson distribution. Hypergeometric and geometric distributions. Negative binomal distribution. Cauchy. Laplace (or Gauss distribution). Gamma. Beta distributions. Comparative analysis of all distribution and their significance.

7. *Sampling Distributions* : Introduction. Small sampling and large sampling and their properties. Students - distribution - distribution. F- distribution. Hypothesis' testing. Estimation and confidence intervals. Analysis of variances.

Book Suggested :

1. Mendenhak. Scheaffer and Wackerly : *Mathematical Statistics with Applications*, Duxbury. Boston.
2. Kapoor and Saxena : *Introduction to Mathematical Statistics*
3. Hridaya B. Shrestha : *Elementary Statistical Methods*. Orient Longman Ltd. 1989.
4. Feller : *Probability Vol I and II*.

g) Numerical Analysis and Computer Programming

Course No. : Math. 337 Full Marks : 75

Nature of the course : Theory (Optional) Pass Marks : 35%

Year : III

Units :

1. *Introduction to Computers :* Background. History. Generation of computers. Type of computers and its architecture. Application areas and scope. Micro-computers and important terminology. Algorithms. Definition. Characteristics and examples. Psuedocode. Flowcharts. Programs. Execution process. Low-level and high-level Languages. Description and examples. Compilers. Operating system description and examples. Binary representation and arithmetic. Basic DOS Commands. 15 hrs.

2. *Programming in Fortran :* Introduction. Syntax (complete) for constant. variable type. Floating point variable. I/O statements. Assignment statements and Control Statements. Structure of program. Structures array etc. Arithmetic library function. Sub - programs. Function and subroutines. Writing small programs. Bugs. Syntax and logical errors. Run - time errors. Characteristic of a good and efficient program. Documentation of programs.25 hr.

3. *Algebraic and Transcendental Equation :* Introduction. Concepi of numerical solution and its importance. Tabulation methods. Graphical methods. Bisection method. Fixed point iteration methods. Newton Raphson method. Graeffs method (root square). Rate of convergence of all iteration methods. Formal programmalute algorithms. Solution of algebraic transcendental equations by different methods. 15 hr.

4. *Solution of Algebraic Simultaneous Equations* : Introduction. Direct methods of special matrices. Gauss Elimination, Gauss Seidel and Gauss - Jacobi methods. Formal algorithms of each of the methods. Comparison of all three methods w.r.t. efficiency or rate of convergence. 15 hr.

5. *Interpolation and Approximation* : Basic concepts. General form. Newton's interpolation formulae. difference tables. Lagrange's method of error estimation etc.. Interpolation of equally spaced prints. Backward, Forward and Central differences. Newton's formulae, Sterling's central differences formulae. Formal Algorithms. 15 hr.

6. *Numerical Differentiation* : Introduction, Techniques of numerical differentiation based on undetermined coefficients. Finite- difference operations and interpolation. Formal algorithm. 10 hr.

7. *Numerical Integration* : Basic concepts and significance. Quatrature formula. Simpson's rule. Newton's formula (interpolation). Formal Algorithms. 10 hr.

8. *Numerical Solution of O.D.E.* : Taylor's series method. Euler's method. Richardson interpolation method. Range - Kutte (2nd and 4th) order methods. Formal algorithms of each of them. 10 hr.

Book Suggested :

1. Searbrough : *Numerical Analysis*. IBH Publication.

2. Rajaraman : *Programming in FORTRAN 77*.

11. Environmental Science

(a) Introductory Environmental Science

Course No. : 311 **Full Marks : 100**

Nature of the course : Theory **Pass Marks : 35**

Year : I

Course Objective : To enable the students to have a basic theoretical knowledge of the elements of environmental science.

1. **Ecology :** History and scope of ecology and its relation with other sciences, evolution of the biosphere, concept of ecosystems and their types : forests grasslands, aridlands and wetlands, concept of primary and secondary productivity, food chain, food web, trophic structure and ecological pyramids, biogeochemical cycles, nutrient cycling, cycling of organic nutriants, major parameters of population ecology; applied ecology : biological conservation, conservation of natural resources, causes of forest degradation and its consequences, in-situ national parks and wildlife conservation, ex-situ-germ plasm conservation, Ecology and its relevance to human soceity. 20 hrs.
2. **Population and Community analysis:** Species, interaction, ammensalism, commensalism, cooperation, mutualism, Competition and its types: space, light, carbon dioxide, nutrients, water, intraspecific competition, growth and regulation of community succession, climax, Heterogeneity and Adaptation, population differentiation and evolution origin and significance of adaptation, ecad, ecotypes, ecocline, speciation. Biotic community : concept, inter-community classification and concept of ecological dominance. 20 hrs.
3. **Ecosystems Analysis :** Concepts of ecological organizations, ecosystem energetics, components of ecosystems, ecosystem development, patterns and processes, Community level of organization, quantitative and qualitative study, Concept of ecotones and Edge effect, Ecological indicators, Biogeo-chemial cycles: Nitrogen, carbon, phosphorous and sulpher, Concepts of productivity of photosynthesis, productivity of agro ecosystem, Method of studying productivity in ecosystems, Human impacts on ecosystems, major impacts and their implications in general. 20 hrs.
4. **Microbial Ecology :** Distribution of microorganisms in the environment, e.g. Actinomycetes, cyanobacteria, Fungi, Protozoa, Waterborne pathogens, Decomposers, biodeteoriation of Organic compounds, waste and water treatment, air pollution, Microbial interaction, Effect of Microorganisms in food, Microorganisms as Food Growth and Death of microorganisms. 14 hrs.
5. **Environmental Earth Sciences:** Conceptual framework of earth as a closed system. Earth material and processes, the internal structure of the earth, evolution of the planetary surface, rocks and minerals, their classification and abundance. Geological agents of change, wind, water, ice, tectonium, volcanism, etc. River flooding, land slides and mass wasting, earthquakes and volcanic activity, Man-environment interaction, water resources, land use and waste disposal mining and its effects, geology and health. 16 hrs.
6. **Principles of Soil Science:** Soil genesis, Weathering of rocks. Factors of soil formation, Soil profile development, Chemical and Mineralogical composition of soil, Composition of primary minerals in soils, soil organic matter : Sources, composition, microbes and microbial decomposition of organic matter, Humus formation, Nature and properties of humus, major soil types of Nepal.

   Significance of C.N. ratio, Soil reaction, Soil colloidal system, cation and anion exchange phenomena, Soil pH, Buffering capacity, Soil acidity, alkalinity, salinity formation, major plant nutrients and trace elements.

   Soil fixation of plant nutrients of Soil water – Different form; hygroscopic, capillary and gravitational, Movement of Soil water under saturated and unsaturated conditions. Soil aeration; composition of soil air, Gaseous exchange between atmosphere and soil air, Soil temperature : Absorption and loss of heat, heat of vaporization, thermal conductivity through a soil profile. 20 hrs.
7. **Environmental Chemistry:** Techniques and Calculations in volumetric and Gravemetric analysis, Errors and statistical methods in Chemical analysis, Potentiometric, conductometric, electrometric titrations, electrolytic and calorimetric analysis, Theory and methods of Air Water, gases, hydrocarbons, pesticides, organic and inorganic herbicides, biological control of pests, soil and organic sample analysis. 20 hrs.
8. **Meteorology:** Meteorological fundamentals, pressure, Temperature, wind, humidity, radiation, Atmospheric Stability, Adiabatic diagrams, Turbulence and Diffusion. Scales of meteorology. Applications of micrometeorology to vegetated surfaces, urban areas, human beings, animals. Application of meteorological principles to transport and diffusion of pollutants. Scavenging processes. Effects of meteorological parameters on pollutants and vice versa. Wind Roses. Topographic effects. Pollution climatology.

Seasons in Nepal, Monsoons, EL Nino, ENSO, Concepts of climate change – global warming, sea level rise, Ozone depletion, green house effect. 20 hrs.

Text book :

1. Odum, F.P. – ***Fundamentals of Ecology***, W.B. Saunters

Books Recommended

2. Kormondy, E.J. – ***Concepts of Ecology***, Prentice Hall.
3. Buckman and Brandy – ***The nature and properties of soils***.
4. M.M. Rai – ***Principles of Soil Science***
5. R.A. Bailey, H.M. Clarke, J.P. Ferris, S. Krause and I.L. Strong – ***Chemistry of the Environment***.
6. Banerji, S.K. – ***Environmental Chemistry***, Prentice Hall of India, Pvt. Ltd., New Delhi.
7. J.K. Miller – ***Living in the Environment***, Wardsworth publishing Co. Belment, California (Text Book)
8. Brock, T.D. – ***Biology of Microorganism*** (Text Book)
9. Ramade, F. ***Ecology of Natural Resources***, John Wiley, New York.
10. Mather, J.R – ***Water Resources, Distribution, Use and Management***, Wiley, New York.
11. Mc Neely J.A. and Kenton, R.M. – ***National Parks Conservation and Development***, Washington D.C., Smithsonian Institution Press.
12. Freedman, B – ***Environmental Ecology***
13. Stainton, J.D.A. – ***Forests of Nepal***.

(b) Practical I

Course No. : Env. 312 **Full Marks : 50**

Nature of the course : Practical **Pass Marks : 20**

Year : I

Course Objective : To enable the students to learn the skill and the practical methods of some environmental analysis and measurement studies.

Experiment No.

1. Measurement of population parameters e.g. Natality, Mortality
2. Measurement of ecosystems processes
3. Measurement of productivity
4. Preparation of buffer solution
5. Measurement of pH of soil and water
6. Measurement of river discharge
7. Estimation of SS and TDS from a sample of water
8. Biological analysis of the soil
9. A visit to nearby protected area of field work
10. Measurement of Dust fall/total suspended particulate
11. Bacterial population count from a sample of water
12. Measurement of weather parameters e.g. temperature, precipitation

(c) Fundamental Aspects in Environmental Science

Course No. : Env. 321 **Full Marks : 100**

Nature of the course : Theory **Pass Marks : 35**

Year : II

Course Objective : To enable the students to acquire advance knowledge and understanding of the fundamentals of environmental science.

1. **Limnology:** Definition, scope and history, types of freshwater bodies (lontic, lotic), Physicochemical properties of water, Morphometry and water movement; Oxygen and other dissolved gases. Life in water : Phytoplankton, Periphyton, zooplankton, fish benthic organisms and Macrophytes. Microbiology of freshwater, Comparative study of lentic and lotic ecosystems. Land water interactions. 20 hrs.
2. **Bio-Statistics:** Defining a population, sampling and types of sampling, Determination of sample size. Data tabulation and presentation. Computation of some fundamental statistical measures such as mean, modes, partition values, moments, Dependent and independent variables, regression and correlation, fitting of different curves, probability and its basic concepts. Estimation and hypothesis testing. 18 hrs.
3. **Engineering Geology:** Earth materials : Solid earth materials, Physical properties and constituent properties, bulk properties, soil mechanics, deformation and failure, stabilization and maintenance. Construction site investigation. 18 hrs.
4. **Environmental Geology:** Landform development, air and water as agents of morphological processes, weathering erosion, types of physiographic provinces – their development, destruction, man's impact on landscape forms, land-use patterns, stream flow and hydraulics factors, urbanization and landform and terrain uses. 15 hrs.

5. **Hydrology:** Introduction : The hydrological cycle, Inventory of Earth's water, Precipitation : Various forms of precipitation, Interpretation of precipitation data/Snow and glaciers, river systems.
Evaporation and Evapotranspiration: Meteorological factors, transpiration, methods of estimating evaporation from land surface using penman's equation.
Infiltration and percolation: Infiltration capacity of soil, Factors influencing infiltration capacity, method of deterring infiltration capacity.
Runoff: Duration of runoff, flow rating curves – their determination, adjustment and extension, catchment characteristics and their effects on runoff, climatic factors.
Hydrological forecasting: Frequency analysis, Probability of the N-year event, series of events, probability plotting, cyclical nature of hydrological phenomena.
Elementary theory of groundwater: Flow, Darcy's law, major subdivision of groundwater flow, rock and soil composition, hydraulic conductivity water table, piezometric head, range of validity of Doray's law, general equation of ground water flow. 30 hrs.
6. **Climatology:** Elements of climate, Climatic controls. Earth and Sun relations, Rotation and Revolution. Special and Temporal Patterns of climatic parameters in Nepal, Indian Monsoon, Jet Streams, General circulation.
Climatic classifications. Climates of Nepal and Indian Region, Elements of Agroclimatology, Urgan climatology, Causes and consequences of Global warming, Ozone hole, Sea level rise. 15 hrs.
7. **Environmental Chemistry Lithosphere:** Chemical composition and chemical history of the earth, metals, minerals and fossil fuels, chemical properties and nature of soils.
Atmosphere: Atmospheric chemistry, reactions in the lower and higher atmosphere, radioactivity in the atmosphere, air pollution chemistry.
Hydrosphere: Structure and properties of water and their environmental significance, soil reactions, soil colloidal systems, cation and anion exchange phenomena. 20 hrs.
8. **Environmental Survey:** Topographical maps and map making, Aerial photographs and their interpretation, Environmental degradation and survey techniques, Diagrammatical representation of survey data, Introduction of GIS in relation to environmental monitoring. 15 hrs.

Text Books

1. Odum, E.P. – ***Fundamental of Ecology***, W.B. Saunters

Books Recommended:

2. Komondy, E.J. – ***Concepts of Ecology***, Prentice Hall.
3. Buckman and Brandy – ***The nature and properties of soils***.
4. M.M. Rai – ***Principles of Soil Science***
5. R.A. Bailey, H.M. Clarke, J.P. Ferris, S. Krause and I.L. Strong – ***Chemistry of the Environment***.
6. Banerji, S.K. – ***Environmental Chemistry***, Prentice Hall of India, Pvt. Ltd., New Delhi.
7. J.K. Miller – ***Living in the Environment***, Wardsworth publishing Co. Belment, California (Text Book)
8. Brock, T.D. – ***Biology of Microorganism*** (Text Book)
9. Ramade, F. ***Ecology of Natural Resources***, John Wiley, New York.
10. Mather, J.R. – ***Water Resources, Distribution, Use and Management***, Wiley, New York.
11. Mc Neely J.A. and Kenton, R.M. – ***National Parks Conservation and Development***, Washington D.C., Smithsonian Institution Press.
12. Freedman, B – ***Environmental Ecology***
13. Stainton, J.D.A. – ***Forests of Nepal***.
14. Garg; Satish K. – ***Hydrology and Water Resources***, Khanna Publications, New Delhi, India, 1996.
15. Critchfield, H.J. - ***Climatology***
16. Blyth, F.G. H. and De Freitas, M.H. – ***Geology for Engineers***, Edward Arnold Pvt. Ltd., Australia, 1985.
17. Degraphy – ***Engineering Geology***.

(d) Practical II

Course No. : Env. 322 **Full Marks : 50**
Nature of the course : Practical **Pass Marks : 20**
Year : II

Course Objective : To enable the students to carry out some systematic advanced environmental studies and estimations.

Experiment No.

1. Qualitative and quantitative estimation of various types of phyto and zooplankton.
2. Study of macrophyte and micro invertibrate communities.
3. Estimation of temperature, pH, dissolved oxygen, hardness, alkilinity, chloride, phosphate and total nitrogen from a sample of water.

4. Grain size analysis of sediments
5. Rock/mass analysis
6. Study of infiltration of water through soil
7. Drawing and analysis of hydrograph and rating curve
8. Frequency analysis of floods and forecasting
9. Estimation of potential evapo transpiration through Penmann, Balklewy Cradle and Thorswailths methods.
10. Study on classification on temperature and precipitation zones of Nepal.

(e) Environmental Pollution and Control

Course No. : 331 **Full Marks : 100**

Nature of the course : Theory **Pass Marks : 35**

Year : III

Course Objective : To acquaint the students with fundamental issues on Environment pollution and control.

1. **Definition and types of environmental pollutions.** 5 hrs.
2. **Air Pollution :**
   - 2.1 Micro-meteorological fundamentals, Nature and effects of meteorological parameters on transport and diffusion of pollutants, Principles of air mass turbulence and diffusion, Effective heights of emission and concentration of pollutants, Natural pollutant removal processes.
   - 2.2 **Agrology of pollutants:** Source, chemistry and nature of exterior and indoor pollutants, Environmental effects of air pollution on climate, vegetation, animal and human beings, Pollution standard index and legislation, Cost of air pollution control and prevention. 20 hrs.
3. **Water Pollution:** Types and sources of surface and ground water pollution. Physico-chemical parameters of water pollution, Water quality standards and legislation, Water pollution prevention, control and treatments. 20 hrs.
4. **Soil erosion and conservation:** Soil erosion – types, causes and consequences, Universal soil loss equation, Soil degradation – salinity, water logging and toxicity, Soil conservation technique, concept of water shed management. 10 hrs.
5. **Solid waste management:** Solid waste sources and types. Solid waste management, collection, disposal and treatment, Selection of disposal sites, Disposal sites reclamation. 10 hrs.
6. **Noise Pollution:** Nature, effects and control, Nature and measurement of urban sounds, Noise pollution level and impacts, Noise prevention and control measures. 5 hrs.
7. **Radiation and Environment:** Basics of radioactivity and its unit, Nuclear power plants, radioactive mining and disposal, Radioactive fall out from nuclear explosions and accidents, Residual radiations, Methods of radioactivity measurements, Effects of increased radiation on environment, Radioactive waste treatment and management.15 hrs.
8. **Environment Toxicology**
   - 8.1 Source and nature of toxins, environment and forensic toxicology, Movement, distribution and fate of toxins, Pesticide problems and toxic effects of pesticide, Dose response, frequency response and cumulative response.
   - 8.2 Effect of toxins, biological and chemical factor influencing toxicity, responses to chemicals, laboratory determination of toxicity, Mechanism to minimize the toxic effects. 15 hrs.
9. **Earth hazard control:**
   - 9.1 Natural hazards, Geomorphic and climatic subdivision of the Himalayas, Danger, hazard and risk, Geological factors of hazards, Strength of rocks and soil masses, Structure and causes of failures, Mechanism of natural hazards, Strength of soil masses and their behaviour, Unified Soil Classification, deformation and failure of soil, Surface run off and viscous flow, classification of mass movements, Landslides and debris flow, Hill slope and river bank processes.
     Earthquakes: nature, motion, intensity and magnitude, Earthquake intensity Scales and earth quake hazard assessment.
     Glacial hazards: flow regime, glacial land forms, glacial lake outburst floods.
     Flood hazards: river channel and river valley morphology, flood frequency and flood damages.
     Droughts and famine.
   - 9.2 **Natural Hazard Control:** Structural retaining engineering techniques and designs, Types and practices of retaining structures, bioengineering techniques and practices, Vegetation structures and their functions. 25 hrs.

10. **Urbanization and sustainable cities:** Urban growth and problems : Introductory background, component of urban growth, Methods and nexus between development and environment, comparison between economic and ecological criteria of urbanization, Origin and development of sustainable development. 10 hrs.
11. **EIA:** EIA in project planning and implementations, EIA processes, Scooping of EIA methodologies, Base line study and impact risk assessments, Management and mitigation measures, Comparison of alternative review and decision making. Compensatory actions, Nepalese perspective, policy and guidelines. 15 hrs.

Text Book

1. Miller G.T. Jr. 1995; ***Living in the Environment***, Wadsworth Publishing Company. Balmont, California, USA.

Reference Books

1. Ambasht, R.S. 1990; ***Environment and Pollution***, Students, Friends and Co. Lanka, Varanashi, India.
2. IUCN, 1997, ***Environmental Impact Assessment***, IUCN, Nepal.
3. IUCN/ESCAPE; ***Mineral Resources of Nepal***, Dept. of Mines and Geology, HMG, Nepal.
4. Deoja and Dhital: ***Mountain Risk Engineering Manual***, ICIMOD, Kathmandu, Nepal.
5. P.D. Sharma, ***Ecology and Environment***, Rastogi Publication, India, 1996.
6. D.K. Asthana and Meera Asthana, ***Environment Problems and Solutions***, S.Chand and Co. India, 1998.
7. Publication Monograph, ***Central Bereau of Standard***, HMG, Nepal, 1995.
8. Bioengineering for road's engineer's training module, vol. I and II Department of Roads, HMG Nepal, 1996.

(f) Resource Conservation and Management

Course No. : 332 **Full Marks : 100**

Nature of the course : Theory **Pass Marks : 35**

Year : III

Course Objective : To enable the students to acquire basic knowledge on resource conservation and management.

1. **Natural Resources:** Environmental crisis on planet earth, History of conservation natural resources, Fundamental principles of conservation. 5 hrs.
2. **Human Resources:** Human Demography, Population growth and their parameters, Factor affecting human population size, Socio-economic and technological factor on society, Attitude towards nature. 15 hrs.
3. **Water Resources:** Hydrologic cycle and sources, Major water reserves: ocean, glacier, surface and ground water, Water supply methods and techniques, Renewable and new sources of water, Water availability, and uses in future, Water management and conservation. 15 hrs.
4. **Biological resources:** Biological resource and biodiversity, Benefit from biological resources, Forest, agriculture, rangeland and wildlife, Destruction of biological resources, Biological resource management. 15 hrs.
5. **Earth resources:**
   - 5.1 **Land resources:** Land resources and land use, Types of land use classifications, Land types and productivity, Land use practices in Nepal, Land reform policies and practices in Nepal, Land use perspectives.
   - 5.2 **Mineral resources:** Mineral resources and mineral consumptions, Types of mineral resources : a. Metallic minerals, b. Nonmetallic minerals, c. Construction materials, d. Chemical minerals, e. Hydrocarbons, Mining practice: a. Open cast mining, b. Underground mining, Mineral resources of Nepal, Mineral Industry of Nepal, Mineral economics and laws of Nepal, Mining Industry and Environmental degradation, Mine field reclamation techniques. 15 hrs.
6. **Energy Resources:** Energy sources: Types and quality and history of energy consumption, Renewable and non renewable energies, Coal, Oil, Natural gas, Nuclear, Solar, Hydropower, etc. Energy economics and policy, Energy consumption trends and prospects, Alternative energy sources, Environmental consequences and energy conservation.
7. **Food Resources:**
   - 7.1 **Food sources:** World food problem, Production and resources of food, Human nutrition and new food resource.
   - 7.2 **Food policies:** Global agricultural policy and food aid land reform, Nepalese food policies and practices. 20 hrs.

8. **Mountain Resources:** Altitudinal feature of the earth, Ecological zonation of mountains Ecological zonation of the Himalayas, Biological, physical, climatic, constraints of mountain life, Altitudinal adjustments and human adaptability, Mountain resources and environmental concerns, Tourism, Alpinism and ecotourism. 20 hrs.
9. **Environmental Economics:** Economic growth and development, Environmental limits of economic growths, Population, technology and resources scarcity, Environmental impacts of economic growths. 10 hrs.
10. **Environmental Conservation:** Environmental policies, Environmental policy in Nepal, Environmental Education, International treaties and conventions, National legislation, International and national environmental organizations. 15 hrs.

Text Book

1. Miller, G.T. Jr. ***Living in the Environment***, Wadsworth Publishing, Company, Belmont, California, USA. 1995.

Reference Books

1. Owen, O.S., ***Natural Resource Conservation and Ecological Approach***, McMillan Publishing Company, Inc. New York.
2. WRI, World Resources ***A Guide to the Global Environment***, Oxford University Press, Oxford UK. 1992.
3. Pandey, R.K., Himalayan Heights : ***Altitude Geography***, Ratna Pustak Bhandar, Kathmandu.
4. Jha, P.K. et al edited, ***Environment and Biodiversity in the context of South Asia***, ECOS, Kathmandu, Nepal, 1996.
5. Majupuria, T.C. and Majupuria, R.K., ***Wildlife Natural Parks and Resources of Nepal***, Reservoirs Management Tec Press, Prahinam Bangkok, Thailand, 1998.
6. Majupuria, T.C., ***Nepal Naturals Paradise*** (Revised edn) Published by editor.

(g) Practical IIIA

Course No. : Env. 333 **Full Marks : 50**
Nature of the course : Practical **Pass Marks : 20**
Year : III

Course Objective : To enable the students to carry out environmental monitoring experiments.

1. To study natural soil profile and to analyze oil samples for texture and particle size using standard methods
2. To study chemical and water contents or soil samples (carbonate, nitrate, phosphate, pH, etc), Chloride.
3. To calculate soil loss using universal soil loss equations.
4. To examine air pollution using, a. natural indicators (e.g. vegetation) and b. standard methods or sampling on parameters such as SO_x, NO_2 etc (using air samples) as indicators.
5. To study water pollution using : a) free carbon dioxide as an indicator, b) dissolved O_2, Bod and COD as indicators and c) heavy metals as indicators.
6. To measure and compare noise levels in public, residential and business areas.
7. a) conduct an EIA on an ongoing or possible development works (eg: construction of residential complex, road, establishment of cottage industries etc., b) construct a simple temperature pattern (of 20-40 years) of an area using available data from Department of Hydrology, Meteorology, Civil Aviation etc, and c) construct a rainfall pattern (of 20-40 years) using available data (from Department of Hydrology, Meteorology, Civil Aviation etc.)

(h) Practical IIIB

Course No. : Env. 334 **Full Marks : 50**
Nature of the course : Practical **Pass Marks : 20**
Year : III

Course Objective : To enable the students to carry out natural resource related experiments.

1. To take random samples e.g., soil, vegetation, animals etc.
2. To study biotic community using multiple observations, quadrate method; a) frequency, density and abundance of animal species and b) frequency, density, and abundance of plant species.
3. To determine the total biomass of plants or animals of an area
4. To study an ecosystem and its functioning in : a) a controlled environment setting an aquarium and b) a natural environment (e.g , pond, forest, grassland)
5. To conduct slope stability analysis of : a) rock slopes, b) soil slopes and c) develop bioengineering technique for slope stability

6. To estimate water resource potentials by different methods.
7. a) short term environment scenario of an area, b) conduct a quick biological survey of a selected area, c) Identify major impacts of epishing mining on vegetation, animals and d) other related topics (e.g., using 23 simple variables analyze ecotourism, population growth and environment, urbanization etc.)

Recommendation:

One week long visit to Natural park/protected area/construction sites etc. is recommended if possible. In such case students should submit a written report of their visit.

12. Computer Science

(a) Computer System and Programming

Course No. : CS 311 **Full Marks : 100**

Nature of Course : Theory **Pass Marks : 35**

Year : 1st Year

Course Objectives :

It is intended that, on completion of the course, the students will be able to:

- describe fundamentals of computer including evolution, classification and architecture
- understand the basis of digital electronics
- understand the functional block diagram of various systems and peripheral
- get familiarized with the computer networking concepts
- develop algorithms
- write programs in C language

Part A : Introduction to Computers :

1. Introduction; history and evolution of computers, classification of computer, typical computer architecture 6 hrs.
2. Review of digital systems, number system, Boolen algebra, logic gates, flip-flops, adders and subtractors. 8 hrs.
3. Digital computer system and architecture;
   - 3.1. Microprocessor, processing organization, register organization, general assembly language system, addressing and formats. 6 hrs.
   - 3.2 Control Unit : hardware control, software control, micro programmed control 6 hrs.
   - 3.3 Memory system; memory organization and types, memory devices, static and dynamic RAM, ROM, PROM, EPROM's high speed and optical memory.6 hrs.
   - 3.4. I/O system; I/O types, I/O processors, bus systems 6 hrs.
   - 3.5. Architecture : modern computer architectures, RISC and CISC architecture 6 hrs.
   - 3.6. Introduction to storate systems 1 hr.
4. Computer Network, overview, topologies, protocals, LAN, WAN 8 hrs.
5. System software;
   - 5.1 Operating system, terminologies, services, file concepts, allocation, CPU scheduling concept, memory management multiprocessing and multitasking 6 hrs.
   - 5.2 Compilers and linkers 2 hrs.
   - 5.3 Programming languages 1 hr.
   - 5.4 System utilities 2 hrs.
   - 5.5 Multi-media systems 2 hrs.

Part B : Computer Programming

1. Review of computing, idea of software and programming, text editing and file concepts, operating systems 6 hrs.
2. Algorithm development; flow chart and pseudocodes, deterministic and non-deterministic techniques, series methods, iterative techniques, recursive procedures and search techniques, requirement analysis, system design, implementation and execution. 6 hrs.
3. Review of structured programming principles 1 hr.
4. The C language 62 hrs.

   The types, variables and constants; simple statements, structured statements; logical and conditional expression; arrays; functions-recursive and non-recursive; strings; structures and unions; pointers; bit oriented instructions; C- preprocessors, C libraries; error and debugging, syntax, runtime errors and debugging, overflow/underflow errors; users interfaces

5 Introduction to data structures 1 hr.
6. Programming project and software management 2 hrs.
6.1 Bottom up and top down design 1 hr.
6.2 Testing sub programs, test of module boundaries, test of boundary conditions. 2 hrs.
6.3 Documentation- structure chart and program description sheets 3 hrs.

Text Books :

1. Morris Mano - Computer System Architecture, 3rd Edition, Prentice Hall International.
2 Kelly and Phol - A Book on C, Benjamin Cummings.

Reference Books:

1 Tanenbaum -Structured Computer Organization, 3rd Edition, Prentice Hall
2. Tracy Laowey and Jeanne C. Rudder - Internet Companion : A Beginners Guide to Global Networking", Addison Wesley.
3. Hughes C.J., I. Michtom - Structured Approach to Programming, Prentice Hall International.
4. G. Keiser, Local Area Networks, McGraw -Hill International Ed.

(b) Computer Practical I

Course No. : CS 312
Nature of Course : Practical

Full Marks : 50
Pass Marks : 20
Year : 1st Year

Course Objectives :

It is intended that, on completion of the course, the students will be able to:

- Use Operating systems and application software
- Write programmes in C language

Part A : Operating Systems/Application Software:

DOS 6 hrs.
Windows 3 hrs.
Word Processing 6 hrs.
Spread Sheet 6 hrs.
Database Management 12 hrs.

Part B : Programming :

1. Simple Programming - declaration, data type I/O commands preprocessors 9 hrs.
2. Arithmetic expression 6 hrs.
3. Logical and conditional expression 9 hrs.
4. Compound Statements 9 hrs.
5. Arrays 9 hrs.
6. Modular programming 15 hrs.
7. String processing 9 hrs.
8. Pointers 12 hrs.
9. Structure and unions 9 hrs.
10. Project 30 hrs.

[Instructor should prepare individual projects for students encompassing all the above features of programming.]

(c) Information System and Design/data structure

Course No. : CS 321
Nature of Course : Theory

Full Marks : 100
Pass Marks : 35
Year : 2nd Year

Course Objectives :

It is intended that, on completion of the course, the students will be able to:

- Describe the basic concepts of Information System.
- Assimilate conceptual Information System Design, Implementation and Evaluation
- List the steps of structural design approach of IS.
- State the different system design techniques.
- Understand different data structures.
- Develop and test algorithm

1 Introduction to information system
1.1 Sources and types of information
1.2 Manual and computer based information system
2. Feasibility assessment 6 hrs.
2.1 Problems and needs in information system development

2.2 Preliminary application requirements
2.3 Preliminary assessment : economic, technical, operational and schedule feasibility — 6 hrs.

3. Planning of information system
   - 3.1 Need of planning
   - 3.2 Planning techniques
   - 3.3 Project planning
   - 3.4 Reporting and controlling

4. Conceptual system design and implementation of IS
   - 4.1 Conceptual system design
     - 4.1.1 Define the problems
     - 4.1.2 Constraints
     - 4.1.3 Alternative conceptual design
     - 4.1.4 Select and document the best design
     - 4.1.5 Prepare the conceptual design report
   - 4.2 Detailed system design
     - 4.2.1 Establish project management
     - 4.2.2 Investigative Preparation
   - 4.3. Implementation, evaluation and maintenance of IS
     - 4.3.1 Implementation alternatives
     - 4.3.2 Plan for implementation
     - 4.3.3 Cut over
     - 4.3.4 Document the system
     - 4.3.5 Evaluate the system
     - 4.3.6 Control and maintain the system
   - 4.4 M.I.S. Planning, design and implementation — 18 hrs.

5. Structured systems analysis
   - 5.1 Steps in structured system analysis
   - 5.2 Standard tool and techniques and related documentation
   - 5.3 Problem analysis — 21 hrs.

6. System design methodology
   - 6.1 Check list methodology
   - 6.2 Process- oriented Methodology
   - 6.3 Application Generation
   - 6.4 Structured design — 18 hrs.

Part B : Data Structure and Algorithm :

1. Introduction to data structure — 3 hrs.
   - 1.1 Abstract data types (ADT)
   - 1.2 Review of C data types
   - 1.3 Review of arrays in C — 6 hrs.

2. Stacks
   - 2.1 Stacks as an abstract data type (ADT)
   - 2.2 Implementation of stacks in C
   - 2.3 Typical application of stacks
     - 2.3.1 Evaluation of expressions (Infix, Postfix and Prefix) — 9 hrs.

3. Recursion
   - 3.1 Recursive definition and processes (factorial functions, multiplication of natural numbers, fibonacci sequence, binary search etc.)
   - 3.2 Writing recursive program in C (Towers of Hanoi problem etc.)
   - 3.3 Efficiency of recursions — 9 hrs.

4. Queues
   - 4.1 The queues and its sequential representation
   - 4.2 Queues as an ADT
   - 4.3 Implementation of sequences in C
   - 4.4 Priority of queues (array implementation) — 12 hrs.

5. Lists
   - 5.1 Linked lists
   - 5.2 Implementation of lists in C
     - 5.2.1 Array implementation
     - 5.2.2 Dynamic implementation
     - 5.2.3 Header nodes
   - 5.3 Other lists structures
     - 5.3.1 Circular list
     - 5.3.2 Doubly lined lists
   - 5.4 Lists implementation of stacks, queues, priority queues — 6½ hrs.

6. Trees
   - 6.1 Binary trees
     - 6.1.1 Operation and applications
     - 6.1.2 Binary tree representation
     - 6.1.3 Binary tree traversals (pre-order, post-order and In-order)
     - 6.1.4 The Huffman algorithm
   - 6.2 Trees and their applications
     - 6.2.1 Representation of trees in C
     - 6.2.2 Tree traversals
     - 6.2.3 Game tree

7. Sorting — 9 hrs.
   - 7.1 Types of sorting (internal and external)
   - 7.2 Efficiency considerations
     - 7.2.1 Big oOo notation
   - 7.3 Exchange sorts
     - 7.3.1 Bubble and quick sort and their efficiency
   - 7.4 Selection and tree sporting
     - 7.4.1 Straight selection sort
     - 7.4.2 Binary tree sort
     - 7.4.3 Heapsort
   - 7.5 Insertion Sorts
     - 7.5.1 Simple insertion
     - 7.5.2 Shell sort
   - 7.6 Merge and Radix sorts

8. Search — 6 hrs.
   - 8.1 Basic search techniques
   - 8.2 Tree searching
   - 8.3 General search trees
   - 8.4 Hashing

9. Graphics and their applications — 12 hrs.
   - 9.1 Graphs
     - 9.1.1 Application and representation of graphs
     - 9.1.2 Transitive closure
     - 9.1.3 Warshall/Es algorithm
     - 9.1.4 Short 6 test path algorithm
   - 9.2 Graph traversal and spanning forests
     - 9.2.1 Transversal methods for graphs
     - 9.2.2 Spanning forests
     - 9.2.3 Depth-first traversal and breadth-first traversal
     - 9.2.4 Minimum spanning trees
     - 9.2.5 Kruskal's and Round-Robin algorithms

10. Types of algorithm — 3 hrs.
    - 10.1 Divide and Conquer Algorithms
    - 10.2 Dynamic Programming
    - 10.3 Greedy algorithms
    - 10.4 Backtracking
    - 10.5 Local Search Algorithms

Text Books :

1. Bruch, E.R. Strater and Grundnitski - Informations Systems: Theory and Practice, 3rd Edition, Wiley- Eastern Publication, 1983.
2. Data Structure and Algorithms by Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman.

References :

1. Collins and G. Blay - Structured System Development Techniques, Strategic Planning to System Testing Pit.
2. Davis and G.C. Everest - Reading in Management Information System, McGraw- Hill.
3. Ganes and T. Sarson - Structured system analysis : Tools and Techniques, Prentice-Hall, Englewood cliff, N.J.
4. Murdick, Ross and Clagget - Information System for Modern Management, McGraw-Hill.
5. Tenenbaum, Langsam, Augenstein- Data structure using C - Prentice Hall Kruse, Leung and Tondo - Data Structure and Program Design in C - Prentice Hall.
6. J. Nivergelt, K. Hinrichs - Algorithms and Data Structures with Applications to Graphics and Geometry, Prentice - Hall.

(d) Computer Practical II

Course No. : CS 322
Nature of Course : Practical

Full Marks : 50
Pass Marks : 20
Year : 2nd Year

Course Objectives :

It is intended that, on completion of the course, the students will be able to:

- learn different data structures
- develop and test algorithm
- analyse and design information system

Part A : Data Structures and Algorithm :

1.	Implementation of stacks in C language	9 hrs.
2.	Writing recursive programs in C language	9 hrs.
3.	Implementation of queues in C language	9 hrs.
4.	Implementation of list in C language	12 hrs.
5.	Representation of trees in C language	15 hrs.
6.	Writing sorting program in C language	12 hrs.
7.	Implementation of search in C language	9 hrs.
8.	Implementation of different types of algorithms	15 hrs.

Part B : Information System and Design 60 hrs.

1. Project work
[Instructor should assign individual projects for student encompassing all the features of information system]

(e) Computer Aided Modeling and Numerical Methods

Course No. : CS 331 (Major)
Nature of Course : Theory

Full Marks : 100
Pass Marks : 35
Year : 3rd Year

Course Objectives :

- To provide the knowledge of Simulation and modeling for discrete and continuous systems
- To study the theory of numerical computational procedure for solving different problems.
- Solution of ordinary and partial differential equation.
- To provide basic knowledge of computer graphics.

(A) Simulation and Modeling:

1.0 Introduction to simulation — 5 hrs.
- 1.1 System concepts.
- 1.2 System modeling
- 1.3 Mathematical models : their nature and assumptions
- 1.4 Calibration and validation

2.0 Discrete and continuous system — 8 hrs.
- 2.1 Queuing System
- 2.2 Markov chains
- 2.3 Differential and partial differential equations

3.0 Generation of random variables — 10 hrs.
- 3.1 Uniform random generators
- 3.2 Testing of uniform random generators
- 3.3 Methods of generating non-uniform variables
- 3.4 Inversion, rejection, composition

4.0 Analysis of simulated output — 10 hrs.
- 4.1 Estimation methods
- 4.2 Simulation run statistics
- 4.3 Replication of internet bias

5.0 Simulation languages — 12 hrs.
- 5.1 Discrete system modeling and simulation with GPSS
- 5.2 Basic concepts
- 5.3 Resources in GPSS, GPSS programs, applications
- 5.4 Continuous systems modeling and simulation with CSMP
- 5.5 Structural data and control statements, hybrid simulation
- 5.6 Feedback system, typical applications

(B) Numerical Methods

1.0 Introduction of Numerical methods: 10 hrs.
- 1.1 Review of calculus, continuity, differentiability, intermediate value theorem, Taylor's theorem
- 1.2 Absolute, relative, and round off errors, error bounds for computational errors
- 1.3 Bisection method, its error bounds and convergence
- 1.4 Newton's method, secant method and their convergence
- 1.5 Fixed point iteration, its convergence properties.
- 1.6. Zeros of polynomials by Horner's method

2.0 Interpolation and approximation: 10 hrs.
- 2.1 Taylor's polynomial approximation, Language's interpolation
- 2.2 Newton's interpolation and divided differences
- 2.3 Iterative interpolation
- 2.4 Cubic spline interpolation
- 2.5 Least square methods of fitting continuous and discrete data or function

3.0 Numerical differentiation and integration: 5 hrs.
- 3.1 Numerical differentiation formulae
- 3.2 Newton-Coot's numerical integration formula.
- 3.3 Composite numerical integration
- 3.4 Gossip interpolation formula

4.0 Linear algebraic equation 10 hrs.
- 4.1 Review of the properties of matrices
- 4.2 Matrix - form of Gossip elimination
- 4.3 Chousky's and related algorithms for matrix factorisation

5.0 Solution of ordinary differential equation : 7 hrs.
- 5.1 Euler's method for solving ordinary differential equation of 1st order and other related methods
- 5.2 Runge- Kutta methods
- 5.3 Extension to higher order equations
- 5.4 Initial value problems
- 5.5 Boundary value problems

6.0 Solution of partial differential equations: 3 hrs.
- 6.1 Introduction to the solution of partial differential equations
- 6.2 Examples of differential equation of two variables

(C) Computer Graphics

1.0 Introduction to computer graphics 3 hrs.
- 1.1 History of computer graphics
- 1.2 Data visualization

2.0 Geometry and modeling of objects : 6 hrs.
- 2.1 Line, circles, ellipsoid, paraboloid and hyperboloid
- 2.2 Projection : Orthographic and perspective
- 2.3 Sectional views

3.0 Hardware component 5 hrs.
- 3.1 Mouse Keyboard, light-pen, touch-screen and tablet input hardware
- 3.2 Raster and vector display
- 3.3 Plotter
- 3.4 Architecture of simple graphics display terminals including frame buffer
- 3.5 Graphics processors

4.0 Two dimensional algorithms: 10 hrs.
- 4.1 Direct and incremental line drawing algorithms
- 4.2 Bresenham algorithm
- 4.3 Two- dimensional geometric transformation
- 4.4 2D viewing
- 4.5 Two dimensional rotation, scaling and transitional transforms

5.0 Three-dimensional graphics : 12 hrs.
- 5.1 3-D geometric and modeling transformations
- 5.2 3-D World top screen perspective viewing
- 5.3 Extension of 2-D to 3-D transfer
- 5.4 Methods of generating non-planar surfaces
- 5.5 Hidden line and hidden surface removal techniques
- 5.6 Visible surface detection techniques
- 5.7 Illumination and surface rendering techniques
- 5.8 Colour models and colour applications
- 5.9 Constant Gouraud and Phone shading models

6.0 Graphic languages and software's : 10 hrs.
- 6.1 Machine independent graphical languages
- 6.2 Use of visual C++ to develop graphics

7.0 Graphics project development 8 hrs.
- 7.1 Project planning and description
- 7.2 Project development using visual C++

8.0 Computer Animation : 2 hrs.

9.0 Introduction to image processing 4 hrs.
- 9.1 Application of image processing

Test Books :

1. Hearn and M.P. Baker - Computer Graphics, 2nd ed PHI
2. Foley, S.K. Feier, J.F. Hughes - Computer Graphics and Practices, 2nd ed. Addison - Wesley

Reference Books :

1. Spriest and G.C. Vansteenkiste. "Computer - Aided Modeling and Simulation", Academic Press.
2. Gorden, "System Simulation", Printice Hall of India Pvt. Ltd.
3. Law and R.F. Perry, "Simulation : A Problem - Solving Approach", Addison Wesley Publishing Company.
4. Law and WD Kelton, "Simulation Modeling and Analysis", McGraw-Hill Editions, 1991.
5. "A course is computer programming with numerical technique", P- Sojan Lal and a. Domkundwar, Dhanpat Rai and Sons, New Delhi, 1996.
6. Yakowitz and F. Szidatovszky, "An Introduction to Numerical Computations", Macmillan Publishing Co.
7. "Numeral Methods for Engineering Problems", N. Krishna Raju and K.U. Mutbu, Second Edition MacMillian India Limited.
8. Programming in Visual C++

(f) Data Base Management System (DBMS)

Course No. : CS 332 (Major)
Nature of Course : Theory

Full Marks : 100
Pass Marks : 35
Year : 3rd Year

Course Objectives :

- To provide the knowledge of Data base management system
- To provide the knowledge of OOPS and familiarization of C++ programming language.

1.0 Introduction : 3 hrs.
- 1.1 Purpose and data abstraction
- 1.2 DMS model, Instances and Schemes
- 1.3 Data independence DDL, DML
- 1.4 Database manager, administrator users
- 1.5 Overall system structure

2.0 Entry - Relationship Model : 12 hrs.
- 2.1 Entities and entity sets
- 2.2 Relationship and Relationship sets
- 2.3 Attributes
- 2.4 Mapping constraints
- 2.5 Keys
- 2.6 E-R diagram
- 2.7 Reducing E-R Diagrams to Tables
- 2.8 Generalization
- 2.9 Aggregation
- 2.10 Design of E-R Database Scheme

3.0 Relational Model : 6 hrs.
- 3.1 Structure of Relational Databases
- 3.2 The Relational Algebra
- 3.3 The Tuple Relational Calculus
- 3.4 The Domain Relational Calculus
- 3.5 Modifying the Database
- 3.6 Views

4.0 Relational Commercial Languages : 6 hrs.
- 4.1 SQL
- 4.2 Query by Example

5.0 Integrity Constraints:
- 5.1 Domain Constraints
- 5.2 Referential Integrity
- 5.3 Functional Dependencies
- 5.4 Assertions
- 5.5 Triggers

6.0 Relational Database Design — 6 hrs.
- 6.1 Features Relational Database Design
- 6.2 Normalisation using Functional/Multivalues/Join and put fall of Dependencies
- 6.3 Domain - Key Normal Form
- 6.4 Alternative approaches to Database Design

7.0 File and System Structure: — 6 hrs.
- 7.1 File organization
- 7.2 Organization of Records into Blocks
- 7.3 Sequential files
- 7.4 Mapping Relational Data to Files
- 7.5 Data Dictionary Storage
- 7.6 Buffer Management

8.0 Indexing and Hashing — 5 hrs.
- 8.1 Indexing, B - Tree Index Files
- 8.2 Hash Functions, Multiple - Key Access

9.0 Query Processing: — 6 hrs.
- 9.1 Query Interpretation
- 9.2 Equivalence of Expressions
- 9.3 Estimation of Query Processing Cost
- 9.4 Estimation of Costs of Access Using Indices
- 9.5 Joint Strategies

10. Crash Recovery: — 5 hrs.
- 10.1 Failure Classification
- 10.2 The Storage Hierarchy
- 10.3 Transaction Model
- 10.4 Log-Based recover
- 10.5 Buffer Management
- 10.6 Checkpoints
- 10.7 Shadow paging
- 10.8 Failure with Loss of Non-volatile Storage
- 10.9 Stable storage implementation

11. Concurrency Control : — 3 hrs
- 11.1 Schedules
- 11.2 Testing for serializability
- 11.3 Lock-based Protocols
- 11.4 Timestamp-based Protocols
- 11.5 Validation Techniques
- 11.6 Multiple Granularity
- 11.7 Multiversion Schemes
- 11.8 Insert and Delete Operations

12. Transaction Processing: — 4 hrs.
- 12.1 Storage Model
- 12.2 Recovery from transaction failure
- 12.3 Deadlock Handing
- 12.4 Weak Levels of Consistency
- 12.5 High Performance Transaction systems.
- 12.6 Concurrency in Index Structures
- 12.7 Long Duration Transactions

13. Security and Integrity : — 3 hrs.
- 13.1 Security and Integrity features and Violations
- 13.2 Authorization and Views.
- 13.3 Encryption

14. Role of Database manager administrator and uses: — 1 hrs.

15. Advanced Topics : — 6 hrs.
- 15.1 Object Oriented Model, Extended Relational Systems
- 15.2 Distributed
- 15.3 Databases
- 15.4 Network Model

Object Oriented Programming In C++ — 6 hrs.

1. Introduction :
   - 1.1 Object Oriented Programming
   - 1.2 Characteristics of Object Oriental Progamming (OOPS) Languages — 15 hrs.
2. C++ Programming Basics :
   - 2.1 C++ Program Construction
   - 2.2 Input and Output Statements
   - 2.3 Manipulators
   - 2.4 Data Types
   - 2.5 Variables
   - 2.6 Pre-Processor Directive
   - 2.7 Type Conversion
   - 2.8 Arithmetic Operators
   - 2.9 Loops and Decisions
   - 2.10 Structures
   - 2.11 Functions
   - 2.12 Arrays, Pointers
   - 2.13 Files and streams — 9 hrs.
3. Objects and Classes :
   - 3.1 A Simple class
   - 3.2 C++ Objects
   - 3.3 Constructors
   - 3.4 Objects as function arguments — 9 hrs.
4. Operator Overloading :
   - 4.1 Overloading Unary and Binary Operations
   - 4.2 Data Conversion
   - 4.3 Advantages and disadvantages — 12 hrs.
5. Inheritance:
   - 5.1 Derived Class and Base Class
   - 5.2 Overriding Member Functions
   - 5.3 Class Hierarchies
   - 5.4 Public and Private Inheritance
   - 5.5 Levels of Inheritance
   - 5.6 Multiple Inheritance — 9 hrs.
6. C++ Functions :
   - 6.1 Virtual Functions
   - 6.2 Friend Functions
   - 6.3 Static Functions
   - 6.4 Assignment and Copy Initialization
   - 6.5 Italics letter pointer — 15 hrs.
7. Visual Program Development Tools :

Text Books :

1. Database System Concepts - Henry, F. Korth and Abraham Silberschatz., McGraw Hill
2. DBMS - C.J. Date.

Reference Books :

1. Object - Oriented Programming in Microsoft C++ - Robert Lafore, Galgotia Publications.

(g) Computer Aided Modeling and Numerical Methods

Course No. : CS 333
Nature of Course : Practical

Full Marks : 50
Pass Marks : 20
Year : 3rd Year

Course Objectives :

- To provide practical experience in simulation and graphic design using graphic software and numerical method with programming language C or C++
- To provide practical experience on topics covered in OOPS and DBMS by the familiarization of C++ programming language and a RDBMS software.

Part A

1. Familiarization with the simulation package.
2. Design and implementation of simple simulation package.

3. Familiarization with the graphic software.
4. Familiarization with graphic system hardware.
5. Development and comparison of various drawing algorithm, color maps and animations.
6. Design of two-dimensional graphics.
7. Design of three-dimensional graphics.
8. Design and implementation of simple graphical software using high-level language like visual C++ or visual basic system.
9. Design and implementation of iterative routine.
10. Design and implementation of interpolation and approximation routine.
11. Design and implementation of numerical differentiation routine.
12. Design and implementation of numerical integration routine.
13. Design and implementation of linear algebraic equation routine.
14. Design and implemgntation of simple partial differential equation routine.

Part B

1. OOPS :
   - 1.1 C++ programming making use of I/O statement, operators, types, overloading functions.
   - 1.2 C++ programming using classes, encapsulation, constructors, destructors.
   - 1.3 C++ programming using drive classes and inheritance
   - 1.4 C++ programming using virtual functions and overloading operations
   - 1.5 Familiarization of visual development for creating windows applications.
2. DBMS :
   - 2.1 Familiarization and practice of E-R modeling techniques for logical database design and converting the logical design to a typical physical design
   - 2.2 Familiarization with and practice on SQL DDL statements.
   - 2.3 Familiarization and practice on SQL DML statements and their optimization.
   - 2.4 Familiarization with concurrency control, security, integrity of a typical RDMS software.

(h) Computer Aided Modeling and Numerical Methods

Course No. : CS 334 **Full Marks : 50**

Nature of Course : Project Work **Pass Marks : 20**

Year : 3rd Year

Project work on a given topics 60 hrs.

Project Work :

Instructor should assign individual projects for students encompassing all the features of information system.