

# Three Years Bachelor in Science Programme

GIF 7



**EFFECTIVE FROM JULY, 1996**

**OFFICE OF THE DEAN**  
Tribhuvan University  
Sanothimi, Bhaktapur Nepal

**Background:**

The two-year B.Sc. programme in Nepal was started in 1948 at Tri-chandra College. The programme was then affiliated to Patna University in India. The courses of instruction and the system of examination were the same as those of Patna University. B. Sc. was considered to be the prerequisite for doing M.Sc. in Nepal and in India and it had, therefore, no specific level objectives. A major modification of the curriculum in terms of structure and content was made in 1973 under the National Education System Plan. The Bachelor's degree was termed "Diploma in Science". Most of the topics prescribed previously were retained in the new courses. These topics were, however, divided into units and placed under "credit" courses in view of the then prevailing semester system. In 1980, Tribhuvan University discontinued the semester system and introduced the annual system. The curriculum was revised so that it might comply with the annual examination system. In this revision also the basic structure of the curriculum remained more or less the same. Since then some efforts have now and then been made to update the contents of the courses. Presently, TU has made a plan to run three year Bachelor's degree course from the academic year 2053/2054. Following structure has been proposed here for the same.

**Objectives:***The objectives of the 3-year B. Sc. programme are:*

- To upgrade the quality of the B. Sc. programme so that TU science graduates could compete academically with the graduates from other Asian universities;
- To broaden the intellectual horizon of the students;
- To make the B. Sc. programme more practical and relevant to the professional needs of national development, and
- To provide the students with in-depth knowledge in the area of specialization.

*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 prerequisite and remedial avenues:**

The students should have a good background of Physics, Chemistry, Mathematics and Biology prescribed for PCL ( I.Sc.) or of a standard equivalent thereto. A student from biology stream of PCL level opting Physics, Statistics or Mathematics as his/her major or one of the minor subjects must have completed Mathematics course of physical group in PCL level. A student majoring in Physics and Statistics must have Mathematics as one of his / her minor subjects in B. Sc. level and a student majoring in Computer science must have Physics as one of his/ her minor subjects. The students who lag behind in some of the subject areas may make up their deficiencies by taking up remedial and bridge courses as required.

**Major/minor combinations, compulsory and / elective courses:**

A student who has fulfilled the prerequisites mentioned above can offer any of the eleven subjects mentioned below in the course structure. They can select one of them as a major subject and two of them as minor subjects depending upon the availability of facility in the campus. They can however, select only one subject from among the subjects: Meteorology, Geology, Microbiology, Environmental Science and Computer Science. The students will have to study compulsory and / elective courses in his/her third year.

**The entry requirement :**

Students securing a minimum of 45% marks in any of the following examinations:

- PCL (science) or I.Sc. examination of Tribhuvan University or any equivalent examination recognized by Tribhuvan University,
- 10 + 2 examination, from the science stream recognized by Tribhuvan University, as equivalent to PCL (science),

will be eligible to apply for admission.

***They must., however, pass the Entrance Examination conducted by the Institute.***

**The course structure: Total weightage: 1400 Marks.**

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

|                      |     |                           |    |
|----------------------|-----|---------------------------|----|
| 1. Physics           | 70  | 2. Chemistry              | 18 |
| 3. Zoology           | 104 | 4. Botany                 | 5  |
| 5. Mathematics       | 44  | 6. Statistics             | 93 |
| 7. Geology           | 31  | 8. Meteorology            | 53 |
| 9. Microbiology      | 70  | 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, excepting Mathematics ) in the first year and the second year.

c) **Compulsory and / Electives: 200. Marks** Details of these courses will be made available in due course of time.

**The course duration and hrs of instruction, etc. will be as follows:**

- a. **Duration** : 3 years (first two years general and the final year specialization)
- b. **Working Days** : 150 work days in one academic year

- c. **Working hrs** : At least 6 work hrs a day
- d. **Class hour** : 1 hour is equivalent to 1 class hour (period)
- e. **Theory** : One theory paper of 100 marks will have 1 class hour per day, i.e. 6 class hrs per week
- f. **Practical** : One practical paper of 50 marks will have 6 practical hour per week
- g. **Practical class** : Each practical class is of three hrs
- h. **Attendance** : Seventy percent attendance in the class is compulsory.

**Course structure and cycle at a glance**

|                | Theory marks | Practical marks | Total marks |
|----------------|--------------|-----------------|-------------|
| Major          | 400          | 200             | 600         |
| Minor 1        | 200          | 100             | 300         |
| Minor 2        | 200          | 100             | 300         |
| Elective/ Comp | 200          | x               | 200         |
| <b>Total</b>   | 1,000        | 400             | 1,400       |

*For Mathematics, there will however, be no practical courses*

**First Year**

| Subjects     | Paper | Marks  |           |       | Class hrs per week |           |
|--------------|-------|--------|-----------|-------|--------------------|-----------|
|              |       | Theory | Practical | Total | Theory             | Practical |
| Major        | I     | 100    | 50        | 150   | 6                  | 6         |
| Minor.1      | I     | 100    | 50        | 150   | 6                  | 6         |
| Minor.2      | I     | 100    | 50        | 150   | 6                  | 6         |
| <b>Total</b> |       | 300    | 150       | 450   | 18                 | 18        |

*For Mathematics, there will however, be two theory courses of 75 full marks and no practical courses*

**Second Year**

| Subjects     | Paper | Marks  |           |       | Class hrs per week |           |
|--------------|-------|--------|-----------|-------|--------------------|-----------|
|              |       | Theory | Practical | Total | Theory             | Practical |
| Major        | II    | 100    | 50        | 150   | 6                  | 6         |
| Minor.1      | II    | 100    | 50        | 150   | 6                  | 6         |
| Minor.2      | II    | 100    | 50        | 150   | 6                  | 6         |
| <b>Total</b> |       | 300    | 150       | 450   | 18                 | 18        |

*For Mathematics, there will however, be two theory courses of 75 full marks and no practical courses*

**Third Year**

| Subjects       | Paper | Marks  |           |       | Class hrs per week |           |
|----------------|-------|--------|-----------|-------|--------------------|-----------|
|                |       | Theory | Practical | Total | Theory             | Practical |
| Major (I)      | III   | 100    | 50        | 150   | 6                  | 9         |
| Major (II)     | IV    | 100    | 50        | 150   | 6                  | 9         |
| Comp/ Elective |       | 200    | x         | 200   | 12                 | x         |
| <b>Total</b>   |       | 400    | 100       | 500   | 24                 | 18        |

*For Mathematics, there will however, be no practical courses*

|                    |                 |   |             |
|--------------------|-----------------|---|-------------|
| <b>Total Marks</b> | <b>I Year</b>   | - | <b>450</b>  |
|                    | <b>II Year</b>  | - | <b>450</b>  |
|                    | <b>III Year</b> | - | <b>500</b>  |
| <b>Total</b>       |                 |   | <b>1400</b> |

**Evaluation :**

*Minimum pass mark : THEORY 35 % and PRACTICAL 40 %*

A student having passed his/her 3 years 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)

The student will have to pass separately in theory and practical examinations.

Regulations framed by the Academic Council will have to be followed by all the students.

Tribhuvan University  
**Institute of Science and Technology**  
 Three year B. Sc. Botany Course of study  
 2052

**Subject:** Cryptogamic Botany, Gymnosperms and Angiosperms.  
**Course No.:** Bot 311 (Major/Minor)  
**Nature of the course:** Theory

**Full Marks:** 100  
**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

**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, characteristics and economic importance.  
 b) Structure and life cycle of the following types: Plasmodiophora, Saprolegnia, Albugo, Eurotium, Peziza, Puccinia, Agaricus, Alternaria, Helminthospreium. 40 hrs.
3. **Plant Pathology:** a). Introduction and scope of plant pathology. b). Symptoms of plant diseases caused by - Fungi, Bacteria and viruses. c). Dissemination of the inoculum through - Soil, Insects, Water, Men, Fungi, Seed, Wind and Birds. d.) Disease control through - Chemical, Biological and Genetical methods. e). Study of the casual organism, symptoms, etiology and control of following diseases - Late blight of potato, Downy mildew of spinach, Loose smut of Maize, Ring rot of potato and 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. 25 hrs.

**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) Steelar system. c) Heterospory d) Habit and Habitat, life cycle, development of sex organs with reference to following types: Lycopodium, Selaginella, Equisetum, Pteris and Marsilea. e) Economic importance, Distribution with reference to Nepal.
3. **Gymnosperms:** a) Classification and characteristic 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. **50 hrs.**

#### 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: Dicotyledonae- Ranunculaceae, Caryophyllaceae, Rutaceae, Lamiaceae, Polygonaceae, Rosaceae, Euphorbiaceae, Scrophulariaceae, Monocotyledonae- Orchidaceae, Poaceae.
2. **Economic Botany:** a. Botany, distribution, cultivation and economic importance of the following plants: Rice, Potato, Soybean, Mustard, Serpentina, Sissoo. b. Ethnobotany: Introduction with selected examples. **40 hrs.**

#### 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 Eastern 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 to 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*,

**Subject :** Cryptogamic Botany, Gymnosperms and Angiosperms  
**Course No.:** Bot 312(Major/Minor)  
**Nature of the course :** Practical

**Full Marks :** 50  
**Pass Marks :** 20  
**Year:** I

1. **Algae:** Study of the habit, structure of vegetative and reproductive parts of the following types: Oscillatoria, 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, Albugo, Eurotium, Peziza, Puccinia graminis, Agaricus, Alternaria, Helminthosporium.
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 of stains : lactophenol, gram stains. d). experiments on : study of 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 viral symptoms with the help of 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:** a). Study of museum specimens. b). Anatomical study of Lycopodium, Equisetum and Pteris. c). Herbarium specimens.
9. **Gymnosperms:** a). Study of herbarium specimens: Pinus, Cycas, Taxus and Cedrus b). Museum specimens: Male and female cone of Pinus. c. Anatomical study of Stem - Pinus and Cedrus.
10. **Taxonomy and Economic Botany:** a). Systematic study of plants from the families mentioned in the syllabus with reference to local flora. b). Preparation of herbarium specimens of local plants. c). Field visit to observe floristic composition. d). Practicals on economic botany based on topics mentioned in the syllabus.

**Subject :** Ecology, Physiology, Cytology and genetics,  
Embryology and Anatomy  
**Course No.:** Bot 321 (Major/Minor)  
**Nature of the course :** Theory

**Full Marks:** 100  
**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 emphasise the role of plants in human affairs

**Unit I**

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 hrs.**

**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, Krebs 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<sub>3</sub> and C<sub>4</sub> plants **40 hrs.**

**Unit III**

1. **Cytology and Genetics:** a) Structural organisation of prokaryotic and Eukaryotic 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 significance. 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 **35hrs.**

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.

#### 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 hrs.**

#### Unit V

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

#### 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 Naggar, New Delhi-110555, India.
9. Odum E.P. : *Fundamentals of Ecology*, WB Saunders; Toppan Co.Ltd. Tokyo, Japan.
10. Ambasht, 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.

**Subject :** Ecology, Physiology, Cytology and genetics,  
Embryology and Anatomy

**Course No.:** Bot 322(Major/Minor)

**Nature of the course :** Practical ✓

**Full Marks :** 50

**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 Vicia faba (photomorphogenesis).
3. **CYTOLOGY AND GENETICS:** a). Mitosis - Study of different stages of mitosis in onion root tip., b). Meiosis: Study of behavior 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.

**Subject:** Plant Bio-chemistry and plant Biotechnology  
**Course No.:** Bot 331(Major)  
**Nature of the course:** Theory

**Full Marks:** 100  
**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 hrs.**
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-saccharides 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 quaternary 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 hrs.**
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 hrs.**
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) Micropropagation 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*,

**Subject:** Plant Bio-chemistry and Plant Biotechnology  
**Course No.:** Bot. 332. (Major)  
**Nature of the course:** Practical

**Full Marks:**50  
**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 catalase 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.

**Subject:** Environment and Biodiversity  
**Course No.:** Bot. 333(Major)  
**Nature of the course:** Theory

**Full Marks:**100  
**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 hrs**
2. **Environmental issues:** Population, deforestation, development activities, Urbanization, Pollution, waste disposal, Pesticide use and abuse, fertilizer. **6 hrs**
3. **Biosphere, biomes and climate:** Major biomes, Structure and composition of the biosphere, Weather and climate **10 hrs**
4. **Matter, Energy and Ecosystem:** Matter: forms and structure, Energy: Types, laws, Ecological pyramids, food chain, trophic level **15 hrs**
5. **Environmental pollution and control measures:** Air, Soil, Water, Noise, Environmental hazards. **(10 hrs)**
6. **Natural resources and their conservation:** Water, land mineral, forest. **10 hrs**
7. **Environmental Affairs:** Education, legislation, Organization. **6 hrs**
8. **Environmental Impact Assessment Methodology.** **6 hrs**

**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 hrs**
2. **Loss of biodiversity:** Causes and consequences, species extinction, Threatened species. **5 hrs**
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 hrs**
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 hrs**
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 hrs**

**Environment and Biodiversity Text Book:**

1. Verma, P.S. and Agrawal, V.K.: *Principles of Ecology*, S. Chhanda & Co(P)Ltd. Ram Naggar, 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. Groombridgbe 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.

**Subject:** 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 quadrat 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.

**TRIBHUVAN UNIVERSITY**  
**Institute of Science and Technology**  
**Three year B. Sc. Chemistry course of study**  
**(2052)**

**Course Title:** Basic Chemistry I  
**Course No.:** CHEM 311 (major/minor)  
**Nature of the course:** Theory

**Full Marks:** 100  
**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**

**Atomic structure:**-Bohr's theory and refinements, wave mechanical model of the atom, matter waves, de Broglie's equation, Heisenberg's uncertainty principle, Schrodinger's wave equation (time independent), physical significance of wave function, probability density pattern for hydrogen atom, radial and angular wave functions, radial distribution curves, shapes of s,p,d orbitals; quantum numbers and their significance, energy level diagram. **10 hrs**

**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 orbitals. **3 hrs**

**Nuclear Chemistry:**-Composition of nucleus (nuclear stability), binding energy, radioactivity, half life determination and nuclear reactions. **4 hrs**

**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. **7 hrs**

**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 character from dipole moments and electronegativity differences, characteristics of ionic compounds, structure of ionic solids, ionic compounds of type AX ( NaCl, CsCl, ZnS ), AX<sub>2</sub> ( CaF<sub>2</sub> TiO<sub>2</sub> ), layer structures, stoichiometric and non-stoichiometric defects. **8 hrs**

**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 lone 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.configurations of simple diatomic molecules (H<sub>2</sub>, He<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, F<sub>2</sub>, CO, NO, HCl and related species). **12 hrs**

**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. **4 hrs**

**Principles of qualitative and quantitative Analysis:**-Solubility product, common ion effect, their application in group separation, principles of gravimetric and volumetric analysis. **5 hrs**

### Group B: Organic Chemistry

**Alkane:**-Energetics of reaction, energy profile diagram, exothermic and endothermic reactions, free rotation about the carbon - 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, reactions, halogenation, mechanism of halogenation, orientation of halogenation, relative reactivity of alkanes towards halogenation, ease of abstraction of hydrogen atom, stability of free radicals, ease of formation of free radicals, reactivity and selectivity, combustion, the green house effect, pyrolysis. **10 hrs**

**Stereochemistry:**- Stereochemistry and stereoisomerism, optical activity, the polarimeter, specific rotation, enantiomerism and tetrahedral carbon, enantiomerism and optical activity, prediction of enantiomerism (chirality), the chiral center, enantiomers, the racemic modification, configuration, specification of configurations (R and S), sequence rules, diastomers. **7 hrs**

**Alkyl halide (Nucleophilic 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). **8hrs**

**Alcohols and Ethers:**-Introduction, structure, physical properties, industrial source, fermentation, fuel from carbohydrate, ethanol: preparation, reactions, alcohols as acids and bases, reaction of alcohols with hydrogen halides, formation of alkyl sulphonates, oxidation of alcohols, industrial source of ethers, preparation of ethers, Williamson synthesis, reactions of ethers. **8hrs**

**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, electrophilic 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.

**Alkynes:**-Structure of acetylene, physical properties, industrial source of acetylene, preparation of alkynes, reactions of alkynes, reduction to alkenes, electrophilic addition to alkynes, hydration of alkynes, acidity of alkynes, reactions of metal acetylides, formation of carbon-carbon bonds. **4 hrs**

**Group C: Physical Chemistry**

**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.

12 hrs

**Liquid State:**-Qualitative treatment of liquids, vapour pressure, vapour pressure and boiling point, surface tension and its determination using stalagmometer, viscosity and its determination by Ostwald viscometer method and applications of surface tension and viscosity measurements.

3 hrs

**Solid State:**-Crystalline and amorphous solids, classification of solids on the basis of dominant type of bond.

2 hrs

**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.

3 hrs

**Ionic Equilibrium:**-Strong and weak electrolytes, 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.

8 hrs

**Colligative Properties:**-Dilute solution, Raoult's law and determination of vapor 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, abnormalities in solution due to association and dissociation.

8 hrs

**Colloidal Solution:**-Colloidal state of matter, lyophilic and lyophobic colloids, preparation and purification of colloids, preparation and purification of colloids, brief discussion of kinetic, optical and electrical properties of colloids.

4 hrs

**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  $\Delta E$  using bomb calorimeter, enthalpy, experimental determination of  $\Delta H$ , 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 (Kirchoffs equation), calorific value of fuel, calorific value of food.

10 hrs

**Course Title:** Basic Practical Chemistry ✓  
**Course No.** CHEM 312 (major/minor)  
**Nature of the Course:** Practical

**Full Marks:** 50  
**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 perform experiments having due regard for safety.
- to develop in students skills of observation and their ability to record and interpret those observations.

**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) **18 hrs**

**Qualitative analysis of simple inorganic salt mixture containing 2 cations and 2 anions:-**Hg<sup>+</sup>, Pb<sup>++</sup>, Ag<sup>+</sup>, Cu<sup>++</sup>, Hg<sup>++</sup>, As<sup>+++</sup>, Sb<sup>+++</sup>, Sn<sup>++</sup>, Bi<sup>+++</sup>, Cd<sup>++</sup>, Al<sup>+++</sup>, Zn<sup>++</sup>, Mn<sup>++</sup>, Fe<sup>+++</sup>, Co<sup>++</sup>, Ni<sup>++</sup>, Cr<sup>++</sup>, Ca<sup>++</sup>, Ba<sup>++</sup>, Sr<sup>++</sup>, Mg<sup>++</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup> NO<sub>3</sub><sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>, SO<sub>4</sub><sup>--</sup>, CO<sub>3</sub><sup>--</sup>, PO<sub>4</sub><sup>--</sup> **30 hrs**

**Purification of organic compounds:-**Purification of crude organic compound- recrystallization (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<sub>2</sub>, -phenol ). **51 hrs**

**Determination of physical properties:-**Determination of surface tension of a liquid using Stalagmometer.. 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.. Comparison 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, naphthalene by Rast's camphor method. **51 hrs**

**Course Title:** Basic Chemistry II  
**Course No.:** CHEM 321 (major/minor)  
**Nature of the Course:** Theory

**Full Marks:** 100  
**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 hrs**

**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 hrs**

**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 hrs**

**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 hrs**

**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 hrs**

**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 reactions, reactivities and orientation, theory of orientation, electron release via resonance, effect of halogenation on electrophilic aromatic substitution. **10 hrs**

**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, Cannizzaro reaction, addition of Grignard

reagents, products of Grignard synthesis, acidity of  $\alpha$ -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 hrs**

**Carboxylic Acids:**-Structure, nomenclature, physical properties, salts of carboxylic 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  $\beta$ -keto acids and malonic acids. **10 hrs**

**Amines:**-Structure, classification, nomenclature, physical properties, industrial source, preparation, reduction of nitro compounds, aminolysis 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 hrs**

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

### 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 hrs**

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

**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 hrs**

**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 hrs**

**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 hrs**

**Thermodynamics:**-Molar heat capacities, relation between  $C_p$  and  $C_v$ , 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 hrs**

**Course Title:** Basic Practical Chemistry II

**Full Marks:** 50

**Course No.:** CHEM 322 (major/minor)

**Pass Marks:** 20

**Nature of the Course:** Practical

**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 hrs**

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

**Preparative Organic Chemistry:-**Single step preparation involving the following types :- methylation, esterification, acetylation, benzylation, 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 vacuum etc. **51 hrs**

**Experiments on Physical Chemistry:-**Study the kinetics of hydrolysis of methyl acetate in presence of hydrochloric acid at room temperature, study the kinetics reaction 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 Déwar flask/polystyrene cup as calorimeter. **48 hrs**

Course Title: General Chemistry  
 Course No.: CHEM 331 (major)  
 Nature of the Course: Theory ✓

Full Marks: 100  
 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 hrs

**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 hrs

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

**Chemical Fertilizers:**-Nitrogen fixation and synthetic fertilizers. 8 hrs

**Reactions in nonaqueous solvents:**-Reactions of  $NH_3$ , reactions of  $SO_2$  6 hrs

**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 hrs

**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 hrs

**Reactive Intermediates:**-Stability, structure, generation and fate of carbocation, carbanion, free radical, carbene, nitrene and benzyne, non classical carbonium ion, neighbouring group participation by  $\pi$  and  $\sigma$  bonds, aromaticity and anti-aromaticity. 14 hrs

**Spectroscopy and Structure:**-Determination of structure (spectroscopic methods), the mass spectrum, the electromagnetic spectrum, the infrared spectrum, infrared 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 hrs

**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 hrs**

**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 hrs**

### 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:  $\Delta H$  and  $\Delta S$  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 hrs**

**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 hour**

**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 hrs**

**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 hrs**

**Course Title:** General Practical Chemistry I  
**Course No.** CHEM 332 (major)  
**Nature of the Course:** Practical

**Full Marks:** 50  
**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 hypotheses.
- 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<sup>++</sup>, Hg<sup>++</sup>, Ag<sup>+</sup>, Hg<sup>+</sup>, Bi<sup>+++</sup>, Cu<sup>++</sup>, Cd<sup>++</sup>, As<sup>+++</sup>, Sb<sup>+++</sup>, Sn<sup>++</sup>, Fe<sup>++</sup>, Fe<sup>+++</sup>, Cr<sup>+++</sup>, Al<sup>+++</sup>, Co<sup>++</sup>, Ni<sup>++</sup>, Mn<sup>++</sup>, Zn<sup>++</sup>, Ba<sup>++</sup>, Ca<sup>++</sup>, Sr<sup>++</sup>, Mg<sup>++</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, CO<sub>3</sub><sup>--</sup>, S<sup>--</sup>, SO<sub>3</sub><sup>--</sup>, S<sub>2</sub>O<sub>3</sub><sup>--</sup>, NO<sub>2</sub><sup>-</sup>, CH<sub>3</sub>COO<sup>-</sup>, F<sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>--</sup>, C<sub>2</sub>O<sub>4</sub><sup>--</sup>, PO<sub>4</sub><sup>--</sup>, BO<sub>3</sub><sup>--</sup>.

**33 hrs**

**Complexometric titration:**-Determination of Zn<sup>++</sup>, Mg<sup>++</sup>, Ca<sup>++</sup>, and total hardness of water using EDTA.

**18 hrs**

**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 hrs**

**Experiments on Physical Chemistry:**-Determination of the transition temperature of hydrated sodium sulphate (Na<sub>2</sub>SO<sub>4</sub> · 10H<sub>2</sub>O), 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 hrs**

**Course Title:** General Chemistry II  
**Course No.** CHEM 333 (major)  
**Nature of the Course:** Theory ✓

**Full Marks:** 100  
**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 hrs**

**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 hrs**

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

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

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

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

**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 hrs**

**Principle of Organic Synthesis:**-Protecting groups, retrosynthetic analysis, retron and synthon, multistep synthesis. **10 hrs**

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

**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 hrs**

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

### **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  $\Delta G$ , 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 hrs**

**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 hrs**

**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 hrs**

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

**Course Title:** General Practical Chemistry II  
**Course No.** CHEM 334 (major)  
**Nature of the Course:** Practical ✓

**Full Marks:** 50  
**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 hematite). 12 hrs

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

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

**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 hrs

**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 hrs

**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 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 Synthetic 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*, Mcmillan & 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. Morrill, *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. Fuson & D. Y. Curtin, *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<sup>1</sup>, E<sup>2</sup> and E<sup>1</sup>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 rearrangement
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<sup>1</sup> and SN<sup>2</sup> reaction
2. Grignard reaction
3. Wittig reaction
4. Malonic ester synthesis
5. Acetoacetic ester synthesis
6. Aromatic nucleophilic substitution

**Addition to carbon-carbon multiple**

1. Michael reaction
2. Diel's Alder reaction

**TRIBHUVAN UNIVERSITY**  
**Institute of Science and Technology**  
 Three year B. Sc. Geology course of study  
 (2052)

**Course Title :** Physical & Historical Geology, Crystallography and Mineralogy.

**Course No. :** GEO 311 (major/minor)

**Nature of the Course :** Theory

**Full Marks :** 100

**Pass Marks :** 35

**Year :** I

**Course Objectives: ( GEO. 311 & 312)**

These courses are designed to provide students theoretical as well 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

**Introduction:-**the science of Geology, scope, application, method of study, its various branches.

**2 hrs.**

**The outer zone of the Earth:-** Atmosphere, Hydrosphere, Lithosphere.

**2 hrs.**

**Isostasy:-** Gravity and continental crust.

**1 hr.**

**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 hrs.**

**Metamorphic rocks and the continental crust:-**Types and texture of metamorphic rocks, factors of metamorphism.

**3 hrs.**

**Earthquake and the earth's interior:-**Earthquakes and faults, seismic waves, core mantle.

**4 hrs.**

**Sediments and sedimentary rocks:-**Rock cycle, rock weathering, sediments, lithification, sedimentary rocks

**3 hrs.**

**Weathering and mass wasting:-**Denotation, soil, initial and sequential land forms, land forms of weathering, types of mass wasting.

**4 hrs.**

**Strata and their deformation:-** Stratigraphy, rock deformation, kinds of faults, joints, folds.

**6 hrs.**

**Groundwater and its geological activities:-**surface and surface water, groundwater movement, porosity and permeability, Aquifers and aquicludes, wells, Karst topography.

**4 hrs.**

**The geological work of running water:-**rainfall, discharge, drainage system and channel network, stream erosion, transportation and deposition land forms associated with running water.

4 hrs.

**Glaciers and glaciations:-**formation of glaciers, kinds of glaciers and their description, glacier erosion and transportation, land forms associated with them, Pleistocene glaciation.

4 hrs.

**Geologic work of wind:-**wind erosion, transport and deposition, land forms.

3 hrs.

**Geologic work of sea and ocean:-** Geologic work of sea and ocean and associated land forms.

4 hrs.

**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

4 hrs.

**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.

2 hrs.

**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, fossils.

7 hrs.

**Time on rock record:-**unit and measurement of geological time, Geochronology, relative age determination, time stratigraphic units, correlation.

7 hrs.

**The main tectonic unit of the earth's crust and their evolution:-**principal tectonic units of the present continents, the tectonics of recent oceanic depressions, the tectonic evolution of the earth's crust.

5 hrs.

**Principles of Paleocology, Paleogeography, Paleotectonics:-**study of paleo-environments along with the influence of organisms on sediments, the paleogeographic methods of studying epirogenic movement of the crust, the analysis of the geological sections as a method of reconstructing crust movements.

6 hrs.

**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 paleogeography, precambrian glaciations.

4 hrs.

**Geological history of phanerozoiceon:-** Plate position and motion: organic evolution paleogeography and the crystal movement of the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Palaeocene, Neogene, and Pleistocene.

18 hrs

**Introduction to crystallography:-**Development of crystallography, geometrical nature of order of crystal, translation vectors, planer and space lattice.

3 hrs

**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

7 hrs

**Crystal growth and twinning:** Growth of crystals from solution and from a melt under controlled conditions, crystal growth in open fractures, solution cavities or vesicles. Twinning in crystals, Different types of crystals twins, causes of twinning in crystals, twin laws. **2 hrs**

**Concept of space groups:** Point group and space group, screw axes and glide planes, international space notation. **2 hrs.**

**Introduction to mineralogy:** Definition of mineral, scope of determinative mineralogy, Examples of rock forming(silicate) minerals and ore forming minerals. **1 hr.**

**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 examples, Hardness: definition, mohsscale of hardness, determination of hardness of minerals, Crystallinity and forms of minerals, Crystalline-crystallized, crystalline, cryptocrystalline and amorphous .Habit of mineral elongated, tabular, flattened and equant. Form of crystalline and cryptocrystalline aggregates-types examples and use in identification. **5 hrs**

**Chemical properties of minerals:** Minerals as a chemical system, Classification of minerals, Examples of Native elements, sulphides, halides, oxides, silicates, titillates, phosphates, arsenates and vanadates, nitrates, borates and uranates, sulphates and chromates, tungstates and molybdates, oxalates and hydrocarbons. **1 hrs**

**Crystal chemistry of minerals:** Concepts of crystals structure of minerals: dimorphism, polymorphism and pseudomorphism: isomorphism and solid solution. **2 hrs**

**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. Twinning 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 anisotropic media, interference figures. Dispersion of optic axes in biaxial crystals. **6 hrs**

**Brief introduction of :-**the geology of the Nepal, Punjab, Kumaon and Sikkim- Bhutan Himalayas, geology of the eastern, central, western and far western Nepal. Mineral resources of Nepal. **12 hrs**

**Minerals genesis and mineral classification:** Formation of minerals in different endogenous and exogenous processes. Physical and optical character and mode of occurrence and important uses of the following minerals: Quartz Feldspar, feldspathoids, mica, amphibole, pyroxine, olivine, garnet, chlorite, epidote, scapolite, andalusite, sillimanite, kyanite, zeolites, zircon, talc, clay, minerals, calcite, apatite, rutile, spiral, pyrite, cordierite. **17 hrs**

**Course Title :** Physical & Historical Geology, Crystallography and Mineralogy.

**Course No. :** GEO 312 (major/minor)

**Nature of the Course :** practical

**Full Marks :** 50

**Pass Marks :** 20

**Year :** I

Drawing of contour maps, study of topographic maps, drawing of topographic maps. **12 hrs**

Study of various geological structures **12 hrs**

Study of geological time scale, preparation and study of paleogeographic maps. **9 hrs**

Drawing & Study of mountain chains of the world. **3 hrs**

Preparation of columnar 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. **12hrs**

**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.

**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 pyrrhotite, 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. **9 hrs**

**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 Michel Levy chart and quartz wedge. Demonstration of Perk compensator plates. Study of optical properties of major silicates: Quartz, orthoclase, microcline, labradorite, muscovite, ziotite, hornblende, augite, diopside, olivine, garnet chloride, epidote, andalusite, kyanite, zircon, calcite, Apatite. **hrs**

### Textbooks

1. Strahler, A.N. Minzt, *Physical Geology*, Harper and Row, New York, recent publication
2. Berry, L.g.and Mason, B., *Principles of Historical Mineralogy*,

**Course Title:** Structural. Geology, Petrology, Geology of Nepal  
and adjoining. region.

**Full Mark:** 100

**Course No:** GEO 321 (major/minor)

**Pass Mark:** 35

**Nature of course:** Theory

**Year:** II

**Course Objectives: ( GEO. 321 & 322)**

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

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

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

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

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 hrs**

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

Bedding conformity and uncoformity, types of conformity, outcrop characteristics, apparent and true dips, Intrusive contacts. Sill and dykes, Diapirs and salt domes. **5 hrs**

Primary structures. Their application in structural geology. **3 hrs**

**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 slip. 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 hrs**

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

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

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, amygdaloidal and vesicular structures, flow structures, shell and platy structures. Prismatic and columnar structures, Pyroclastic materials. Textures and microstructures of igneous rocks **6 hrs**

- Magma:** Definition, composition, physico-chemical constitution, primary magma **5 hrs**
- Formation of magma:** Rift zones, melting process, Evolution of magma: Differentiation, fractional crystallization, other differentiation mechanisms, Magma mixing and assimilation. **5 hrs**
- 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 hrs**
- Igneous rock at continental margins:**The ophiolite suite. The calcalkaline and tholeiitic groups, plutonic rocks. Intracontinental igneous rocks: gabbroic layered intrusions Anorthosites, Alkali Basalts and Nephelinites, Carbonates Kimberlites and related rocks. **4 hrs**
- Composition and Mineralogy of earth's interior:** Seismic data, The geothermal gradient, xenolith, High pressure experimentation, Mantle petrology, the low velocity zone. **3 hrs**
- 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 crystalloblastic, maculose, gneissose and augen structures.. Petrographic description of phyllite, slate, schist, gneiss amphibolite, marble, quartzite, granulite, eclogite. **7 hrs**
- 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 hrs**
- Metamorphic zones:** Index minerals, zones in contact metamorphism, isogrades: Definition, dependence on temperature and pressures.
- Facies:** Definition, evolution of concept of metamorphic facies. Relationship of zones, grades and facies. **3 hrs**
- Mineralogical phase rule:** Invariant, bivalent reaction, invariant point and their significance(Triple point of Al<sub>2</sub>SiO<sub>5</sub> 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 hrs**
- Time, temperature and deformational relationships. Porphyroblasts and rectionism:** Post tectonic porphyroblasts polymetamorphism. Determination of pressure and temperature using total assemblage and changes in mineral composition. **3 hrs**
- Metamorphic rocks:** Metamorphic rocks and global tectonics. Metamorphism at transform faults, divergent and convergent junctions **2 hrs**
- 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, fluvial, lacustrine, glacial and marine deposits. **3 hrs**

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 hrs**

Characteristics of terrigenous, fluvial, lacustrine and marine sediments. **2 hrs**

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

**Diagenesis:** Definition Diagenesis of sandstones and limestones. Basic knowledge on compaction, cementation authigenesis, replacement and recrystallization. **2 hrs**

**Provenance.** Extrabasinal and intra-basinal. Maturity of sedimentary environment paleocurrent analysis facies concept. **3 hrs**

Introduction to the physiography and tectonic divisions of the Himalayas (with special reference to Nepal Himalaya) and the adjacent regions. **3 hrs**

Brief introduction to the geology of the peninsular India with special reference to the archaens, proterozoic gneisses and Deccan trap. **6 hrs**

Introduction to the history of evolution of the Himalaya. **9 hrs**

**Course Title:** Structural. Geology, Petrology, Geology of Nepal  
and adjoining. region.

**Course No:** Geo 322 (major/minor)

**Nature of course:** Practical

**Full Mark:** 50

**Pass Mark:** 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 hrs**

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 hrs**

Strike, true dip and apparent dip problems measurement of thickness and with of out crop. 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 hrs**

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

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

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 hrs**

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

Drawing of different sedimentary structures. **3 hrs**

#### **Textbooks**

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

**Course Title :** Stratigraphy and Sedimentology, Palaeontology  
& Economic Geol.

**Course No. :** Geo 331 (major)

**Nature of the Course :** Theory

**Full Marks :** 100

**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 Palaeontology  
economic minerals, rocks and their origins

**Introduction:** Aim, scope and objectives of stratigraphy, development of stratigraphy through time, conceptual 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. **12hrs**

**Method of stratigraph:** Principles of lithostratigraphy, 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 hrs**

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

**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 hrs**

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

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

**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 hrs**

**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 hrs**

**Chemical Composition of eco. min. & rocks :** Chemical composition important physical properties, mode of occurrence, 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 hrs**

**Course Title :** Stratigraphy and Sedimentology,  
Palaeontology & Economic Geol.

**Course No. :** Geo 332 (major)

**Nature of the Course :** Practical

**Full Marks :** 50

**Pass Marks :** 20

**Year :** III

**Study of stratification and sedimentary cycles,** Study and preparation of stratigraphic columns of some sections of Nepal Himalay and adjacent areas. **5 hrs**

**Study of morphological feataure 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 hrs**

Preparation of mineral maps of Nepal. **6 hrs**

**Study of ores and industrial mineral and rocks in handspecimen :** Lepidolite, Halite, Native copper, Chalcocite, Covellite, Chalcopyrite, Malachite, Azurite, Baauzite, Rutile, Limonite, Goethite, 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 hrs**

**Textbooks**

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

**Course Title :** Engineering Geology, Exploration Geology  
and Environmental Geology

**Course No. :** Geo 333 (major)

**Nature of the Course :** Theory

**Full Marks :** 100

**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 hrs**

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

**15 hrs**

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

**4 hrs**

**Exploration methods:** a) Mapping, b) Remote sensing, c) Subsurface exploration

**7 hrs**

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

**5 hrs**

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

**5 hrs**

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

**6 hrs**

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

**12 hrs**

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

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

**3 hrs**

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

**6 hrs**

**Drilling :** Hand drilling, percussion drilling rotary drilling.

**4 hrs**

|   |               |
|---|---------------|
| <b>Sampling :</b> Its types, sample spacing in mine openings sampling of exploratory boreholes  | <b>4 hrs</b>  |
| <b>Estimation of reserves :</b> Reserves, their classification, Reference data for reserve estimation and estimation of fluid and solid minerals reserves.  | <b>4 hrs</b>  |
| Ore dressing and beneficiation.   | <b>4 hrs</b>  |
| Oceans as new areas for exploration of mineral resources.   | <b>32 hrs</b> |
| <b>Introduction fundamental concept of environmental geology:</b> Biosphere and concept of geology processes and geological hazard.   | <b>2 hrs</b>  |
| <b>River flooding :</b> Magnitude and frequency of flood Hazards landslides, slope stability, causes of landslides, Human influence and landslide, prevention and correction of landslides.   |               |
| <b>Earthquakes:</b> Magnitude, intensity and frequency of earthquakes, man made earthquakes prediction of earthquakes, earthquake hazard reduction earthquake control.  |               |
| <b>Volcanoes:</b> Effects of volcanic activity, adjustment to volcanic hazards.   |               |
| <b>Coastal Hazard :</b> tropical cyclones tsunamis, coastal erosion, coastal hazard mitigation measures.  | <b>27 hrs</b> |
| <b>Hydrogeology and landslide planning :</b> surface and ground water Hydrology and soil erosion.. The land use plan, soil surveys in relation to land use planning environment friendly land use.  | <b>8 hrs</b>  |
| Mineral resources and environment minerals and population, environmental impact of exploration processing and smelting of minerals.   | <b>3 hrs</b>  |
| 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. | <b>11 hrs</b> |

**Course Title :** Engineering Geology. Exploration Geology and Environmental Geology

**Course No. :** Geo 334 (major)

**Nature of the Course :** Practical

**Full Marks :** 50

**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 hrs**

Measurement of shear strength **3 hrs**

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

Determination of compressive, shear and tensile strength of rocks. **6 hrs**

Calculation of rock slope stability using stereographic projections. **12 hrs**

Calculation of mass strength **6 hrs**

Preparation of isopleth maps determination of true dip of mineral veins tracing outcrop, mineral vein, etc construction of folds **12 hrs**

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

Estimation of volume by triangular method, Estimation of volume by polygon method. **12 hrs**

Estimation of ore reserve by various methods **12 hrs**

**Textbooks**

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., *Principals of Physical Geology*, ELBS Publication, 1992
2. Sanders, J. E., *Principals 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

Tribhuvan University  
**Institute of Science and Technology**  
 Three year B. Sc. Mathematics course of study  
 2052

**Introduction**

In the three years 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 hrs. The distribution of the 8 papers (equivalent to 600 marks) will be in 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 hrs theory) and 3 (or full 2 hrs 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:**

|                    |                      |   |
|--------------------|----------------------|---|
| <b>First year</b>  | Course I (Math311)   | : Calculus                                |
|                    | Course II (Math312)  | : Analytical Geometry and Vector Analysis |
| <b>Second year</b> | Course III (Math321) | : Algebra I                               |
|                    | Course IV (Math322)  | : Mathematical Analysis I                 |
| <b>Third year</b>  | Course V (Math331)   | : Mathematical Analysis II                |
|                    | Course VI (Math332)  | : Advanced Calculus                       |
|                    | Course VII (Math333) | : Algebra II                              |

**and one of the following:**

|                       |                      |
|-----------------------|----------------------|
| Course VIII (Math334) | : Mechanics          |
| Course IX (Math335)   | : Linear Programming |

**Course Title:** Calculus  
**Course No.:** Math. 311 (major/minor)  
**Nature of the Course:** Theory

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

**Unit 0. Review of Elementary Calculus:-** Functions, graphs, Evaluation of limits, Continuity, Discontinuity, Test of continuity and properties of continuous functions. Integration. **6 hrs**

**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. **6 hrs.**

**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 applications in expanding functions. **8 hrs**

**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). **6 hrs**

**Unit 4. Asymptotes and Curve Tracing** Asymptotes, Types of asymptotes, Asymptotes of algebraic curves, Curve tracing techniques, Standard curve and their tracing. **6 hrs**

**Unit 5. Curvature:-** Concept of curvature, Chord of curvature, Curvature at origin, Centre and circle of curvatures. **6 hrs**

**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, Lagrange's method of undetermined multipliers. **8 hrs**

**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. **8 hrs**

**Unit 8. Beta and Gamma Functions and Reduction Formulae:-** Beta and Gamma functions and their properties, Reduction formulae. **4 hrs**

**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. **8 hrs**

**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. **6 hrs**

**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 solvable for x and y, Equations homogeneous in x and y, Clairaut's equation. **6 hrs**

**Unit 12. Linear Differential Equations with Constant Coefficients:**-Linear equation with constant coefficients, Linear equations solvable using symbolic operators, symbolic operation techniques, Particular integral and complementary function, Homogeneous linear equations, Equations reducible to homogeneous form. **6 hrs**

**Unit 13. Applications of First order and first degree differential equations:**-Formation of problems into differential equations, Initial and boundary conditions, solution technique. **6 hrs**

**Book Suggested:**

1. M.B.Singh and B.C. Bajracharya, : *Differential Calculus*, Sukund Pustak Bhandar,Kath.(1995)
2. G.D.Pant and G.S. Shrestha, : *Integral Calculus and Differential Equations*.Sunita Prakashan,Kath. (1994)
3. D.A.Murray, : *Introductory Course in Differential 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 abd Mukherjee, : *Integral Calculus*, U.N. Dhar and Sons, Calcutta.

**Course Title:** Analytical Geometry and Vector Analysis  
**Course No.:** Math. 312 (major/minor)  
**Nature of the Course:** Theory

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

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

4 hrs

**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 of 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 the hyperbola, its asymptotes and the conjugate hyperbola, Equation of a hyperbola referred to the asymptotes as coordinate axes.

14 hrs

**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.

6 hrs

**Unit 4. General Equation of the Second degree :** General equation of the second degree and the conic representatoin 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.

6 hrs

**Unit 5. Co-ordinates 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.

6 hrs

**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.

8 hrs

**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.

6 hrs

**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, right circular cylinder.

8 hrs

**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 the six feet of the normals, polar plane and plane of contact, enveloping cone of the central conicoid and enveloping cylinder to a conicoid section of a conicoid, diametral plane, conjugate diameters and diametral planes of an ellipsoid, properties of conjugate semi-diameters. **10 hrs**

**Unit 10. Product of three or more vectors :**Multiplication of three vectors, scalar triple products, applications and geometrical meanings of scalar triple product, properties of scalar triple product, condition of coplanarity of these vectors, vector triple product, scalar product of four vectors and vector product of four vectors, reciprocal system of vectors. **6 hrs**

**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 function 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. **8 hrs**

**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 derivative, 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. **8 hrs**

**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.T. Bell, : *An Elementary Treatise of Coordonate Geometry of Three Dimensions*, MacMillan Book Co. N.Y. (1986).
4. M.B.Singh and B.C.Bajracharya, : *A Text Book of Vector Analysis*, Sukunda Pustak Bhandar
5. S.Narayan, : *Analytical Solid Geometry*, S. Chand and Co.
6. Lalji Prasad, : *Vector Analysis*, Paramount Publication (1986).

**Course Title:**Algebra I  
**Course No.:**Math 321(major/minor)  
**Nature of the Course:**Theory

**Full Marks:**75  
**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 hrs**

**Unit 2. Matrices and Determinants:-** Matrices and entries, Standard matrices, submatrices, equal matrices, algebra of matrices, Tranpose 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 hrs**

**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 hrs**

**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 homomorphism, isomorphism, permutation groups, cyclic permutations, even and odd permutations. **10 hrs**

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

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

**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 hrs**

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

**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 hrs

**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., Princeton.
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.

**Course Title:**Mathematical Analysis I  
**Course No.:**Math 322(major/minor)  
**Nature of the Course:**Theory

**Full Marks:**75  
**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 hrs**

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

**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 hrs**

**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 hrs**

**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 hrs**

**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 hrs**

**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 hrs**

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

**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 hrs**

**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]**

|                              |                                   |
|------------------------------|-----------------------------------|
| <b>Course V (Math331)</b>    | <b>: Mathematical Analysis II</b> |
| <b>Course VI (Math332)</b>   | <b>: Advanced Calculus</b>        |
| <b>Course VII (Math333)</b>  | <b>: Algebra II</b>               |
| <b>Course VIII (Math334)</b> | <b>: Mechanics</b>                |
| <b>Course IX (Math335)</b>   | <b>: Linear Programming</b>       |

- will be made available as early as possible.

Tribhuvan University  
**Institute of Science and Technology**  
 Three year B. Sc. Meteorology course of study  
 2052

**Course Title :** Physical Meteorology  
**Course Number:** MET 311(major/minor)  
**Nature of the course:** Theoretical

**Full Marks:** 50  
**Pass Marks:** 20  
**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.

**Introduction of the Atmosphere:-** Physical Foundation, Units and Dimension, Characteristic of the atmosphere, composition of the atmosphere: Troposphere. 2 hrs

**Equation of State:-** Variables of state, Equation of State of an Ideal Gas, Mixture of gasses (Dalton's law) 3 hrs

**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. 8 hrs

**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 8 hrs

**Equation of State of Moist Air:-** Change of phase and latent heat, Clausius- Clapeyron Equation, Adiabatic process of saturated air, Numericals 7 hrs

**Thermodynamic Diagrams:-** General consideration, The Emagram, The T-phi gram 3 hrs

**Hydrostatic equilibrium:** Hydrostatic equation, Height computation for upper level, hydrostatics of a special Atmosphere; Homogeneous; Isothermal; Constant Lapse/ rates, Dry adiabatic, Standard atmosphere, Numericals 7 hrs

**Hydrostatic Stability:-** Stability criteria; Absolute stability, absolute instability; conditional instability, latent instability, Parcel method, slice method, entrainment. 8 hrs

**Atmospheric Optical Phenomena:-** Halo, Rainbow, Visual range Coronas 2 hrs

**Condensation and Precipitation:-** Condensation, Evaporation and Sublimation, Size spectrum of Aerosol particles, Solute effect, Ice Nucleation, Growth by coalescence, Atmospheric Electricity. 7 hrs

**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

**Course Title :** Climatology  
**Course Number:** MET 312 (major/minor)  
**Nature of the course:** Theoretical

**Full Marks:** 50  
**Pass Marks:** 20  
**Year:** I

**Course Objectives**

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

**Definition and Scope of Climatology:-** Purpose of study; definition of climatology. climate and weather, Elements of climate and statistics to describe them. **1 hrs**

**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 hrs**

**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; Lapse rates of Temperature **3 hrs**

**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; Monsoon circulation; The climatic effects of ocean currents, wind and Pressure distribution at higher levels **4 hrs**

**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. **5 hrs**

**Air Masses, Cyclones, Fronts etc. :-** Air masses Definition, source, regions of air masses, Types of air masses, Modification of air masses. Fronts: Definition and classifications. Cyclones and anticyclones. **3 hrs**

**Climatic Classification:-** Purpose of climatic classification; Various Types e.g. Kopper's Thornthwaite's climatic classification **4 hrs**

**Description of the climatic Type:-** The Tropical rainy climates, The dry climates, The warm temperate rainy climates, The Snow forest climates, The polar climates. **2 hrs**

**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. **4 hrs**

**Climate of Nepal:-** Climate of Nepal **6 hrs**

**Climatic changes:-** Climatic changes through geological time; Evidence of climate change; Theories of climate change; Impacts of climate changes. **6 hrs**

**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 withdrawal. **10 hrs**

**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

**Course Title :** Meteorological Practical  
**Course Number:** MET 313 (major/minor)  
**Nature of the course:** Practical

**Full Marks:** 50  
**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 delineation of climates by different methods.

**Meteorological Practicals:-** Network density Norms of precipitation station, meteorological stations Installation Criteria for Meteorological stations **6 hrs**

**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 Differences between two stations using Hydrostatic equation, Lag Coefficient of Thermometer, Altimetry, Asmann psychrometer and Humidity chart. Analysis solar radiation charts, Preparation of wind roses **3x9 hrs**

**Climatology:-** Use of moving averages technique in meteorological data, Protability analysis, Climatic classification by both Koppens and Thornthwaites methods, Analysis of evaporation data (is evaporation a stable parameter ?), 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 **3x16 hrs**

**Text Books**

1. World Met. Org. No.8 - Guide to Meteorological Instrument and Observing Practices, WMO, Geneva, Swizerland, 1983

**Refrence Books**

1. Ratauack, WMO Publication - Compendium of Lecture's Notes for class IV meteorological Personnel.
2. Her Majesty's Queen Service, London - Observer's Hand Book.

**Course Title :** Synoptic and Tropical Meteorology

**Course Number:** MET 321 (major/minor)

**Nature of the course:** Theoretical

**Full Marks:** 50

**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.

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

**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 hrs**

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

**Anticyclones:-**Types of anticyclones, general properties of anticyclones, Cold anticyclones, warm anticyclones, col, Ridge of High Pressure **5 hrs**

**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 hrs**

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

**Visibility and Fog:-** Significance of Visibility, Types of fog and its formation, artificial dispersal of fog. **2 hrs**

**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 hrs**

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

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

**Temperature:-** Global (seasonal distribution) and Temperature distribution in Nepal **1 hrs**

- Rainfall:-** Global and local (Distribution of rainfall with special reference to Nepal) 1 hrs
- Introduction to Tropical Meteorology:-** Introduction on Tropical Meteorology 1 hrs
- 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 hrs
- 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 hrs
- Pressure and Winds:-** Mean sea level Pressure; Diurnal Pressure variations; Large scale pressure changes 3 hrs
- Winds:-** General; Resultant, gradient level wind; Resultant 200 MB wind; Mean wind cross sections; Jet streams; Diurnal and local wind effects. 3 hrs
- 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 hrs
- Cloudiness:-** Cloudiness; mean cloud cover; Interannual cloud cover variations; Zonal cloud cover averages; Tropical cloud types; Diurnal cloudiness variation 1 hrs
- 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 hrs
- Tropical Synoptic Models:-** Waves:- easterly waves, Equatorial waves Vortices:- Low Tropospheric cyclones Low tropospheric anticyclones, Mid -Tropospheric and Upper tropospheric circulations. 5 hrs
- Linear Disturbances:-** General; Shear lines; clear air turbulence, Asymptotes 1 hrs
- 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 hrs
- 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 hrs
- 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 hrs

**Tropical Forecasting:-** Short range Forecasting methods, Prognostic charts; use of Radar; use of stability Indices 3 hrs

**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 hrs

**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

**Refrence Books**

1. Byers, H.R. - Synoptic Meteorology, New York: McGraw-Hell. 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.

**Course Title :** Fluid Mechanics and Dynamical Meteorology

**Full Marks:** 50

**Course Number:** MET322(major/minor)

**Pass Marks:** 20

**Nature of the course:** Theoretical

**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

**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 hrs**

**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 hrs**

**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 hrs**

**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 barotropic 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 hrs**

**Introduction:-** Aim, Atmospheric Continuum, hypotheses, units and dimensions, dynamical operations, coordinate systems

**5 hrs**

**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 hrs**

**Other Basic Equations:-** Continuity, Thermodynamic and Hydrostatic equations, Numericals **6 hrs**

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

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

**General circulation of the Atmosphere:-** Mean circulation in the Troposphere, Meridional Circulation, Jet streams **6 hrs**

**Effects of Friction:-** Introduction to boundary layer meteorology **3 hrs**

#### 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

**Course Title :** Meteorological Practical  
**Course Number:** MET323(major/minor)  
**Nature of the course:** Practical

**Full Marks:** 50  
**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.

|  |               |
|--|---------------|
| <b>Computation of:-</b> Coriolis parameter, Geostrophic wind, Gradient wind, Thermal wind, Divergence, Vorticity, Vertical motion, Deformation                         | <b>8 hrs</b>  |
| Study of report of surface observation from a land station,  | <b>8 hrs</b>  |
| Study of surface observation from a sea station,   | <b>8 hrs</b>  |
| Coding and Decoding of surface report from a land station,   | <b>8 hrs</b>  |
| T-q gram   | <b>8 hrs</b>  |
| Detailed study of Aviation routine weather report and Aviation selected special weather report, Coding and decoding of METER and SPECI.                                | <b>6 hrs</b>  |
| Study of upper wind report from land station (PILOT),  | <b>6 hrs</b>  |
| Study of upper level pressure, temperature, humidity and wind report from land station,  | <b>6 hrs</b>  |
| Plotting of TEMP and PILOT data,   | <b>6 hrs</b>  |
| Plotting TEMP data on pseudo adiabatic chart,  | <b>6 hrs</b>  |
| Study of terminal Aerodrome forecast (TAF) Code,   | <b>6 hrs</b>  |
| Analysis of surface and upper air plotted charts.  | <b>12 hrs</b> |
| <b>Introduction to micro computers:-</b> Hardware, Input device; Central Processor; Output devices; Software; System Software; Application software                    | <b>3 hrs</b>  |
| <b>Introduction to disk operation system (DOS) :-</b> Resident commands; Copy; Dir; Del; Type; MD/CD/RD, External command; Edit; Xcopy; Diskcopy; Format;              | <b>3 hrs</b>  |
| <b>Program development for meteorological application:-</b> FORTRAN statements, Flow Chart, IF --- ELSE ----, DO-----CONTINUE-----, READ---WRITE FORMAT DIM, DATA etc. | <b>14 hrs</b> |
| <b>Basic programming language:-</b> Concept; Flow chart; Command; Rem; Print; if.....ELSE; For.....NEXT; DIM   | <b>10 hrs</b> |

**Text Books**

1. WMO No. 261 - Problems in Dynamic Meteorology, World Meteorological Organization, Geneva, Swizerland, 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, Swizerland, 1978

**Course Title:** Hydrology  
**Course Number:** MET331 (major)  
**Nature of the course:** Theoretical

**Full Marks:** 100  
**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

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

**Catchment characteristics:-** Drainage shape, slope, altitude; hydrometric curve, stream length, catchment area; drainage pattern, density and stream order **3 hrs**

**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, hydrograph, depth area duration. **7 hrs**

**Infiltration:-** Factors affecting infiltration, measurement; infiltration equation, and indices; capacity, infiltration process **5 hrs**

**Water Losses:-** Classification of water losses, evaporation process, factors affecting evaporation, estimation, measurement, reduction of evaporation, interception, depression storage, transpiration and factors affecting transpiration. **6 hrs**

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

**Hydrographs:-** Components of hydrograph, and separation; effective rain-fall; unit hydrograph, and theory; assumptions, use and limitation of Unit Hydrograph **7 hrs**

**Ground water:-** Definition, occurrence, type of aquifers, coefficient of transmissibility and permeability, Darcy's law and its range validity, and field measurement of permeability. **6 hrs**

**Hydrometry Basics and Applications:-** Definition and scope of hydrometry, History of hydrometry in Nepal, and application of hydrometry in Engineering field. **1 hrs**

**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 hrs**

**Site Survey:-** Equipment, selection of site, longitudinal and cross section survey: leveling, layout plan preparation **3 hrs**

**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 hrs**

**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 hrs**

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

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

**Sediment Discharge Measurement:-** Site selection, Sampling instruments, measurement of suspended and bed load **4 hrs**

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

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

**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 hrs**

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

**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 hrs**

**Computation of Runoff from Snowmelt:-** (a) seasonal water yield forecasting. (b) Runoff forecasting in river regulation. (c) Design flood due to Snow **7 hrs**

**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 hrs**

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

**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 hrs**

#### Text Books

1. Ven Te Chow, Chief Ed - Handbook of Applied Hydrology, McGraw Hill Book Co., New York
2. M. Gunnell 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. Hersey - 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
- ६। किरण शकर ( जल विज्ञान )
7. Linsley et al, Raghunathan - Hydrology for Engineers, McGraw Hill, New York, 1975
8. Eagleson - Dynamic Hydrology, McGraw Hill Book Co., New York
9. Todd - Ground water Hydrology, John Wiley
10. Bruce and R.H. Clark - Introduction to Hydrometeorology Pergamen 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

**Course Title :** Applied Meteorology  
**Course Number:** MET332 (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 addresses 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 can 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 hrs**

**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 hrs**

**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 hrs**

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

**7 hrs**

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

**4 hrs**

**Air Pollution Climatology:-** Spatial and transport variations of meteorological parameters including inversions mixing depths, ventilation coefficient etc.

**3 hrs**

**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 hrs**

**Climatological Factors affecting Agriculture:-** Radiation; Temperature; Moisture; Wind etc. **3 hrs**

**Agricultural Meteorology Plant growth:-** Seed germination; Pollination; Crop development and Growth; Crop pests and diseases **5 hrs**

**Agricultural Meteorology and Soil:-** Soil condition and drainage; Fertilizers; Mulches **4 hrs**

**Agricultural Climate:-** Rice, Wheat, Corn, Soyabean, Tomato, Apple, Sugarcane, Tea, and Colfee **5 hrs**

**Weather and Plant Diseases:-** Weather and pathogens; weather and the host; Forecasting disease development **5 hrs**

**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

**Refrence 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

**Course Title:** Hydrology and Surveying Practical  
**Course Number:** MET333 (major)  
**Nature of the course:** Practical

**Full Marks:** 100  
**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

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

**Rainfall analysis**

**Practical Number 1:-** Double mass Curve analysis **3 hrs**

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

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

**Practical Number 4:-** Depth area duration analysis **6 hrs**

**Practical Number 5:-** Missing data interpretation **6 hrs**

**Infiltration**

**Practical Number 4:-** Ring infiltrometer data analysis. **6 hrs**

**Runoff** Different methods of base flow separation, Unit hydrograph analysis with given data **6 hrs**

**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 hrs**

**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 hrs**

**Surveying**

**Practical Number 1:-** Fundamental concepts and principle of surveying. **10 hrs**

**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

**6x3 hrs**

**Text Books**

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

**Reference Books**

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

Tribhuvan University  
Institute of Science and Technology  
Three year B. Sc. Microbiology course of study  
(2052)

**Course Title :** General Microbiology  
**Course No. :** MB 311 (Major/Minor)  
**Nature of the Course :** Theory

**Full Marks :** 100  
**Pass Marks :** 35  
**Year :** I

**Course Objectives, (MB 311 & 312)**

The main objective 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, genetics and ecology of microbes.

**Chronological development of microbiology and discovery:-** Introduction, Microorganisms as a cell, General history of microbiology and microorganisms, Microbial diversity, Discovery of Microorganisms, Spontaneous generation, Germ theory of diseases. **11 hrs.**

**Correlate microbiology with different areas:-** Disciplines of Microbiology, Medical and public health microbiology, Agricultural microbiology, Food microbiology, Microbial biotechnology, Industrial and environmental microbiology. **15 hrs.**

**Nomenclature of microorganisms:-** Classification and Nomenclature.

**Physiology of bacteria:-** Morphological characteristics and the fine structure of bacteria, Nutrition, reproduction and cultivation.

**Fungus:-** Fungi, Classification, Structure, Growth and reproduction, fungi of medical importance.

**Introductory parasitology:-** Protozoan: structure and reproduction, Nematodes: structure and its role in agriculture

**Introductory knowledge about virus:-** Structure, Classification and medical importance of virus. **19 hrs**

**Microbial techniques:-** Types of microscope, Types of culture medium, Types of microorganisms including anaerobic bacteria. **6 hrs**

**Handling microorganisms:-** Aseptic techniques during the handling of microorganisms, Isolation

**Practical**ification of microorganisms (bacteria, fungi and viruses), Enumeration and counting of leveling **15 hrs**

**Practical Number 9:-** Recu  
method

**Methods of sterilization:-** Principles of sterilization, Control of micro-organisms by, temperature (high and low temperature), Irradiation, Ultrasonic, Filtration, Chemical agents. **19 hrs**

**Physiological characteristics of microorganisms:-** Growth of microorganisms (growth curve), Factors affecting the growth of microorganism, Essential nutrient including carbon, nitrogen, mineral and other sources of vitamin. Temperature, Water activity, Salinity, pH, Gases, CEC.

**Biochemical properties of microorganisms:-** Nutritional types, photolithotrophic, chemolithotrophic, photorganotrophic, chemoorganotrophic, microbial energetic, carbon metabolisms (general concept of glycolysis and T C A cycle), ATP generation, fermentative pathways. **29 hrs**

**Microbial genetics:-** Introduction, Prokaryotic genome, Genetic code, Plasmids, Recombination of gene, Mutation, Auxotrophic mutation. **21 hrs**

**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 **12 hrs**

**Course Title :** General Microbiology  
**Course No. :** MB 312( Major/Minor)  
**Nature of the Course :** Practical

**Full Marks :** 50  
**Pass Marks :** 20  
**Year :** I

**To identify role of microscope and operate it scientifically:-** Introduction of microscope, Types of microscope, Use of microscope in microbiology, numerical aperture, resolving power.

3 hrs

**Application of equipment in microbiology for sterilization:-** Structure and method of working of: Hot air oven, Autoclave, Incubator, UV- safety hood, Steam sterilizer.

3 hrs

**To prepare and use different stains:-** Doner stain, Gram's stain, Methylene blue stain, Ziehl Neelson stain, Nigrosin stain

6 hrs

**To perform the biochemical tests and make use of them:-** Sugar fermentation, MR. tests, VP test, Catalase test, Oxidase test, Nitrate test, Hydrolysis tests, Starch hydrolysis, Fat hydrolysis, Tryptophane hydrolysis.

6 hrs.

**To prepare various culture media:-** Basic media, Synthetic media, Differential media, Enriched media, Enrichment media.

3 hrs

**To identify the bacteria:-** Methods and approach to identify the bacteria.

3 hrs

**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. 3 hrs

**To detect the factors affecting microbial growth:-** Temperature, Atmospheric pressure, Hydrogen ion Concentration (pH), Miscellaneous physical requirement i.e. light and salt.

3 hrs

**To identify various medical and agriculture importance of fungal elements:-** Collection of sample, Cultural techniques, Identification.

6 hrs

**To measure the Bacterial growth:-** Determination of cells: breed method, counting chamber, proportional count method, plate count, membrane filter count, turbidity measurements.

3 hrs

**To calculate the size of microorganisms:-** Micrometry technique.

3 hrs

**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.

3 hrs

**To distinguish the growth characteristics of anaerobes:-** Anaerobic bacteria and growth characteristics, Methods of cultivation.

3 hrs

**Evaluation of antibiotics:-** Effects of antibiotics on bacteria growth

3 hrs

**Text Book (MB 101 &102) :**

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

**Reference books:**

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

**Course Title :** Microbial, Biochemistry and Biotechnology  
**Course No.:** MB 321 (Major/Minor)  
**Nature of the Course :** Theory

**Full Marks :** 100  
**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 living organisms
- concept of biotechnology and genetic engineering.

**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 hrs

**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 hrs

**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 hrs

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

20 hrs

**Concept of biotechnology:-**Definition and history, Scope and importance, Risk and hazards of biotechnology

18 hrs

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

14 hrs

**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 hrs

**Biotechnology in dairy industry:-** Cheese production, Others milk products, sour milk, dry power milk.

10 hrs

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

12 hrs

**Enzyme technology in various areas:-** Introduction, Source of enzymes, Selection of source of enzymes, Advantage of microbial enzymes.

16 hrs

**Course Title :** Microbial, Biochemistry and Biotechnology  
**Course No.:** MB 322 (Major/Minor)  
**Nature of the Course :** Practical

**Full Marks :** 50  
**Pass Marks :** 20  
**Year :** II

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

**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 hrs**

**To perform the qualitative and quantitative estimate of various types 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 hrs**

**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 hrs**

**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 hrs**

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

**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 hrs**

**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 hrs**

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

**Text Book (MB 201 & 202) :**

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

**Reference Books:**

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

**Course Title :** Agriculture and Food Microbiology  
**Course No. :** MB 331 Major  
**Nature of the Course :** Theory

**Full Marks :** 100  
**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 hrs**

**Soil and its constitutions:-** Mineral matters, Organic matters, Soil solution, Gases. **8 hrs**

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

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

**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 hrs**

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

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

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

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

**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 hrs**

**Food preservations:-** Chemical, Irradiation, Low temperature, High temperature, Drying. **10 hrs**

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

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

**Course Title :** Agriculture and Food Microbiology  
**Course No. :** MB 332 Major  
**Nature of the Course :** Practical

**Full Marks :** 50  
**Pass Marks :** 20  
**Year :** III

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

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

**Azotobacter:-** Introduction, Morphological Structure, Culture of Azotobacter. **3 hrs**

**Rhizobium:-** Morphological Structure, Cultural properties, Methods of isolation and identification. **3 hrs**

**Cellulolysis produced by organisms:-** Demonstration of cellulolysis, Use of cellulolysis. **3 hrs**

**Micro organisms from Biofertilizers:-** Isolation and identification of Organisms responsible for formation of fertilizers. **3 hrs**

**Distinction of various organisms present in soil. :-**Demonstration of winograskys column, Uses of column in differentiation of microbial ecology. **6 hrs**

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

**Cyanobacteria:-** Isolation, growth characteristics, Identification. **3 hrs**

**Phosphorus solubilisers:-** Methods of culture, Identification of solubilisers. **3 hrs**

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

**Dairy products milk, cheese & ice-cream:-** Culture of organisms, Detection and demonstration of micro organisms. **3 hrs**

**Reduction test in milk:-** MBRT test, **3 hrs**

**Presence of microorganisms in meat and meat products:-** Isolation and identification of types of organism in meat and meat products. **3 hrs**

**Microorganisms present in fruits.:-** Culture of micro organism in fruits (their types), Methods of identification. **3 hrs**

**TextBooks (MB 331 & 332) :**

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.

**Course Title :** Medical and Environmental Microbiology  
**Course No. :** MB 333 Major  
**Nature of the Course :** Theory

**Full Marks :** 100  
**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 biosafety
- microbes and its environments

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

**Bacterial flora of the human body:-** Study of microorganisms from skin Gastrointestinal tract, Respiratory tract, Commensals, Symbiotic, Opportunistic. **10 hrs**

**Methods of transmission of diseases:-** Explanation of: Epidemic, Endemic, Pandemic **8 hrs**

**Types of infection:-** Mechanism of infection, Host parasite interaction. **6 hrs**

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

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

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

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

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

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

**Sample collection and lab diagnosis of nicotinic infections:-**Samples, Nasal Swab, Skin scraping, Other samples **9 hrs**

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

**Microbial ecology:-**Microbial association of soil, water and air. **6 hrs**

**Aquatic microbiology:-**Introduction, Types of water, Characteristics of water. **6 hrs**

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

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

**Microbial air pollution:-**Introduction, Methods of measuring microorganisms in air (indoor and out door), Air-borne diseases, Air-pollution control. **9 hrs**

**Course Title :** Medical and Environmental Microbiology  
**Course No. :** MB 334 Major  
**Nature of the Course :** Practical

**Full Marks :** 50  
**Pass Marks :** 20  
**Year :** III

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

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

**To illustrate different staining procedure.:-**Gram's staining, etc. **3 hrs**

**To categories different cultural media:-**Preparation of media, Nutrient Agar, Blood Agar, Mac Conkey Agar. **3 hrs**

**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 hrs**

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

**To operate enzymatic test of the bacteria:-**To perform important enzymatic tests, coagulase test, Catalase test, Oxidase test **6 hrs**

**To explain serological test on virus:-**ELISA test, Hemagglutination test. **3 hrs**

**To operate Nicotinic infection samples:-**Sample collection, skin scrapping, nail clipping, sputum. **6 hrs**

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

**To predict fungal culture media:-**Preparation of media: Sabouraud dextrose agar, Potato dextrose agar, Malt extract agar **6 hrs**

**To operate bacteriological examination of drinking water:-**MPN methods, MF methods. **6 hrs**

**To predict microbial and biochemical parameters of sewage:-**Perform microbial count, DO and BOD test **6 hrs**

**To demonstrate water treatment station:-**Field visit to water treatment station. **3 hrs**

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

**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, 5<sup>th</sup> edition Tata McGraw Hill, Delhi, 1993

**Reference Book:**

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

Tribhuvan University  
**Institute of Science and Technology**  
 Three year B. Sc. Physics course of study  
 2052

**Course Title:** (Mechanics I, thermodynamics, statistical physics, electricity and magnetism.)

**Full Marks :** 100

**Course No.:** Phy. 311. (Major/Minor)

**Pass Marks :** 35

**Nature of the Course :** Theory

**Year :** I

**Course Objectives**

At the end of 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 :**

**Probability and Statistical Analysis of Data:-** Concept of Probability, distribution function (Binomial, Normal and Poisson), Systematic and random errors, Laws of errors, Standard errors, least square fit, Chi square, F and T tests, interpolation, numerical value. **8 hrs.**

**Momentum and Elastic Collisions:-** Principles of linear and angular momentum, elastic and inelastic collision. Centre of mass of a system of particles. **3 hrs.**

**Gravitational Field and Potential:-** Kepler's Law of planetary motion, gravitational field and potential, Gauss and Poisson equations for gravitational field, gravitational self-energy, rocket-single and multistage, reduced mass, central forces. **6 hrs.**

**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 hrs.**

**Oscillatory Motion:-** Small oscillation in a potential well, harmonic oscillation equation and general solution, examples 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. **10 hrs.**

**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. **6 hrs.**

**Elastic Properties:-** Inter-relation between elastic constants, coefficient of rigidity of a cylinder, bending moments, shearing forces, cantilever, supported beam. **7 hrs.**

**Fluid Mechanics:**-Kinematics of moving fluid, Equation of continuity, Euler's equation, Bernoulli's theorem, Viscous fluids, stream line and turbulent flow, Poiseuille's law, and its application, Reynold's number. **5 hrs.**

**THERMODYNAMICS:**

**Thermodynamic Fundamental Concepts:**-Thermodynamic systems, thermal and thermodynamic-equilibrium, equation of state, thermodynamics processes, external and internal work, internal energy, quasi-statics, isothermal, adiabatic, isobaric and isochoric processes. **2 hrs.**

**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 application. **6 hrs.**

**Thermodynamic Relations:**-First and Second latent heat equations, Triple point, Thermodynamics potentials, Helmholtz's function, enthalpy, Gibb's function, Maxwell's thermodynamics relation, phase transition, Clausius-Clapeyron equation. **6 hrs.**

**Concept of Ideal and Real Gasses:**-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. **6 hrs.**

**Production of Low 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. **6 hrs.**

**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. **5 hrs.**

**Black Body Radiation:**-Total energy density, spectral energy density, emissive power, absorptive power, Kirchoff's Law, pressure of radiation, pressure of diffuse radiation, Stefan-Boltzmann's law, spectrum of black body radiation, Wien's Displacement Law, Planck's Radiation law, Rayleigh-Jean's Law. **6 hrs.**

**STATISTICAL PHYSICS:-**

**Classical Statistical Physics:**-Phase-space, microstate and macrostate, ensemble, constraints and accessible state, 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. **10 hrs.**

**Quantum Statistical Physics:**- Introduction, Bose-Einstein Statistics, Fermi-Dirac statistics, electron gas in metals, Fermi level and energy. **3 hrs.**

**ELECTRICITY AND MAGNETISM:**

**Elementary Vector Analysis:**- Gradient, Divergence and curl of a vector in Cartesian, Polar coordinates, Gauss's Stoke's and Green's theorems, Laplacian in polar co-ordinate system. **6 hrs.**

**Electrostatic Potential and Field:-**Coulomb's law, the electric field, electric flux, Gauss's law and its applications, Equipotential surface, potential due to charge distributions, 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. **8 hrs.**

**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, Clausius Mossotti relation, Langevin Debye formula. **6 hrs.**

**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. **4 hrs.**

**Magnetic Properties and Fields:-**Magnetic dipole moment of current loop and angular momentum, magnetization, Langevin's theory of para and diamagnetism, ferromagnetism, magnetic domain theory, magnetic susceptibility and permeability, ferrities. **6 hrs,**

**Interaction between Currents:-**Current and distribution of current, Field and interaction of moving charges, force between parallel currents. **4 hrs,**

**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. **6 hrs.**

**LCR Circuit :-**LCR circuits with AC and DC sources, phase diagrams, impedance, resonance, the quality factor, power factor. **5 hrs.**

**Maxwell's E. M. Equations:-** 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 transmissions of electromagnetic waves at the interface between two media. **5 hrs.**

#### Text Books

1. Mathur, D.S. :, *Mechanics*, S. Chand and Co.,Ltd.New Delhi, 1993.
2. Singal, 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 Electromagnetic*, Narosa Publishing House, New Delhi.

#### References:

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 (Rreprint 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 Kommer : *Thermal Physics*, CBS Publishers, New Delhi.

Course Title : 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: (150 hrs.)

**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.

**Thermodynamic Experiment Constant:**-Determination of Stefan's constant., -Determination of the ratio of  $C_p$  and  $C_v$  by Clement and Desorme's method.

**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 Books

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

**Course Title :** Physics (Optics, Atomic and Nuclear Physics, Electronics). **Full Marks :** 100  
**Course No. :** Phy. 321. (Major/Minor) **Pass Marks :** 35  
**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.

### OPTICS:

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

**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 hrs.**

**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 hrs.**

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

**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 hrs.**

**Dispersion and Scattering:-** Normal and anomalous dispersion, scattering of light. **2 hrs.**

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

**Holography:-**Basic technique of holography, theory of holography, applications. **4 hrs.**

### 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 hrs.**

**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 hrs.**

**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 hrs.**

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

**Zeeman Effect:**-Normal and anomalous Zeeman effect for one electron system. **4 hrs.**

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

**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 hrs.**

**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  $\alpha$  particles, range, straggling and stopping power, theory of  $\alpha$  decay, Neutrino hypothesis of  $\beta$  -decay, qualitative discussion of the theory of  $\beta$  - decay. **7 hrs.**

**Interaction of Nuclear radiation with matter:**-Interaction of  $\gamma$  - rays with matter, absorption, photoelectric effect, Compton scattering, pair production, measurement of  $\gamma$  - ray energies internal conversion. **6 hrs.**

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

**Accelerators:**-Cyclotron, synchrotron, synchrocyclotron, Betatron, Linear accelerator. **3 hrs.**

### **ELECTRONICS:**

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

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

**Bipolar Junction Transistors:**- PNP and NPN transistors, transistor characteristics in different modes,  $\alpha$  and  $\beta$  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 hrs.**

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

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

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

**4 hrs.**

**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 hrs.**

**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 Boolean equation. NAND gate as basic building block. RS, JK, D flip - flops. Half adders and full adders.

**6 hrs.**

**Text Books:**

1. Subrahmanyam, 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 Mc Graw 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.

**Course Title :** Physics Laboratory II.  
**Course No. :** Phy. 322.(Major/Minor)  
**Nature of the Course :** Practical

**Full Marks :** 50  
**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 of 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.

### References:

**Course Title:** (Solid State Physics, Nuclear Physics, Mechanics.)

**Full Marks :** 100

**Nature of the Course :** Theory.

**Pass Marks :** 35

**Course No.** Phy.:331(Major)

**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 hrs.

**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 hrs.

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

5 hrs.

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

5 hrs.

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

5 hrs.

**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 hrs.

**Band Structure of Crystals:-**Concept of energy band in solids, valence and conduction band, distinction between conductor, insulator and semiconductors on the basis of band theory.

6 hrs.

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

6 hrs.

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

4 hrs.

**Magnetism:** classical theories of magnetism, Approach to quantum theory of magnetism.

2 hrs.

### 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 hrs.

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

**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 hrs.**

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

**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 hrs.**

**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 hrs.**

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

**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 hrs.**

**Inertial frames:-**Moving co-ordinate system, translating and rotating co-ordinate systems, Coriolis force, Foucault's pendulum. **6 hrs.**

**Motion of Rigid Bodies:-**Motion of rigid body, Euler's theorem, angular momentum and kinetic energy, the inertia tensor, Euler's equation of motion, torque free motion, Eulerian angle, symmetrical top- **10 hrs.**

**Relativity:-**Gallilean invariance, inertial frames of reference, Gallilean transformations non-inertial frames and fictitious 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 hrs.**

**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. Greewood, *Classical Dynamics*.
5. Resnick *Special Theory of Relativity*
6. D.S.Mann & Mukhejke, *Relativity Mechanics and Statistical Physics*.
7. Kompañyets 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.E.Hall: *Solid state physics*, E. L. B. S.

**Course Title** : Physics (Quantum Mechanics, Mathematical Physics.).

**Full Marks** : 100

**Course No.** : Phy. 332.( Major)

**Pass Marks** :35

**Nature of the Course** : Theory .

**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 hrs.

**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 hrs

**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 momentum operator. 15 hrs

**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 hrs

**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 hrs**

**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 hrs**

**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 Theorems, 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 hrs.**

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

**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 hrs**

**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 hrs**

**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 hrs**

**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, Legendre, Laguerre and Bessel equations and solutions. **12 hrs**

**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 hrs**

**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 Test-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 (Reprint).
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.

**Course Title :** Physics Laboratory III.

**Marks :** 100

**Course No. :** Phy. 333.(Major)

**Marks :**35

**Nature of the Course :** Practical  
III

**Full**

**Pass**

**Year :**

### Course Objectives

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

- to perform Laboratory works related to the course.
- to set experiments related to the course.
- to design laboratory experiment.
- to draw conclusions from the laboratory experiments.
- to develop laboratory skills.
- to interpret the result of Laboratory work.
- to conduct mini projects.
- to interpret the findings of the project work.

### 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  $\beta / \gamma$  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*

**TRIBHUVAN UNIVERSITY**  
**Institute of Science and Technology**  
 Three Years B. Sc. / B. A. Statistics Course of Study  
 2052

Statistics, which is mostly understood by a layman as a set of data has developed from its primitive form as a "Political Arithmetics" to present day's most sophisticated scientific method for describing any phenomenon whether natural or man-made; making inferences on the causes 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 varies 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 separate 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 an integrated course to help other disciplines.

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  |                              |      | Total Marks |
|---------------|------------|--|------|------------|------------------------------|------|-------------|
|               | Course No. | Course Title   | Mark | Course No. | Course Title                 | Mark |             |
| I             | Stat 311   | Descriptive Statistics & Introduction to Probability | 100  | Stat 312   | Computational Statistics I   | 50   | 150         |
| II            | Stat 321   | Probability Theory & Statistical Methods             | 100  | Stat 322   | Computational Statistics II  | 50   | 150         |
| III           | Stat 331   | Design of Experiments & Sample Surveys               | 100  | Stat 333   | Computational Statistics III | 100  | 300         |
|               | Stat 332   | Applied Statistics                                   | 100  |            |                              |      |             |

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

**Title of the Course:** Descriptive Statistics & Introduction to Probability  
**Course no. :** Stat 311 (major/minor)  
**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 results.
- 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**

Number of Periods: 75

- 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 data and tables by diagram: Frequency distribution for discrete and 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 Measures:** Concepts of moments, Moments of different orders, their relationships. 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:** Fundamental set of Frequencies; Consistency of Data; Conditions for consistency; Independence and association of attributes; Various measures of association.

**Unit 2: Introduction to Probability:**

Number of Periods: 75

- 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 and kurtosis 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 Binomial, 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.

**Title of the Course:** Statistical Computation I  
**Course no. :** Stat 312(major/minor)  
**Nature of the course :** Practical

**Full marks:** 50  
**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.

**Specifics:**

- 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:**

Number of Periods: 100

- 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 Coefficients:** 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 correlations for three variables.
- 1.5 **Fitting of Standard Distributions:** Fitting of Binomial, Poisson, Normal, Hypergeometric & Negative binomial distribution; Numerical problems based on Standard univariate 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 Numerical Exercise on Theory of Probability & related theorems
- 2.3 Numerical Exercise on Expectation & related theorems

**Title of the Course:** Probability Theory and Statistical Methods  
**Course no. :** Stat 321(major/minor)  
**Nature of the course :** Theory

**Full marks:** 100  
**Pass Marks:** 35  
**Year :** II

**Objectives:**

**General:**

- To impart Statistical knowledge at 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.

**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).  $\chi^2$ , 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, consistency, efficiency 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 2<sup>nd</sup> 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.

**Title of the Course:** *Statistical Computation II*  
**Course no. :** Stat 322(major/minor)  
**Nature of the course :** Practical

**Full marks:** 50  
**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 form various fields that need parametric confidence interval and application of Statistical hypothesis testing.

**Unit 1: Fitting of Distributions and Statistical tests**

Number 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**

Number of Periods: 40

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

**Title of the Course:** Sample Surveys and Design of Experiments  
**Course no. :** Stat 331(major)  
**Nature of the course :** Theory

**Full marks:** 100  
**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:**

Number of Periods: 90

- 1.1 Analysis of Variance:** Concepts of linear model in ANOVA; Statement of Cochran theorem; Analysis of one way, two way classification (1 & 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:**

Number 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. Kemphorane O., "Design and Analysis of Experiments", Wiley Eastern, New York..

**Title of the Course:** 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 Nepalese Official Statistics.

**Unit 1: Demography:**

Number 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: Economic Statistics:**

Number 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 Nepalese 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. Goon A. M., Gupta M. K. and Dasgupta B., "**Fundamentals of Statistics Vol. 2**", World Press, Calcutta, India.

**Title of the Course:** Statistical Computation III  
**Course no. :** Stat 333(major)  
**Nature of the course :** Practical

**Full marks:** 100  
**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.

**Unit 1: Statistical Computation Techniques in experimental design:**

Number 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:**

Number 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:**

Number 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:**

Number 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:** Number 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. Kemphorne 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", Iowa State University Press.
8. Anderson T. W., & Clove S. L., "An Introduction to Statistical Analysis of Data", Houghton Mifflin & Co.
9. Chung K. L., "Elementary Probability Theory with Stochastic Processes", Springer 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., "Non 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.

Tribhuvan University  
**Institute of Science and Technology**  
 Three Year B. Sc. Zoology Course of Study  
 2052

Course Title : Non - Chordata  
 Course No. : Zol.311 ( Major/Minor )  
 Nature of Course : Theory

Full Marks : 100  
 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 organized animals.
- To explain the structures and characteristics of different parasites.
- To identify and study the bewildering variety of insects found on earth.
- To participate team work even in small animals.
- To distinguish between various shelled animals and study their habitats.

**Group A : Lower Non - chordata**

**Detailed study of following animals types :**

**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 hrs.**

**Metazoa** : Introduction to metazoa, origin of metazoa. **1 hr.**

**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 hrs.**

**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 hrs.**

**Platyhelminthes** : Detailed study of *Fasciola hepatica* and *Taenia solium*. Distinguishing characters and classification upto orders with ecological notes on *Dugesia*, *Schistosoma*, *Echinococcus*, *Planaria*. **14 hrs.**

**Aschelminthes** : Detailed study of *Ascaris lumbricoides* and *Wuchereria bancrofti* (Filaria). Economic Importances of Helminths. Distinguishing characters and classification upto orders with ecological note on *Oxyuris*. **10 hrs.**

**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 hrs.**

**Group B : Higher Non-Chordata and Protochordata**

**Arthropoda** : External characters and Organ system of cockroach and prawn. Mouth parts of insects : (a) Chewing and biting type (b) Piercing and sucking type (c) Sponging type (d) 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 moth, *Julus* (Millipede), *Scolopendra*, Scorpion, spider and *Limulus*. **22 hrs.**

**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*, *Haliothis*, *Patella*, *Aplysia*, *Doris*, *Limax*, *Loligo*, *Sepia*, *Octopus*, *Nautilus* and *Dentalium*. **20 hrs.**

**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 hrs.**

**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 hrs.**

**Text Books**

1. Kotpal (retd.), R. L., *Modern Text Book of Zoology, Invertebrates*. 6th edition. Rastogi Publication, Meerut India, 1992.

**Reference Books**

1. Dhama & Dhama, *Invertebrate Zoology*. R. Chand & Co. New Delhi, 1989.
2. Majumuria, T. C., *Invertebrates Zoology*. S. Nagin & Co. India
3. Prasad, S. N., *Life of Invertebrates*. Vikas Publishing House Pvt. Ltd., New Delhi, 1992

**Course Title :** Lower & Higher Non-chordata, Protochordata

**Course No. :** Zol 312 (Major / Minor).

**Nature of course :** Practical

**Full Marks :** 50

**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 examples of different phyla (mentioned in theory papers) upto order from museum specimens / slides.

**Study of slides :** Binary fission and conjugation in *Paramecium*. L.S. & T. S. of *Sycon*. Sporocyst, redia, cercaria, scolex, and proglottids of *Taenia*. T. S. of *Fasciola* (Different regions). T.S. of *Ascaris*. T. S. *Neris*. T.S. of Star fish arm. T.S. of (*Branchiostomata*) *Amphioxus* (Various regions). Spicules and pharynx of *Herdmania* and pharynx of *Amphioxus*. Mounting of cocciliferates by sucking 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.

**Mounting :** 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. Werse, P.B., *Science of Biology*. McGraw Hill Co. India
2. Lal, S.S., *A Text Book of Practical Zoology Invertebrate*.

Course Title : Chordata., Cell and Tissue Biology  
 Course No. : Zol 321. (Major/Minor).  
 Nature of Course : Theory

Full Marks : 100  
 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.

**Group A : Chordata**

**Cyclostomata** : External characters of *Petromyzon* and *Myxine*. Distinguishing characters and classification upto orders. **2 hrs.**

**Pisces** : External characters and functional anatomy of *Scoliodon*. Economic importance of fishes. Distinguishing characters and classification upto orders. Ecological notes, habit and habitat and economic importance of : *Chondrichthyes*: *Zygaena*, *Pristis*, *Trygon*, *Rhinobatus* and *Chimaera*. *Actinopterygii* :- *Polypterus*, *Acipencer*, *Lepidosteus*, *Mystus*, *Tetradon*, *Echeneis* and *Solea*. **Dipnoi**: *Protopterus*. **16 hrs.**

**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 *Rachophrus*. **14 hrs.**

**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*, *Gavialis* and *Alligator*. **16 hrs.**

**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 *Casuaris*. **15 hrs.**

**Mammalia** : Functional Anatomy of Rabbit. Distinguishing characters and classifications upto orders. Characters and affinities of Prototheria, Metatheria and Eutheria. **10 hrs.**  
 Ecological notes on :- *Ornithorhynchus*, *Echidna*, *Didelphys*, Kangaroo, *Panthera leo*, *Manis* (Pangolin or Spiny ant-eater), *Herpestes* (Mongoose), *Pteropus* (fruit and small bat). **7 hrs.**

**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 hrs.**

**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. Bohr 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 hrs.**

**Endocrinology :** Structure and function of mammalian endocrine glands with particular reference to pituitary, thyroid, parathyroid, pancreas, adrenal and gonads. **8 hrs.**

**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. **20hrs.**

**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 hrs.**

**Text Books**

1. Dhama & Dhama, *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. Dhama & Dhama, *Vertebrate Zoology*. S. Chand & Co., New Delhi, 1978.

**Course Title :** Chordata, Cell and Tissue Biology  
**Course No. :** 322 ( Major/Minor).  
**Nature of Course :** Practical.

**Full Marks :** 50  
**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.

**Course Title :** Ecology, Fish and Aquaculture  
**Course No. :** Zol 331, Major.  
**Nature of Course :** Theory

**Full Marks :** 100  
**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.

**Group A : Ecology**

**Developmental Biology :** Gametogenesis. Fertilization and Parthenogenesis. Types 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 hrs.**

**Ecology :** Components of ecosystem. Ecosystem energetics (Energy flow through trophic levels, food web and food pyramid). 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, noise 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 hrs.**

Short history of evolutionary thought. Evidences in favour of evolution. Darwinism and neo-Darwinism. Evolution of horse. **8 hrs.**

**Zoo-geography :** Brief account of Zoo-geography realms. Oriental fauna - its boundaries and important fauna. **5 hrs.**

**Animal behaviour :** Learning and innate behaviour, territorial, relationship, and mating behaviour. **6 hrs.**

**Group B : Fish and Aquaculture**

**Fish and Aqaculture :** *Fishes of Nepal* :- Occurrence, distribution and morphology of *Labeo*, *Cirrhina*, *Catla*, *Mystis*, *Channa (Ophiocephalus)*, *Schizothorax*. Diagnostic characters and distribution of Dipnoi. Scales and fins in fishes. Migration in fishes. Aquarium and its maintenance. Economic importance of fishes. **17 hrs.**

**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 hrs.**

**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 hrs.**

#### 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*. radeep 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.

**Course Title :** Medical Zoology, Applied Entomology  
**Course No. :** Zol 332. Major.  
**Nature of Course :** Theory

**Full Marks :** 100  
**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.

**Group A : Medical Zoology**

**Introduction to parasitology :** Terminology.

**Pathogenic microbes :** Viruses, Rickettsia, Spirochetes and Bacteria.

**Protozoan parasites :** Brief account of life histories, mode of infection, pathogenicity, prophylax and treatment of pathogens with reference to human parasitic protozoa :- *Trypanosoma*, *Leishmania*, *Giardia*, *Plasmodium*, *Entamoeba* and *Trichomonas*. **17 hrs.**

**Helminths :** *Fasciolopsis*, *Schistosoma*, *Echinococcus*, *Trichinella*. Phyto and entomopathogenic nematodes :- *Meloidogyne* 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 hrs.**

**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 hrs.**

**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 vittella*, (pedtinophoro) *gossypiella*. **15 hrs.**

**Crop Pests :** Wheat :- *Sesamia inferens*. Paddy - *Tryporyza incertulus*, *Leptocarisa acuta*. Pulses - *Heliothis armigera*. Cash crop pests : Sugarcane - *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 hrs.**

**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-integreted approach to pest management. 20 hrs.

### 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 hrs.

#### 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.



**Books**

Verma, P. S., *A Manual and Practical Zoology*. S. Chand & Co., New Delhi, 1978.

**Reference Books**

Werse, P. B., *Science and Biology*. McGraw Hill, London.

TEXT BOOK

