त्रिभुवन विश्वविद्यालय

# विज्ञान तथा प्रविधि अध्ययन संस्थान

## डीनको कार्यालय

कीर्तिपुर, काठमाण्डौ, नेपाल

विज्ञान तथा प्रविधि अध्ययन संस्थान
२०४५

विज्ञान तथा प्रविधि अध्ययन संस्थान
डीनको कार्यालय
कीर्तिपुर, २०४५

पत्र संख्या
च.नं. ५२६/९३१७४

मिति : ०७३।८।२६

श्री क्याम्पस प्रमुख ज्यू,

B.Sc. ऐचाल्लिठ...क्याम्पस,

सैठ.....।

विषय : **पाठ्यक्रम परिमार्जन गरिएको बारे ।**

उपरोक्त विषयमा विज्ञान तथा प्रविधि अध्ययन संस्थान अन्तर्गत अध्ययन अध्यापन हुने ४ वर्षे B.Sc. तहको प्रथम तथा द्वितिय वर्षको पाठ्यक्रम परिमार्जन गरिएकोले सो अनुसार शै.स. ०७३।०७४ देखि लागू हुने गरि अध्ययन अध्यापन गराउने व्यवस्थाको लागि निर्णयानुसार अनुरोध गर्दछु । परिमार्जित पाठ्यक्रम यस अध्ययन संस्थानको Website : www.tuiost.edu.np बाट Download गर्न सकिने व्यहोरा समेत जानकारी गराउदछु ।

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प्रा.डा. राम प्रसाद खतिवडा
नि. डीन

**बोधार्थ :**

श्री अध्यक्ष ज्यू,

.....विषय समिति

त्रि.वि. कीर्तिपुर ।

टेलिफोन: ९७७-१-४३३०८४४ फयाक्स: ९७७-१-४३३१७५५ Website: www.tuiost.edu.np E-mail: deaniost7@gmail.com

# Tribhuvan University

# Institute of Science and Technology

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## 4 year's Bachelors of Science Revised course of Study-2073

## First & Second Year

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## Effective form 2073 Admission Batches

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## Dean's Office, Kirtipur

## Subjects : I$^{st}$ year

1. Botany
2. Chemistry
3. Environmental Science
4. Geology
5. Mathematics
6. Meteorology
7. Microbiology
8. Physics(Only Practical Paper Rivision)
9. Statistics
10. Scientific Communication-compulsory (revised)
11. Zoology

# Tribhuvan University

## Institute of Science & Technology

# STRUCTURE OF
# B.Sc. Four Year System

| Year | Description | Nature |
|---|---|---|
| **First Year** | **a) Core Course:** Any three subjects either from physical or biological group. | Theory (100 x 3)<br>Practical (50 x 3)<br>**(450)** |
| | **b) Scientific Communication(Compulsory Paper)** | Theory (50 x1 ) **(50)** |
| **Second Year** | **a) Core Course:** Same subjects as first year. | Theory (100 x 3)<br>Practical (50 x 3)<br>**(450)** |
| | **b) Applied Statistics** | Theory (50 x1 ) **(50)** |
| **Third Year** | a) **Core Course:** Any two subjects from first/second year either from physical or biological group. | Theory (100 x 2)<br>Practical (50 x 2)<br>**(300)** |
| | b) **Research Methodology** | Theory **(100)** |
| | c) **Elective Course**: Any two subjects from the respective subject pool. | Theory (50 x 2)<br>**(100)** |
| **Fourth Year** | a) **Core Course:** any one subject from third year (one-major)<br>(Two courses from same subject (any one) from third year) | Theory (100 x 2)<br>Practical (50 x 2)<br>**(300)** |
| | b) **Project Work/Field Work**<br>OR<br>**Applied Science**<br>(leading to core subject) | Research work & Presentation<br>Theory **(100)** |
| | c) **Computational Course** (Compulsory Paper) | Theory/Lab **(50)** |
| | d) **Interdisciplinary Course**: one | Theory **(50)** |
| **Marks** | | **2000** |

# Tribhuvan University
# Institute of Science & Technology

**Four Year B. Sc. (Botany) Curriculum**
**(2073/2016)**

**Course Title : Plant Diversity and Ecology**

**Course No**: BOT 101 **Full Marks**: 100

**Nature of the Course**: Theory **Pass Marks**: 35

**Year**: I year **Lecture** : 150

**Course Objectives (Bot. 101 and Bot. 102)**

- To introduce concept of diversity of lower (non-vascular) plants and higher (vascular) plants, with suitable examples
- To give a comparative idea of range of vegetative and reproductive structures
- To explain the life cycle patterns
- To recognize the evolutionary trends in different groups of plants.

## Unit 1. Introduction 5

1. **Classification of living organisms**: Introduction; History of Classification (Aristotle; Theophrastus; Dioscorides; Pliny the Elder; John Ray; Carolus Linnaeus); Basis for classification; Classification type (Artificial and Natural); Hierarchical classification of living things (Kingdom, Phylum, Class, Order, Family, Genus, Species).…….....…..……..…….1
2. **Two-Kingdom system:** Two-Kingdom System by Linnaeus (Plantae and Animalia); Limitations of the Two-Kingdom System; Three-Kingdom System (Haeckel 1866); The Copeland Four-Kingdom System (Monera, Protista, Plantae and Animalia); Limitations of the Copeland System…….....……..…2
3. **Five-Kingdom system** (Whittaker 1969): Characteristics of the Five-Kingdom System; **Monera** (Archaebacteria and Eubacteria); **Protoctista/Protista** (Chrysophytes, Dinoflagellates, Euglenoids, Slime Moulds, Protozoans); **Fungi** (Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes); **Plantae** (Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms); **Animalia** (Viruses, Viroids and Lichen); Concept of Six- Kingdoms (Archaebacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).....…..2

***Suggested Readings:***


1. Cavalier-Smith, T. 2004. Only six kingdoms of life. *Proc. R. Soc. Lond*. B 271: 1251 – 262.
2. Taylor, D.J., Green, N.P.O. and Stout, G.W. 1997. *Biological Science*. Third Edition. Cambridge University Press.
3. Whittaker, R. H. 1969. New concepts of kingdom of organisms. *Science, New Series* **163** (3863): 150 – 160.

## Unit 2. Kingdom: Monera 6

1. **General characteristics**: Features of Bacteria; Morphology; Cell structure (capsule, cell wall, cell membrane, cytoplasm, genetic material, ribosomes, inclusion bodies, flagella).....1
2. **Classification** up to class (Whittaker1969).....1
3. **Reproduction** (Binary fission; Spore formation; Transformation; Conjugation and Transduction).....1
4. **Economic importance bacteria: Beneficial activities**: Genetic engineering; Bacteria and Soil fertility; Bacterial metabolism-its commercial importance; Bacteria as human symbionts; **Harmful effects**: Spoilage of food stuff; Causes of animal diseases; Causes of human diseases; Causes of plant diseases.....1

**Oscillatoria** (Cyanobacteria)
**General characteristics**: General features; **Systematic position** (Division, Class, Order, Family, Genus); Occurrence; Structure of the thallus. **Reproduction**: Vegetative reproduction (Fragmentation); Asexual reproduction (Hormogonia formation, Akinete or resting spore). **Economic importance**. **Life cycle**: Diagrammatic representation……1
**Spirulina** (Cyanobacteria)
**General characteristics**: General features; **Systematic position** (Division, Class, Order, Family, Genus); Occurrence; Structure of the thallus; Cell structure. **Reproduction**: Vegetative reproduction (Binary fission); Asexual reproduction (Hormogonia formation). **Economic importance**. **Life cycle**: Diagrammatic representation……1

***Suggested Readings:***


1. Gangulee, H. C. and A. K. Kar. 1994. College Botany. Vol.II 565-597.
2. Kumar, H.D. and S. Kumar. 1998. *Modern Concepts of Microbiology*. Vikas Publishing House Pvt. Ltd, New Delhi.
3. Rao, A.S. 2004. *Introduction to Microbiology*. University Prentice'Hall of India, New Delhi.
4. Shrivastava, R. P. and S. B. Agarwal. Modern Text Book of Botany: Algae, Fungi, Bacteria, Virus and Lichen. Vol. I. 267.Bacteria (220-240)


## Unit 3.A. Kingdom: Fungi (Mycota) 16

1. **Introduction of fungi**: General features (Distribution of fungi; Cell structure; Habitat and Habitat [Aquatic, Terrestrial, **Parasitic** (Ectoparasite, Endoparasite): Obligate, Facultative; Saprophytic: Obligate, Facultative; Symbiosis)]; Somatic structure (Unicellular; Filamentous: Aseptate, Septate); Aggregation and modification of hyphae: i) Plectenchyma [a) Prosenchyma b) Pseudoparenchyma], ii) Rhizomorph iii) Stroma iv) Sclerotium v) Appressorium vi) Haustorium).....1

2. **Nutrition in fungi**: i) Nutritional requirements ii) Essential elements iii) Reserve food; **Growth factors**: Temperature, light, moisture. **Reproduction**: a) Vegetative reproduction (Fragmentation & Budding); b)

Asexual reproduction (Conidia, Zoospores, Spores, Chlamydospores, Oidiospores); c) Sexual reproduction [Planogametic copulation, Gametangial contact (gametangiogamy), Gametangial copulation, Spermatization, Somatogamy]……1

3. **Classification of fungi:** A natural system of classification of fungi as proposed by G.C. Anisworth (1973) (Kingdom, Division, Sub-division, Class, Order, Family, Genus, Species)……1

**Albugo candida (Cystopus)**

General features, **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction:** Vegetative (fragmentation); Asexual reproduction (conidia formation) and Sexual reproduction (Oogamous type). **Life cycle**: Diagrammatic representation. **Economic importance**: **'White rust disease',** Symptoms of diseases, Control measure (Chemical method; Biological method; Agriculture method)……1

**Aspergillus (Eurotium )**

General features; **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction**: Vegetative reproduction (fragmentation); Asexual reproduction (conidia formation); Sexual reproduction (Formation of antheridia and archicarps; Fertilization, Cleistothecium/Ascocarp formation [closed fruiting body]; Ascus; Ascospores. **Life cycle**: (Haplophase, Dikaryophase, Diplophase) Diagrammatic representation. **Economic importance**: **Useful activities**: Destruction of organic waste; Industrial mycology; Bio-assays; Antibiotics; Vitamins; Therapeutic uses; Enzymes; Fat production; etc. **Harmful effects**: Spoilage of food; Tropical deterioration; Mycoses;……2

**Peziza (Sac fungi)**

General features; **Systematic position**; Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction**: Asexual reproduction (conidia formation); Sexual reproduction (Somatogamy, Ascogenous hyphae, Crozier formation, Karyogamy, Ascus, Ascospores, Apothecium (fruiting body). Structure of apothecium (Hymenium, Hypothecium, Excipulum). **Life cycle**: Diagrammatic representation. **Economic importance**: ……2

**Agaricus or psalliota (Club fungi)**

General features; **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure (monokaryotic and dikaryotic mycelium). **Reproduction**: Asexual reproduction (chlamydospores, oidia); Sexual reproduction (Somatogamy; Development of sporophores (Fructification); Basidiocarp (Mature fructification); Basidiospores). Structure of Basidiocarp (Stipe, Pileus, Gills); Liberation and germination of the basidiospores. **Life cycle**: Diagrammatic representation. **Economic importance**: **Useful activites:** Sources of food, decomposition of dead bodies, wastes materials, Ink, etc. **Harmful effects**: Wood rotters; Poisonous mushroom; Antibiotics; Mycorrhizal associations; Diseases caused by mushrooms, etc.……2

**Puccinia graminis (Rust fungi)**

General features; **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure (septed hyphae, monokaryotic and dikaryotic). **Reproduction**: Spore formation, **Occurs through five stages** (Polymorphic stage-Stage 0-Pycnidiospore, Stage i-Aceidiospores, Stage ii-Uredospores, Stage iii-Teleutospores, Stage iv-Basidiospores), Heteroecious (Two host–Wheat and Barberry). In **Wheat:** Uredial stage (Formation, structure and germination of uredospore), Teleuto stage (Formation, structure and germination of teleutospore), Basidiospore stage (Formation, and germination of basidiospore). In **Barberry**: Pycnidial stage (formation of pycniospores, spermatization-takes part in sexual reproduction) and Aecidial stage (Formation, structure and germination of aecidiospores). **Life cycle**: Diagrammatic representation (Alternation of generation). **Economic importance: "Black rust of wheat"**, Symptoms of disease; Rust disease in different cereals; Control measure (Chemical and Agriculture method)……2

**Alternaria (Fungi imperfecti)**

General features; **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction**: Asexual reproduction (Conidia formation). **Life cycle**: Diagrammatic representation. **Economic importance: 'Early blight of potato';** Symptoms of diseases; Other diseases caused by different species of *Alternaria*. eg. *A. solani* cause 'Early blight'diseases in potato and members of Solanaceae, *A. brassicae A. brassicicola* cause' leaf spot disease' in Crucifers, etc.; Control measure (Chemical, Biological and Agriculture practice)……1

**4. Vesicular Arbuscular Mycorrhizae (VAM)**

**Introduction of mycorhiza:** Types of mycorrhiza (a. Ectomycorrhiza [Ectotrophic] and b. Endomycorrhiza [Endotrophic]).

**VAM (Vesicular arbuscular mycorrhizae)**: Vesciular (vesicle–storage organs or as resting spores) and Arbuscules (dichotomously branched, complex haustoria) containing intercellular hyphae. **Classification** (Class–Zygomycetes, Order–Mucorales, Family–Endogonaceae, Genus: Gloius, Glomerulus, Gigaspora, Sclerocystis, etc.). **Economic importance**: Biofertilizers ……1

**5. Economic importance of fungi:**

**Useful activities:** Destruction of organic waste; Formation of humus; Release of carbon dioxide; Role of fungi in medicine (**a.** Antibiotics: Pencilliim, Streptomycin, etc., **b.** Ergot: *Claviceps purpurea* used in veterinary and human medicine, **c.** Vitamines: vitamin B, vitamin D, Biotin, Riboflavin, Biotin, Thiamine etc., **d**. Therapeutic uses: Extract of *Aspergillus niger* and *Sacchaaromyces cerevisiae* have proved in extreme cases of maligacy, **e**. Alcohol fermentation, **f.** Steroids.); Role of fungi in Industry (Baking, Brewing, Cheese industry, Preparation of organic acids [Oxalic acids, Citric acid, Gluconic acid, Gallic acid]); Fungi as food (Mushroom, morels, and yeast); Fungal enzyme (Invertase, Amylase, Pertinose); Mycorrhizae (VAM); Growth hormones (Giberrelin); Use of fungi in Bio–assays; Fungi as test organism.(eg Neurospora). **Harmful effects:** Plant diseases (eg. Rust disease, Smut disease, Blight disease, etc.); Destruction of wood; Destruction of utensils and other products

(eg electrical equipment, Textiles, papers, leather, optical instrument, etc.; Food spoilage (Dairy product, Fruits, Canning products, Bakery products, Meat, Vegetable, etc); Mycoses; Poisonous Mushroom……1

### *Suggested Readings:*


1. Alexopoulos, C.J., Mims, C.W. and Blackwell. 2002. *Introductory Mycology*. Wiley Eastern Ltd.
2. Gangulee, H.C. and Kar, A.K. 1994. *College Botany* Vol II. New Central Book Agency, Calcutta.
3. Webster, J. 1993. *Introduction to Fungi.* Second Edition. Cambridge University Press, New Delhi.
4. Adhikari, M.K. 2000. *Mushrooms of Nepal.* P.U. Printers, Kathmandu, Nepal.
5. Pandey, S.N. and Trivedi, P.S. 1994. *A Text Book of Botany* Vol. 1. Vikash Publishing House, New Delhi.
6. Deacon, J. W. 2005. *Fungal Biology*. Blackwell Publishing, UK.
7. Smith, G.M. 2004. *Cryptogamic Botany*, Vol I. McGraw Hill Book Company, Inc., N.Y.


## Unit 3.B. Lichens: 5

**1. Introduction of Lichens**: General features; Mode of nutrition–biotrophic; Distribution; Habit and Habitat (Saxicolous, Corticolous, Terricolous)…..1

**2**. **Lichen thallus**: i. Crustose lichen, ii. Foliose lichen, iii. Fruiticose lichen. **Classification**: On the basis of (i) nature of the fungal element and (ii) kind of the frutification.

**Thallus on the basis of the nature of the fungal element**: I. **Ascolichen** (fungal component is an Ascomycete), Sub divided into two according to ascocarp– (a) Gymnocarpeae (ascocarp-an apothecium type) (b) Pyrenocarpeae (ascocarp-perithecium type) eg. *Parmelia, Physcia, Usnea, Cladonia, Graphis, Verrucaria*, etc. II. **Basidiolichen/Hymenolichen** (fungal component is a Basidiomycetes) eg. *Cora, Rhipidonema*.

**Thallus on the basis of the fruitification (structure of asci and ascocarps):** I. **Hymeno-ascolichens** with unitunicate asci paraphyses in apothecia; II. **Loculo-ascolichens** with bitunicate asci in apothecia .or hysterothecia; III. **Loculo-ascolichens** with bitunicate asci in pseudothecia; IV. **Deuterolichens** (The lichenes imperfecti): mostly sterile lichens that produce no spores……1

**3. Structure of lichen thallus**: Anatomy and Morphology.

On the basis of internal structure of thallus, two groups: (i) Structure of Homoiomerous Lichen thallus, (ii) Structure of Heteromerous Lichen thallus. Structure associated with the lichen thallus: (i) Breathing pores (ii) Cyphellae (iii) Cephellae (iv) Cephalodia (v) Isidia. **Nutrition** ……1

**4. Reproduction:** Vegetative reproduction (Fragmentation and propagules (i) Soredia (ii) Isidia); Reproduction of Algal component (phycobiont): (i) Cell division (ii) Hormogonia (iii) Akinetes (iv) Heterocysts; Reproduction of fungal component (mycobiont): (i) Asexual reproduction (sporulation) (ii) Sexual reproduction: Oogamous type (Male reproductive organ spermogonium; Female reproductive organ carpogonium; Fertilization; Post-plasmogamy changes; Fruiting body: (i) apothecia (ii) Perithecia……1

**5. Economic importance**: **Useful activities:** Sources of food; Source of medicines; Source for dyes; For perfume; For minerals; For acid extraction; Indicators of air pollution; Soil formation; As nitrogen fixers; For ecological importance. **Harmful effects:** Source of fire; Serious damage to the windows; Poisonous; Destruction of mosses ……..1

***Suggested Readings:***


1. Gangulee, H.C. and Kar, A.K. 1994. *College Botany* Vol II. New Central Book Agency, Calcutta.
2. Shrivastava, R. P. and S. B. Agarwal. Modern Text Book of Botany: Algae, Fungi, Bacteria, Virus and Lichen. Vol. I. 267.Bacteria (220-240)


## Unit 4. Kingdom Plantae: Algae 21

1. **General features**; Cell structure; **Distribution** (occurrence and habitat: phytoplanktons, endophytes, symbionts, epiphytes, parasites)……..……..2

2. C**lassification up to class** (Fritsch 1944)…….. ……..……2

3. **Range of thallus** (Motile Unicellular form; Motile colonial form; Non-motile Unicellular form; Non-motile colonial form; Palmelloid form; Filamentous form; Heterotrichous form (Erect system and Prostrate system); Thalloid form; Siphoneous form; Special form)…… …..…..……..……..……..……..……1

4. **Reproductive structures**: **Asexual reproductive structures**: Spores–nonmotile (Akinetes; Hormogonia; Hormospores; Endospores; Exospores; Aplanospores; Hypnospores; tetraspores; monospores; Palmella stage); Motile spores: Zoospores. **Sexual reproductive structures**: Gametes (isogamy, anisogamy, oogamy); Alternation of generation in algae (Haplont, Diplont, Isomorphic, Heteromorphic)…..……. ……..……..……..……..……..……..……..…3

**Chlamydomonas** (Chlorophyceae)

**Systematic position** (Division, Class, Order, Family, Genus); **Occurrence and distribution**; **Organization of the thallus**; **Cell structure**; **Reproduction**: Asexual reproduction (Zoospore formation; Aplanospore formation; Palmelloid stage), Sexual reproduction: Isogamy; Anisogamy; Oogamy; Origin of sex. **Life cycle**: Diagrammatic representation……..…1

**Chara** (Chlorophyceae)

**Systematic position** (Division, Class, Order, Family, Genus); **Occurrence and distribution**; **Organization of the thallus:** The plant body (nodes and internodes); Branches of limited growth; Branches of unlimited growth; Stipules. **Cell structure**; **Reproduction**: Vegetative reproduction (Amylum stars, Tubers/bulbils, Protonema). Sexual reproduction: Oogamy (Male reproductive organ-globules; Structure and development of globule; Female reproductive organ-nucule; Structure and development of nucule; Fertilization; Structure of oospore; Germination of oospore). **Life cycle**: Diagrammatic representation……..……..……..……..……..……..……..…2

**Vaucheria** (Xanthophyceae),

**Systematic position** (Division, Class, Order, Family, Genus); **Occurrence and distribution**; **Structure of the thallus**; **Cell structure. Reproduction**: Vegetative reproduction (Fragmentation), Asexual reproduction (Spores: Synzoospore [formation, structure and germination], Aplanospore formation, akinetes, Hypnospores or cysts formation); Sexual reproduction: Oogamy (Position of sex organs; Structure and development of Antheridia; Structure and development of oogonia; Fertilization; Germination of oospore); Alternation of generation. Position of Vaucheria. **Life cycle**: Diagrammatic representation……..……..……..…….2

**Navicula** (Bacillariophyceae)

**Systematic position** (Division, Class, Order, Family, Genus); **Occurrence and distribution**; **Cell structure:** Shape, made up of two halves (epitheca, hypotheca); Girdle and valve view; **Reproduction**: Asexual reproduction (Cell division and Auxospores); Sexual reproduction: Conjugation. **Life cycle**: Diagrammatic representation……..……..……..…1

**Fucus** (Phaeophyceae)

**Systematic position** (Division, Class, Order, Family, Genus); **Occurrence and distribution**; **Organization of the thallus (**Holdfast, Stipe, Frond); **Internal structure of the thallus** (Meristoderm, Cortex or Storage tissue, Medulla). **Reproduction**: Vegetative reproduction (Fragmentation); Sexual reproduction: Oogamous type (Structure and development of conceptacle; Male reproductive organ-antheridia; Development of antheridia; Female reproductive organ-oogonium; Development of oogonium; Fertilization; Post fertilization; Formation of new thallus). **Life cycle**: Diagrammatic representation……..……..……..……..……..……..…..3

**Batrachospermum** (Rhodophyceae)

**Systematic position** (Division, Class, Order, Family, Genus); **Occurrence and distribution**; **Organization of the thallus:** Branches of limited and unlimited growth; Cell structure. **Reproduction**: Sexual reproduction: Oogamous type (Male reproductive organ-spematium; Development of antheridium; Female reproductive organ-capogonium; Development of carpogonium; Fertilization; Post fertilization changes; Formation of carposporangia; Carpospores; and Cystocarp; Formation of new thallus); Alternation of generation. **Life cycle**: Diagrammatic representation……..……..……..……..……...……2

**Economic importance of Algae**: **Useful activities**: Algae constitute the link of food chain; Useful in fish culture; Sewage treatment plant; As food; As fodder; As fertilizer; As medicine; In industries (Algin, Agar, cosmetics, paints, etc); Diatomaceae earth; Soil fertility; Algae and limestone formation; Parasitic algae. **Harmful effects**: Ship fouling; Water blooms……..2

***Suggested Readings:***


1. Fritsch, F.E. 1979. Structure and Reproduction of Algae, Vols I & II. Cambridge University Press, London.
2. Gangulee, H.C. and Kar, A.K. 1994. *College Botany* Vol II. New Central Book Agency, Calcutta.
3. Kumar, H.D. 1999. Introductory Phycology. East West Publications, New Delhi
4. Baral, S.R. 1995. Algae of Nepal. Report of Biodiversity Profile Project.
5. Kumar, H.D. and H.N. Singh. 1995. A Textbook on Algae. Fourth Edition. East West Press Pvt. Ltd., New Delhi.
6. Pandey, S.N. and Trivedi, P.S. 1994. A Text book of Botany Vol. 1. Vikash Publishing House Ltd., New Delhi.
7. Smith, G.M. 1971. Cryptogamic Botany, Vol I. Algae and Fungi. Second Edition. Tata McGraw-Hill Publishing Co. Ltd., New Edition.


## Unit 4B. Bryophyta 15

1. **Characteristics and distribution of bryophytes** (Distribution, Habit and habitat, morphology of gametophytes, Vegetative reproduction; Structure of sex organs (development of jacketed sex organs, presence of motile male gametes and necessity of water for fertilization); Fertilization and development of embryo/ sporophytes (Concept of embryophyta); Generalized life cycle of bryophytes (alternation of generations)…….2

2. Classification of bryophytes: General basis of bryophyte classification; Outline classification Rothmaler (1951); General characteristics of different groups (upto classes)…… ……..…....1

3. **Origin and evolution of bryophytes** (Progressive evolution theory (Algal origin); Regressive evolution theory (Pteridophyte origin); Bryophytes as connecting link between algae and pteridophytes;…… ……1

**Riccia** (Hepaticopsida**)**

**Systematic position**; Habit and habitat (occurrence or distribution); Morphology; Internal structure of thallus; Growth; Vegetative reproduction Sexual reproduction: Distribution of sex organs; Structure of antheridium and structure of archegonium; Fertilization;…...… …….……1

Development and structure of sporophyte; Spore dispersal and germination; Formation of gametophytes; **Life cycle:** Diagrammatic representation….…….……...1

**Pellia** (Hepaticopsida**)**

**Systematic position**; Distribution and habitat (occurrence or distribution); Morphology of the gametophyte; Internal structure of thallus; Growth; Vegetative reproduction; Sexual reproduction (Distribution of sex organs; Structure of antheridium and structure of archegonium; Fertilization;……...…… ……..……..……..……1

Development and structure of sporophyte; Spore dispersal and germination; Formation of gametophytes; **Life cycle:** Diagrammatic representation……..……...1

**Anthoceros** (Anthocerotopsida)

**Systematic** position; Distribution and habitat (occurrence or distribution); Morphology of the gametophyte; Internal structure of thallus; Growth; Vegetative reproduction; Sexual reproduction (Distribution of sex organs; Structure of antheridium and archegonium; Fertilization;) ……..……...1

Development and structure of sporophyte; Spore dispersal and germination; Formation of gametophytes; **Life cycle**: Diagrammatic representation……...1

**Polytrichum** (Bryopsida)

**Systematic position**; Habit and habitat (occurrence or distribution); Morphology; Internal structure (axis and leaves)……..……...1

Structure of sex organs; Development of sporophyte……1

Structure of sporophyte; Spore dispersal; Germination. **Life cycle**: Diagrammatic representation……1

4. **Sterilization of sporogenous tissue in bryophytes** (with reference to sporophytes in *Riccia, Marchantia, Pellia, Antheceros* and *Funaria/Polytrichum*)…… ……1

5. **Economic importance of bryophytes: Useful activities**: As indicator species; As nitrogen fixation; As Erosion control; Bio-indicators of heavy metals in air pollution; Treatment of Waste; Moss Gardens; Moss Industry (Fuel, Harvesting peat and other mosses, Household uses; Packing); Medical Uses; Food Sources; etc. **Harmful effects**: Skin allergy; Source of fire; Poisonous liverworts; ……1

(*Note: While dealing with the development of sex organs in different bryophyte Riccia should be taken as a model and only the deviations from this model should be dealt with in other models).*

***Suggested Readings:***


1. Watson, E.V. 1964. *The Structure and Life of Bryophytes*. Hutchinson and Company, UK.
2. Goffinet, B. and Shaw, A,J. 2009. *Bryophyte Biology*, Second edition. Cambridge University Press, UK.


## Unit 4C. Pteridophyta 23

1. **Characteristics and distribution of pteridophytes** (General distribution (habitat); Pteridophytes as plants having independent gametophytes and sporophytes; Pteridophytes as land plants; Pteridophytes as vascular plants; General morphology of the sporophyte (root, stem, leaves, sporophylls); Reproduction in

pteridophytes (vegetative, asexual and sexual); Sporangia and spores; Gametophytes and sex organs; Fertilization, development of embryo)……..……1

2. **Classification of pteridophytes upto divisions** (General basis of pteridophyte classification; Outline classification (Reimers, 1954); General characteristics of different groups [upto classes])…….. ……..……1
3. **Origin and evolution of pteridophytes**
   - Theories on algal and bryophytic origin of pteridophytes……..……1
   - General evolutionary trends in pteridophytes: Telome theory, Evolution of roots; Evolution of stem (morphology, stele); Evolution of leaves (microphylls, scale leaves, megaphylls); Evolution of sporophylls; Evolution of gametophytes (Progressive reduction in size of gametophytes)…… ……..……..3

Lycoposida (**Lycopodium** *sensu lato*)

General characteristic features of Lycopsida. **Systematic position**; Habit and habitat (occurrence or distribution of *Lycopodium*), morphology ……..……..……..…1

Internal structure of root, stem and leaves; Structure of sporophylls based on two subgenera: Urostachya, Rhopalostachya……..1

Structure of sporangia; Spore dispersal; Types of gametophyte……..1

Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte. **Life cycle**: Diagrammatic representation……..1

Lycoposida (**Selaginella**)

**Systematic position**; Habit and habitat (occurrence or distribution); Morphology (Sporophyte); Internal structure of rhizophore, root, stem, leaves and ligule.....…… ……..……..……..…… ….1

Structure of strobilus (Heterosporous); Structure of sporangia; Spore dispersal;……. ……1

Structure of gametophyte; Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte. **Life cycle**: Diagrammatic representation ……..…..1

Sphenopsida (**Equisetum**)

General characteristic features of Sphenopsida. **Systematic position**; Habit and habitat (occurrence or distribution of *Equisetum*); Morphology (*Sporophyte*)…… ……..……..……..1

Internal structure of roots, rhizome and stem; Structure of strobilus; Structure of sporangia; Spore dispersal ……..……..…1

Structure of gametophyte; Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte. **Life cycle**: Diagrammatic representation…….……1

Pteropsida (**Marsilea)**

General characteristic features of Pteropsida. **Systematic position**; Habit and habitat (occurrence or distribution of *Marsilea*); Morphology (*Sporophyte*); Internal structure of rhizome, stem and leaves…….……..……..……..……..……..1

Structure of sporocarp; Structure of sporangia; Dehiscence of sporocarp……1

Structure of gametophytes; Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte……..……1

Pteropsida (**Pteris)**

**Systematic position**; Habit and habitat (occurrence or distribution of *Pteris*); Morphology (*Sporophyte*); Internal structure of rhizome, pinnule and petiole……..1

Structure of sorus, sporangia; spore dispersal and germination; Structure of gametophyte, structure of sex organs; Embryo and development of sporophyte ……..……...……1

4. **Stelar system and its evolution in pteridophytes** (with reference to *Lycopodium, Selaginella*, *Equisetum, Marsilea and Pteris*) ……..1

5. **Heterospory and evolution of seed habit; Alternation of generations in pteridophyt**……..1

6. **Economic importance of pteridophytes: Useful activities:** Ornamental value; Food value; Medicinal; Biofertilizers; Environmental aspects; Horticultural uses; Handicrafts; Dye; Photography; Forensic investigation; etc. **Harmful effects**: Toxic to livestock; Spore as source of allergy; Water pollution; etc……1

*(Note: While dealing with different pteridophytes development of sex organs should be dealt to reflect the structural differences and evolution of these organs in different groups. Emphasis should be given to give the concept of general evolutionary trends in pteridophytes, i.e., the reduction of gametophyte and elaboration of sporophyte. Life cycle should be dealt with in generalized way for all the model species).*

***Suggested Readings:***


1. Pandey, S.N. and Trivedi, P.S. 1998. A text book of Botany vol II. Vikash Publications, New Delhi.
2. Parihar, N.S. 1992. The biology and morphology of Pteridophytes. Central Book Depot, New Delhi
3. Smith, G.M. 1955. Cryptogamic Botany, Volume II. Tata McGraw-Hill Publishing company.
4. Sporne, K.R. 1962. The Morphology of Pteridophyte. Hutchinson and Company, UK.

## Unit 4.D. Gymnosperms 16

1. **General characteristics of Gymnosperms:** Introduction; Distribution; Morphology (Habit, stem, leaf, cone, root)..…… ……..……..……...1

2. **Classification of Gymnosperm:** History of classification (Robert Brown (1827); J.D. Hooker (1857); Eichler (1883); Coulter and Chamberlain (1917); Birbal Sahni (1920); Chamberlain (1934); Arnold (1948); Takhtajan (1950); Pant(1957); Raizada and Sahni (1960); Andrews (1961); Sporne (1965); Takhtajan, Cronquist and Zimmermann (1966); Gangulee (1968)) Classification by Sporne (1965) to be followed……..……..……..……..……..

3. **Origin and Evolution of Gymnosperm:** (Evolutionary history of gymnosperms; Heterospory; Gametophytes and ovule……..……..……..……..…2

**Cycadopsida** (**Cycas**)

General features of Cycadopsida. **Systematic position** of **Cycas**: Morphology (habit, stem, leaf, cones, root); Internal structure of stem…….....…….....1

Internal structure of rachis, leaflet, root and coralloid root……1

**Reproduction**: Vegetative reproduction (Buds or Bulbil); Sexual reproduction: Male cone or strobilus; Microsporophyll (Development of microsporangia and microspores; Germination of the microspores); Female cone or strobilus; Megasporophyll (Megaspore and development of female gametophyte; Development of archegonia)……... …….……..……..1

Pollination; Fertilization; Development of embryo; Formation of seed; Germination of the seed……1

**Coniferopsida (Pinus)**

General features of Coniferopsida. **Systematic position** of **Pinus**: Morphology (Habit, branches of limited and unlimited growth, leaves (Scale and foliage) cones, root); Internal structure of root……..…….....……..……..…….....1

Internal structure of stem and leaf. **Reproduction**: Development of microsporangium and microspores; Development of the megasporangium (Ovule) ……1

Pollination; Development of male and female gametophyte; Development of archegonium; Fertilization; Development of embryo; Formation of Seed; Dispersal and germination of the seed……1

**Gnetopsida (Ephedra)**

General features of Gnetopsida. **Systematic position** of **Ephedra**: Morphology; Internal structure of stem. **Reproduction**: Male cone (Microsporogenesis); Female cone (Megasprogenesis)..……..…….1

Development of the male gametophyte; Development of the female gametophyte and archegonium; Pollination; Fertilization; Development of embryo; Formation of Seed; Dispersal and germination of the seed……1

4. **Distribution of Gymnosperm in Nepal:** Total taxa in Nepal (Family, Genus and Species); Distribution pattern (Ecological zones/Bioclimatic zone)……..1
5. **Economic Importance of Gymnosperm: Useful activities:** Medicinal value; Timber; Resin and oils; Craft paper; Food; Fuel; Ornamental; Industrial uses; etc. **Harmful effects**: Soil acidity; Allelopathic effects; Forest fire; Harmful to human health; etc……..1

***Suggested Readings:***


1. Bhatnagar, S.P. and A. Mitra. 1996. *Gymnosperms*. New Age International Limited, New Delhi.
2. Gangulee, H.C. and Kar, A.K. 1994. *College Botany* Vol II. New Central Book Agency, Calcutta.
3. Pandey, S.N. and Trivedi, P.S. 1997. *Botany Vol. II*. Vikash Publications, New Delhi.
4. Chamberlain, C.J. 1986. *Gymnosperms*: Structure and Evolution. CBS Publishers & Distributors, New Delhi.
5. Shrestha, T.B. 1999. *Indigenous Gymnosperms*. In: Majpuriya, T.C. and Majpuria, R.K. (eds.). *Nepal Nature's Paradise*. M. Devi, Gwalior, India.
6. Sporne, K. R. 1974.*The Morphology of Gymnosperms*, Hutchinson & Co., London.


## Unit 4F. Paleobotany 8

1. **Introduction:** History and scope of Paleobotany……1
2. **Origin of and evolution of life on earth…**…… 2
3. **General account of the geological eras and periods with examples...**…… …… ……1
4. **Mode of fossil formation**: Molecule by molecule replacement theory; Infiltration theory…… …… 1
5. **Type of fossils:** Compression; Impression; Incrustation; Petrification (Mineralized plants); Compactions (Mummified plants); Amber …… .2
6. **Morphology and anatomy of Rhynia: Morphology (**Occurrence and External feature); **Anatomy of Rhynia:** (aerial axis; sporangium) ……..1

***Suggested Readings:***


1. Andrews, H.N. 1961. *Studies in Paleobotany*. John Wiley & Sons, New York.
2. Arnold, C. A. 2007. *An Introduction to Paleobotany*. Miller Press, South Dakota, USA.
3. Pandey, S.N. and Trivedi, P.S. 1998. *Botany Vol. II*. Vikash Publications, New Delhi.


**Unit 4E. Ecology** **35**

1. Basic Concept: Branches and scopes of ecology; Biotic and abiotic factors; Species interactions. 4
2. Biogeochemical Cycles: Carbon, Nitrogen, Phosphorus, and Sulphur . 4
3. Community Ecology: Nature (organismic vs. continuum-individualistic views) and attributes; Succession: Types, Mechanisms and examples from aquatic and terrestrial ecosystems; Vegetation types and distribution in Nepal. 10
4. Ecosystem: Structure and function of major ecosystems (forest, grassland and fresh water). 3
5. Plant adaptation: Plant adaptation in xerophyte, hydrophyte, epiphyte, alpine plants. 5
6. Environmental Issues: pollution (air, water, soil and noise), acid rain, global warming, ozone depletion. 5
7. Nature Conservation: Protected areas, landscape approaches for conservation. 4

***Suggested Readings***

**Ecology**


Ambasht RS. Environment and Pollution. Students, Friends and Co., Lanka, Varanasi, India.

Chapman and Reis. Ecology: Principle and Applications. Cambridge.

Chaudhary RP. Biodiversity in Nepal. S Devi, Saharanpur, UP, India, and Tecpress Books, Bangkok, Thailand.

Odum EP and GW Barrett. Fundamental of Ecology. Thomson Brooks/Cole, Thompson Business Information India Pvt. Ltd., India.

Sharma PD. Ecology and Environment. Rastogi Publications, India.

Verma PS and VK Agrawal. Principles of Ecology. S. Chand & Co. (P) Ltd., New Delhi, India

# Botany

**Subject:** Plant Diversity & Ecology **Full Marks:** 50
**Course No.:** BOT 102 (Major/Minor) **Pass Marks**: 20
**Nature of the course**: Practical **Year**: 1
**Total Number of Periods: 180**

**1. Bacteria**

1. Study of sterilization Techniques (Structure and Operation of Hot Air Oven, Autoclave, Ultraviolet chamber, Incubator).
2. Preparation of culture media (Preparation of Nutrient Agar (solid and broth).
3. Culture of Bacteria (Soil microorganism by Serial Dilution Plating Technique, on Nutrient Agar medium).
4. Study of gram positive and gram negative staining of bacteria.
5. Study of vegetative and reproductive structure of *Anabaena/ Oscillatoria* and *Spirulina* (Preparation of slide by using iodine and glycerol).

**2. Fungi**

1. Preparation of culture media –Natural media –PDA (Potato dextrose agar).
2. The culture of *Aspergillus* in Lab. (Bell jar method)
3. Field visit for collection of the infected plant host. (*Albugo, Alternaria, Puccinia*)
4. Study of habit and habitat, vegetative structure, symptoms of diseases (*Albugo, Puccinia, Alternaria*)
5. Study of vegetative reproduction through section cutting: conidia – *Albugo,* and different spores of *Puccinia* (Uredospores, Teleutospores, Basidispores , Pycnidiospores, aeciospores) by preparing semi-permanent slide.
6. Study of different spores of *Agaricus* (Basidiospores); *Aspergillus* (Conidia); *Alternaria* (Conidia) by preparing semi-permanent slide.
7. Study of reproductive parts in *Albugo* (Oogonium, Antheridium); *Aspergillus* (Cleistothecium, ascus, ascospores); *Peziza* (Apothecium, asci, ascospores) by preparing semi-permanent slide and permanent slide.

**3. Lichens**

1. Study of habit and habitat, morphological study of different types of Lichens (crustose, foliose, fruticose)
2. Anatomy of vegetative structure (Internal structure of thallus). i) V.S of Homomerous thallus, ii)V.S of Heteromerous thallus by preparing semi-permanent slide.
3. Reproductive structure of foliose and fruticose lichens by preparing semi-permanent slide.
4. Study of museum specimens and permanent slides.
5. Field visit for the collection of different lichens species.

**4. Algae**

1. Study of permanent slides for *Chlamydomonas, Vaucheria, Chara, Navicula, Fucus* and *Batrachospermum.*
2. Study of vegetative and reproductive parts in *Chlamydomonas, Vaucheria,* and *Chara* through slide preparation.
3. Study of vegetative and reproductive parts in in *Navicula, Fucus* and *Batrachospermum* through slide preparation.
4. Field visit. (Collection and preservation of representative algal species)

**5. Bryophytes**

1. Study of vegetative and reproductive structures in *Riccia* (Habit, dorsal and ventral surface, VS of thallus, VS of thallus through antheridium, VS of thallus through archegonium, VS of thallus through sporophyte).
2. Study of vegetative and reproductive structures in *Pellia* (Habit, dorsal and ventral surface, VS of thallus, VS of thallus through antheridium, VS of thallus through archegonium, LS of sporogonium).
3. Study of vegetative and reproductive structures in *Anthoceros* (Habit, dorsal and ventral surface, VS of thallus, VS of thallus through antheridium, VS of thallus through archegonium, TS/VS of sporophyte).
4. Study of vegetative and reproductive structures in *Polytrichum* (Habit, VS through leaf, TS of stem; LS of the apex of male and female branches; LS of sporophyte).
5. Comparative study of saprophytes in *Riccia, Marchantia, Pellia, Antheceros* and *Funaria/Polytrichum* to study the sterilization of sporogenous tissue in bryophytes.

(*Students should be motivated to make drawings directly on the practial sheets in the laboratory and efforts should be made to engage the students in the lab throughout the practical session.)*

**6. Pteridophyta**

1. General survey of pteridophytes: Different species of representative types (*Lycopodium, Selaginella, Equisetum, Marsilea*, and *Pteris*) as well as economically important species from nearby locality (if possible) should be dealt with.
2. Study of vegetative and reproductive structures in *Lycopodium:* Morphology of the sporophyte (one representative from each sub genus); internal structure of the stem (*L. clavatum, L. cernum, L. serratum*); structure of sporophylls; Structure of gametophyte (using permanent slide); early sporophyte (using permanent slide)
3. Study of vegetative and reproductive structures in *Selaginella*: Morphology of the sporophyte; internal structure of the rhizophore, stem; structure of strobilus and sporophylls (micro- and mega-sporophylls); Structure of micro- and mega-gametophyte (through permanent slides); early sporophyte (using permanent slide).
4. Study of vegetative and reproductive structures in *Equisetum:* Morphology of the sporophyte; internal structure of the stem; structure of strobilus; Structure of gametophyte (through permanent slides); early sporophyte (permanent slide).
5. Study of vegetative and reproductive structures in *Marsilea:* Morphology of the sporophyte; internal structure of the stem; structure of sporocarp *(permanent slide)*
6. Study of vegetative and reproductive structures in *Pteris:* Morphology of the sporophyte; internal structure of the rachis and pinnules; structure of sorus; Structure of sporangium; structure of prothallus (permanent slide); early sporophyte (permanent slide)
7. Study of stellar system in *Lycopodium, Selaginella*, *Equisetum, Marsilea* and *Pteris.*

**7. Gymnosperms**

1. Study of vegetative and reproductive structures, T.S. of coralloid root, leaflet and rachis of *Cycas*
2. Study of vegetative, reproductive structures, T.S. of young stem and needle of *Pinus*.
3. Study of vegetative, reproductive structures, T.S. of stem of *Ephedra*

## 8. Paleobotany

1. Study of museum specimens for different fossil types.
2. Study of museum specimens and permanent slide for external and internal structure of *Rhynia.*

### 9. Ecology

1. To enumerate plants of the study area.
2. To determine the minimum size of the quadrat by species area curve method.
3. To determine the minimum number of quadrat to be sampled in study area.
4. To determine density of different plant species by quadrat method.
5. To determine frequency of different plant species by quadrat method.
6. To determine coverage of different plant species by quadrat method.
7. To determine importance value index (IVI) of different plant species by quadrat method.
8. To determine pH of various soil samples.
9. To determine texture of given soil samples.
10. To determine humus content of the soil samples
11. To study food web of a pond ecosystem
12. To study food web of a grassland ecosystem.
13. To estimate dissolved oxygen in polluted and non-polluted water samples.
14. To study ecological anatomy of hydrophytes.
15. To study ecological anatomy of xerophytes.

**Tribhuvan University**
**Institute of Science and Technology**
**4 Years B. Sc. Chemistry Course of Study**
**(Revised–2073)**

The structure of the course for the 4 Years B. Sc. Chemistry will be as follows:

**1st Year:**

| Subjects | Course No. | Full Marks | Pass Marks |
|---|---|---|---|
| Basic Chemistry I | CHE-101 | 100 | 35 |
| Basic Chemistry Practical I | CHE-102 | 50 | 20 |

**Tribhuvan University**
**Institute of Science and Technology**
**Four Year B. Sc. Chemistry Course of Study**
**(Revised–2073)**

**Course Title:** Basic Chemistry I **Full Marks:** 100
**Course No.:** CHE 101 (major/minor) **Pass Marks:** 35
**Nature of the Course:** Theory **Year:** I

**Course Objectives:**

- 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.
- To provide mechanistic approaches of organic reactions.

## 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, Schrödinger'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 orbital ; charge cloud diagrams and boundary surface diagrams, nodal planes, quantum numbers and their significance, energy level diagram. **9 hrs**

**Multi-electron system**:- Pauli exclusion principle, Hund's rule of maximum multiplicity, energy level diagrams across d-block elements, stability of completely filled, half filled and empty orbital. **3 hrs**

**Nuclear Chemistry**:- Composition of nucleus, nuclear stability, binding energy, radioactivity, half life determination and nuclear reactions, group displacement law and radioactivity series, application of nuclear chemistry. **4 hrs**

**Periodic classification of elements and physical properties:** Long form of periodic table (significance and limitation), IUPAC classification of periodic table and its merits and demerits, 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, electro negativity, different scales of electro negativity measurements (Pauling, Mulliken and Allred and Rochow), electron affinity (Periodic variation, experimental determination of 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 electro negativity differences, characteristics of ionic compounds, structure of ionic solids, ionic compounds of type AX (NaCl, CsCl, ZnS), $AX_2$ ( $CaF_2$, $TiO_2$), layer structures, stoichometric and non- stoichometric defects. **8 hrs**

**Covalent Bond:** General characteristics of coordinate-covalent bond, valence bond approach, directional characteristics of covalent bond, resonance energy, hybridization, the extent of orbital participation in molecular bonding, (sp, $sp^2$, $sp^3$, $d^2sp^3$, $dsp^2$, $sd^3$, $dsp^2$, $dsp^3$), 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 (Free electron theory and band theory), conductors, insulators and semiconductors, 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 ($H_2$, $He_2$, $N_2$, $O_2$, $F_2$, CO, NO, HCl and related species) and molecular ions ($O_2^-$, $O_2^{--}$, $NO^+$, $CO^+$). σ and π bonds and delocalized π-bonds in inorganic species ($CO_2$, $SO_2$, $SO_3^{--}$, $CO_3^{--}$, $NO_3^-$, $N_3^-$ etc). **10 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

**Structure and Properties:** Atomic orbitals, molecular orbitals, hybrid orbitals, polarity of bonds, melting point, acids and bases, dipole-dipole interaction, hydrogen bonding, inductive effect, electromeric effect, resonance, mesomeric effect or conjugative effect, hyperconjugation effect, steric effect, IUPAC nomenclature. **4 hrs**

**Alkanes:** Energy of activation, progress of reaction, energy profile diagram, exothermic and endothermic reaction, Fischer projection formulas, Andiron formulas, Newman projection formula, free rotation about the C-C single bond, conformation of n-butane, physical properties, industrial source, industrial source vs. laboratory preparation, Grignard reagent, coupling of alkyl halide with organometallic compounds, reactions: halogenations (substitution reaction), mechanism of halogenations, orientation of halogenations, relative reactivity of alkanes toward halogenations, ease of abstraction of hydrogen, homolytic bond dissociation energies and relative stability of free radicals, ease of formation of free radicals, structure of free radicals, transition state for

halogenations, orientation, reactivity and selectivity, non-rearrangement of free radicals, combustion, pyrolysis. **10 hrs**

**Stereochemistry:** Introduction, structural isomers and stereoisomer, stereoisomerism, optical activity, polarimeter, specific rotation, enantiomerism and optical activity, chirality, chiral centre, enantiomers, racemic modification, resolution of racemic modification, configuration, absolute configuration (R and S), sequence rules, diastereomers, meso compound, reaction involving stereoisomers, generation of a chiral centre (only one chiral centre), geometrical isomerism.

**7 hrs**

**Alkyl Halide (Nucleophilic Substitution):** Homolytic and heterolytic fission, structure (the functional group), classification and nomenclature of alkyl halides, physical properties, preparation, nucleophilic aliphatic substitution reactions, nucleophiles and leaving groups, rate of reaction (effect of concentration), the $S_N2$ reaction (mechanism and kinetics), the $S_N2$ reaction (stereochemistry, inversion of configuration), the $S_N1$ reaction (mechanism and kinetics), carbocations (structure and relative stability), $S_N1$ reaction (stereochemistry), rearrangement of carbocations, $S_N1$ vs. $S_N2$ reaction, factors affecting $S_N$ mechanism (effect of substrate, nucleophile, solvent, and leaving group). **10 hrs**

**Alcohols and Ethers:** Introduction, nomenclature, structure, physical properties, industrial source, fermentation, fuel from carbohydrate, ethanol, preparation, reactions, alcohols as acids, 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 ($PCl_5$, HX), role of solvent, solubility (ionic solutes, protic and aprotic solvents, ionic pair).

**6 hrs**

**Alkenes:** Physical properties, industrial source, preparation, dehydrohalogenation of alkyl halide, kinetics of dehydrohalogenation, E2 reaction (mechanism, orientation and reactivity), E1 reaction (mechanism, orientation and reactivity), dehydration of alcohols, reaction of alkenes, reaction at the carbon-carbon double bond, (hydrogenation, addition of hydrogen halides, addition of hydrogen bromide and peroxide effect, addition of sulphuric acid, addition of water, electrophilic addition (mechanism, orientation and reactivity), addition of halogens, and mechanism, halohydrin formation, oxymercuration-demercuration, hydroboration-oxidation, (orientation and mechanism of hydroboration), free radical addition (mechanism and orientation), hydroxylation, ozonolysis, analysis of alkenes, application of alkenes to prepare polymers (polypropelene and polyethylene).

**9 hrs**

**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, analysis of alkyne. **4 hrs**

**Group C: Physical Chemistry**

**Gaseous State**: Review on kinetic theory of gases, derivation of kinetic gas equation, average velocity, most probable velocity, average kinetic energy of gas molecules, molecular interpretation of temperature, gas laws (Boyle's, Charles's, Graham's, Avogadro's & Dalton's laws) and root mean square velocity of gas molecules derived from kinetic gas equation, related numericals

Maxwell-Boltzmann distribution law for molecular velocities, distribution of velocities, different types of velocities (most probable, average & root mean square) of gas molecules and their derivation from Maxwell's equation, collision properties: collision diameter, collision frequency, mean free path, related numericals

Deviation of real gas from ideal behavior, van der Waals equation (derivation and explanation of volume and pressure corrections), Boyle's temperature and van der Waals constants, compressibility factors and its uses, critical phenomenon, relation between van der Waals constants and critical constants, related numericals.

Liquefaction of gases: Faraday method, Linde's and Claude's principles of liquefaction of air.

**12 hrs**

**Liquid and Solid States**: Properties of liquids, surface tension and its determination by drop weight & capillary rise methods, viscosity and fluidity, effect of temperature on viscosity & surface tension, determination of viscosity by Ostwald's viscometer, applications of surface tension and viscosity measurements, numericals.

Properties of crystalline & amorphous; ionic, covalent, metallic & molecular solids, crystal structure and unit cells, crystal systems and Bravais lattices, cubic crystals (simple, body centered and face centered cubic), laws of crystallography, Miller indices, numericals. **8 hrs**

**Chemical and Ionic Equilibriums**: Applications of law of mass action to homogeneous equilibrium, effect of temperature, pressure, concentration and inert gases on chemical equilibrium, numerical problems on chemical equilibrium

Quantitative treatments on hydrolysis of salts and related numerical problems, common ion effects in ionic equilibrium, buffer solution, buffer capacity and buffer range, numerical problems in pH and buffer, pH change in acid base titration (weak and strong), theory of acid base indicator: Ostwald's theory, quinonoid theory, selection of acid base indicators in titrations.

**8 hrs**

**Colligative Properties**: Raoult's law and determination of vapor pressure lowering, laws of elevation of boiling point and depression of freezing point, osmotic pressure and determination of molecular weight from colligative properties, van't Hoff factor, abnormalities in solution due to association and dissociation, numerical problems. **6 hrs**

Chemical Kinetics**:** Review on the rate of a chemical reaction, pseudo order reaction, rate equations (differential and integrated form) for zero and second order reaction, half life of reaction, determination of order of a reaction, effect of temperature on the reaction rate: Arrhenius equation and activation energy, related numerical, kinetic study of some reaction mechanism (reaction between $O_2$ and HBr, $I_2$ and propanone in acidic medium) **8 hrs**

**Thermodynamics and Thermo-chemistry**: Review on (some thermodynamic terms, Hess law & bond energy), isothermal but not reversible expansion of an ideal gas, isothermal reversible expansion of an ideal gas, experimental determination of $\triangle E$ using bomb calorimeter, (H) enthalpy, experimental determination of $\triangle H$, enthalpy of physical changes (enthalpy of fusion, vaporization, sublimation), molar heat capacity at constant pressure and volume, relation between $C_p$ and $C_v$, variation of heat of reaction with temperature (Kirchoff's equation), calorific value of fuel and food, numerical problems. **8 hrs**

**Tribhuvan University**

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**Course Title:** Basic Chemistry Practical I **Full Mark:** 50
**Course No.:** CHE 102 (major/minor) **Pass Mark:** 20
**Nature of the Course:** Practical **Year:** I

**Course Objectives:**

- To make students aware of the importance of scientific methods of accurate experimental works about chemistry.
- To develop in students' abilities to perform experiments having due regard for safety.
- To develop in students skill of observation and their ability to record and interpret those observations.

## Experiments on Inorganic Chemistry

**Volumetric analysis:** Volumetric analysis involving acidimetry and alkalimetry (combination of strong and weak acids and bases); Determination of total alkalinity and phenolphthalein alkalinity in a given sample of water, Permanganate titration (estimation of iron in Mohr's salt), Determination of calcium in calcium carbonate, Silver nitrate titration (determination of chloride content in a given sample of water), Iodometric titration (potassium dichromate and copper sulphate, determination of residual chlorine in a given sample of water). **27 hrs**

**Inorganic Preparation:** Sodium thiosulphate, Potassium dichromate, Ammonium ferric sulphate, Potash alum, Tetrammine copper sulphate, Prussian blue **33 hrs**

## Experiments on Organic Chemistry

1. Thermometer calibration.
2. Purification of crude organic compounds.
3. Re-crystallization (acids, acetanilide, amides, benzoates, etc.).
4. Determination of melting point and mixed melting point.
5. Purification of liquid compounds by distillation.
6. Determination of boiling points (aniline, nitrobenzene, nitroaniline, etc.).
7. Isolation of steam volatile compounds.
8. Classification of organic compounds by solubility (water, ether, 5% HCl, 5% sodium hydroxide, 5% sodium bicarbonate, conc. $H_2SO_4$).
9. Identification of functional groups.

**60 hrs**

**Experiments on Physical Chemistry**

1. Determination of surface tension of liquid using Stalagmometer.
2. Determination of viscosity using Ostwald viscometer.
3. Preparation of standard buffer solution using sodium acetate and acetic acid and determine the pH of unknown solution using universal indicator.
4. Preparation of standard buffer solution using ammonium hydroxide and ammonium chloride and determine the pH of unknown solution using universal indicators.
5. Determination of heat of solution of potassium acetate.
6. To study the kinetics of acid catalysed hydrolysis of methyl acetate
7. To study the kinetics of reaction between potassium persulphate and iodine by iodine clock method.
8. Determination of molecular weight of organic compound by Rast method.

**60 hrs**

**Text Books: for theoretical course CHEM 101**


1. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edition, John Wiley and sons, Inc., 2007.
2. F. A. Cotton, G. Wilkinson & C. Gaus, *Basic Inorganic Chemistry*, 3rd Edition, John Wiley & Sons (Asia), Pvt., Ltd., 2007.
3. D. F. Shriver & P. W. Atkins, *Inorganic Chemistry*, Oxford University Press.
4. R. T. Morrison & R. N. Boyd, *Organic Chemistry*, 6th and 7th Edition, Prentice- Hall of India Pvt., Ltd., 2008.
5. I. L. Finar, *Organic Chemistry*, Vol. I and Vol. II, Prentice Hall, London, 1955, (available recent edition).
6. Streitweiser & Heathcock, *Introductory Organic Chemistry*, Wiley and Sons, New York, 1981
7. J. March, *Advanced Organic Chemistry*, 4th Edition, Wiley Eastern Ltd., India, 2005.
8. N. D. Cheronis and J.B. Entrikin, *Identification of Organic Compounds*, A Student's Text using Semi-micro Techniques, John Wiley& Sons, Inc (Latest edition).
9. L. Shriner, R.C Fusion and D.Y Cartin, *The Systematic Identification of Organic Compounds*, A Hand Manual, John Wiley and Sons, Inc. New York (Latest).
10. S. H. Maron & C. Prutton, *Principles of Physical Chemistry*, 4th Edition, Oxford & IBH Pub.Co., 1992
11. P. Atkins & J. de Paula, *Elements of Physical Chemistry*, 5th Edition, Oxford University Press Inc., Printed in India by Saurabh Printers Pvt. Ltd., New Delhi, 2009.

**Reference Books: for theoretical course CHEM 101**


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. G. Marc Loudon, *Organic Chemistry*, Oxford University, 4th Edition
5. Lawry & Richardson, *Mechanism and Theory in Organic Chemistry*, Haper and Row, New York, 1981
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. (available recent edition)
8. House, *Modern Synthesis Reactions*, 2nd Edition, W. A. Benjamin. New York, 1972
9. R. M. Silverstein, G. L.Bassler & T. C. Morril, *Spectrometric Identification of Organic Compounds*, Wiley, New York, 1981, (Preferably available recent edition)
10. C. Agrawal, *Modern Inorganic Chemistry*, Wiley Eastern, New Delhi, 1981(available recent edition)
11. T.W. Graham Solomons, *Organic Chemistry*, (latest edition), John Wiley and Sons, New York.
12. R. A. Bansal, *A Textbook of Organic Chemistry*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1993 (available recent edition)
13. K. L. Kapoor, *Textbook of Physical Chemistry*, Macmillan India Ltd., Vol. I to Vol.V, 3rd edition, 2001
14. D. Alberty, *Physical Chemistry*, 6th Edition, Wiley Eastern Ltd., New Delhi, 1992
15. S. Glasstone & D. Lewis, *Elements of Physical Chemistry*, Mcmillan & Co., Ltd.
16. S. Negi & S. C. Anand, *A Text Book of Physical Chemistry*, Wiley Eastern Ltd., 1991
17. S. Bahl, G. D. Tuli & A. Bhal, *Essential of Physical Chemistry*, 24th Edition, S. Chand & Co. 2000.
18. M. K. Sthapit & R. R. Pradhananga, *A Textbook of Physical Chemistry*, Taleju Prakashan, Nepal, 2007.
19. S. D. Gautam, M. K. Prasad & D. P. Bhattarai, *Fundamental Chemistry*, 1st Edition, Heritage Publishers and Distributors Pvt. Ltd., Nepal, 2013
20. M. L. Sharma & P. N. Chaudhary, *A Textbook of B. Sc. Chemistry* (Vol. I & II), 2nd Edition, Ekta Books Nepal, 2007.
21. A. K. Bhagi & G. R. Chatwal, *Bioinorganic and Supramolecular Chemistry*, Himalaya Publishing House, Mumbai.
22. A. K. Bhagi & G. R. Chatwal, *Environmental Chemistry*, Himalaya Publishing House, Mumbai.

23. M. R. Pokhrel & B. R. Poudel, *A Textbook of Inorganic Chemistry*, National Book Centre, Bhotahity, Kathmandu, 2011.
24. James E. Huheey, Ellen A. Keiter & Richard L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*, Addison Wesley Publishing House.

**Text Books: for practical courses CHEM 102**

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. K. N. Ghimire, M. R. Pokhrel & K. P. Bohara, *University Experimental Inorganic Chemistry*, Quest Publication, Kirtipur, Kathmandu, 2008.
4. R. L. Shriner, R. C. Fusion & D. Y. Cartin, *The Systematic Identification of Organic Compounds, A Laboratory Manual*, John Wiley and Sons, Inc. New York, 1986. (Preferably available recent edition).
5. Moti Kaji Sthapit & R. R. Pradhananga, *Experimental Physical Chemistry*, Taleju Prakasan, Kathmandu, 1998.
6. N. M. Khadka, S. D. Gautam & P. N. Yadav, *A Core Experimental Chemistry for B.Sc.*, Heritage Publication, Kathmandu, 2016.

**Reference Books: for practical course CHEM 102**

1. Gurdeep Raj, *Advanced Practical Inorganic*, 10th Edition, Goel 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 & B. C. Saunders, *Practical Organic Chemistry*, Orient Longman, 1986, (recent edition).
4. B. D. Khosla, A. Guali & V. C.Garg, *Senior Practical Physical Chemistry*, 5th Edition, R. Chand & Co., New Delhi, 1987.
5. J. N. Gurtu & A. Gurtu, *Advanced Physical Chemistry Experiments*, 4th Edition, Pragati Prakashan, 2008.
6. S. K. L. Karna, *Chemistry Practical for B. Sc.*, Subharambha Publication, Kathmandu, 2013.
7. S. C. Rastogi & S. K. Agrawal, *Advanced Inorganic Analysis*.
8. S. K. Agrawal and Keemti Lal, *Advanced Inorganic Chemistry*, Pragati Prakasan, Meerut.
9. A. K. De, *Environmental Chemistry*, New age International Ltd. Publishers, New Delhi.

**Tribhuvan University**

**Institute of Science and Technology**

**4 Years B. Sc. Environmental Science Course of Study**

# Introduction

In recent years, there is an increasing awareness of the consequences of environmental degradation and resource depletion, together with the need to conserve biodiversity and ensure the sustainability of human activities. This has increased the demand for professionals capable of solving environmental problems. In 1997, Tribhuvan University introduced Environmental Science at Bachelor's Level with an objective to produce qualified human resources having understanding of natural environmental processes and environmental management techniques and to prepare for careers in the utilities and conservation. In order to put its graduates in par with other Bachelor's graduates in technical subjects and also to qualify at international market, the B.Sc. in Environmental Science degree has been upgraded to four-year course since 2012. After completion of one syllabus cycle, some revisions have been made this year (2016) to include and focus on more applied subjects. Some redundancies noted in the syllabus have also been corrected, while others updated where applicable.

Environmental science is about understanding how the planet and its ecosystems work in providing resources and absorbing our actions. The governments, development partners and industries are always looking for way outs or better alternative to reduce the impacts of human activities on the environment. As such these organizations need professionals having sound knowledge on:

- interactions between natural systems
- sustainable management of natural resources, waste and energy
- human influences on the environment
- knowledge of environmental changes, natural hazards and disasters

A basic feature of the subject environmental science is its interdisciplinary nature, as it brings understanding of principles from various disciplines of natural science and the social studies. The course emphasizes in imparting skills to diagnose the problems intricately associated with human activities and the natural world, focusing on contemporary issues such as climate change, pollution of land and water and the management of natural resources. Being an interdisciplinary subject, the students will be given exposure to methods, facilities and research agenda that span the environment– from life sciences including biology and biotechnology, through chemistry, hydrology, meteorology, geology, pollution control technology, statistics to socio-economic and policy aspects of managing environment. This provides the learners a firm and rigorous foundation for a career in the environment. The students will attend class lectures, do practical experiments in the laboratory and field, submit assignments given such as report writing, case studies, and attend examinations at the end of courses on annual basis.

The employment opportunities for B.Sc. Environmental Science graduates are various sectors across the country and abroad. They will fit in the civil service as environmental inspectors, environment officers in manufacturing/service industries, and as environmental science teachers for secondary

school levels. They will also work as research officers or extension officers in various environmental institutions and development agencies. They may also be privately engaged in environment related entrepreneurship, such as consultancy in environmental impact assessment, vulnerability assessment, etc. The degree will also qualify the graduates to pursue higher studies leading to master's degree in environmental science or other relevant subjects.

**Eligibility and Criteria for Admission**

For admission in B.Sc. Environmental Science course, the candidates having 10+2 with second division in science stream or equivalent are eligible to apply. The applicant must appear and pass entrance examination conducted by the Institute of Science and Technology (IoST), Tribhuvan University. The admission will be on merit basis.

**Medium of Instruction -** English

**Duration of the Program-** B.Sc. in Environmental Science is completed in four academic years.

**Course Structure**

The B.Sc. course of Environmental Science at Tribhuvan University is divided into four academic years: introductory in first year, fundamentals in second year, advanced in third year, and applied in fourth year. The course module contains compulsory, interdisciplinary, practical and research project. The total lecture hour of the course is 3,750; however, there is additional 150 hours when the project work is included, which is optional. The total mark of the course is 2,000.

The courses in the first year cover compulsory subjects and Scientific Communication and carries total of 500 marks with total 975 lecture hours. The students in the first year take environmental science as major subject and two allied subjects from among Botany, Chemistry, Mathematics, Physics, Statistics, and Zoology depending on the academic background of the student, whether physical or biological group.

The courses in the second year contain fundamentals of environmental science, applied statistics and two combination papers from physical or biological group. It carries 500 marks with 975 lecture hours.

The courses in third year offer one subject from environmental science and one subject from either biological or physical groups. The major course of third year in environmental science offers environmental pollution and environmental management tools, research methodology and two electives (one from each combination). It carries 500 marks with 900 lecture hours.

The fourth year offers one major specialization course with two compulsory papers. The compulsory papers are: environmental resources and biodiversity conservation, and pollution monitoring and control. The students must complete a project work or applied science (leading to core subject). There

will also be one interdisciplinary subject dealing with climate change. It carries 500 marks with 900 lecture hours or 1050 lecture hours in case a student takes project work.

**Evaluation**

Students must obtain pass marks in all theory and practical subjects separately. The Office of Examinations Control will conduct final examinations at the end of the academic year. The duration of examinations will be three hours for theory and six hours for practical. For the students taking project work, it is required to work equivalent to 300 working hours while that for Community Work/Internship it is 150 working hours. The grading of students' performance will be as follows:

| **Grade** | **Four-year Average (%)** |
|---|---:|
| Distinction | 75 and above |
| First division | 60-74 |
| Second division | 45-59 |
| Third division | 35-44 |
| Failed | Below 35 |

# Course Distribution

**Course Title: Introductory Environmental Science**
**Course Code: ENV. 101**
**Year : I (Compulsory)**

| SN | Unit Title | Lecture hours |
|---|---|---|
| 1 | Introduction to Environmental Science | 25 |
| 2 | Population and Community Analysis | 25 |
| 3 | Ecosystem Dynamics | 25 |
| 4 | Environmental Chemistry | 25 |
| 5 | Atmospheric Environment | 25 |
| 6 | Environmental Earth Science | 25 |
| | **TOTAL** | **150** |

## FIRST YEAR

**Course Title: Introductory Environmental Science** **Lecture hours: 150**
**Course Code: ENV 101** **Full marks: 100**
**Nature of Course: Theory (Compulsory)** **Pass marks: 35**

### Objectives

The broad objective of the course is to provide basic theoretical knowledge on Environmental Science. The specific objectives of the course are as follows:

- To understand the concept of environmental science
- To acquaint with the society, culture and environment
- To familiarize with population, community and ecosystem dynamics
- To provide knowledge on environmental chemistry
- To provide knowledge on basic geology and atmospheric environment

### Unit 1: Introduction to Environmental Science 25 hrs

Environmental Science: Concept of environment and environmental science, historical development, objective, scope and importance, its relation to other disciplines of science; Multidisciplinary nature of environmental sciences; Environmental issues in Nepal and role of environmental science, state of environmental awareness; Historical and philosophical basis: the interconnectedness of lithosphere, hydrosphere, atmosphere and biosphere.

Relationship between society and environment; Concept of culture and human civilization; Historical development of society and culture: Hunting and gathering, pastoral, agrarian, and industrial society and environment; Mode of production, resource utilization and environment; Population growth and

environmental degradation; Use of sociological and anthropological knowledge on environment conservation; Environmental worldviews and ethics, developed countries, developing countries, sustainability.

**Unit 2: Population and Community Analysis** **25 hrs**

Ecology: Concept, history, scope, types, ecological hierarchy; Biosphere: Evolution, realms; Ecosystem: components and factors, life supporting systems, concept of food chain, food web, trophic structure, ecological pyramids; Concept of limiting factors; Liebig-Blackman law; Shelford's law of tolerance.

Population characteristics: Size and density, pattern of dispersion, age structure, natality, mortality, biotic potential; Population dynamics and theory of population growth; Rate of natural increase; Species interaction: Positive and negative; Regulation of population size.

Community characteristics: Classification and composition; Characters used in community structure: Analytical and synthetics; Concept of ecological dominance; Habitat and niche; Ecological indicators; Keystone species; Ecotone and edge effect; Heterogeneity and equitability; Adaptation: Origin and significance; Ecads; Ecotypes; Ecocline; Speciation and extinction.

**Unit 3: Ecosystem Dynamics** **25 hrs**

Terrestrial and aquatic ecosystems: Structural and functional aspects of forest, grassland, deserts, lentic and lotic environment; Energy sources for ecosystem dynamics; P/R ratio; Ecological efficiency; Energy flow model- simple and Y-shaped model; Application of thermodynamic laws in ecosystems; Productivity and its types; Methods of measuring primary and secondary productivity; Global primary productivity; Biogeochemical cycles: Hydrological, gaseous (oxygen, nitrogen and carbon) and sedimentary (sulphur and phosphorus); Ecological stability: Carrying capacity, persistence, constancy, resilience; Homeostasis and feedback mechanism; Ecosystem regulation; Ecological succession and climax community; Human impacts on ecosystem.

**Unit 4: Environmental Chemistry** **25 hrs**

Environmental Analytical techniques; Volumetric and gravimetric analysis; Potentiometric titration; Conductometric titration; Colorimetric/spectrophotometric analysis; Errors and statistical methods in chemical analysis; Atmospheric Chemistry: Characteristics of the atmosphere; Atmospheric processes and reaction of gases and particulates; Chemistry in ozone depletion; Chemical reactions of global warming; Chemistry of aquatic media: Water in the Environment; Characteristics of water bodies; Major aquatic chemical processes, structure and property of water, solubility; Acid base reactions: general behavior, carbonic acid, pH and solubility; Oxidation-reduction processes; Soil chemistry: Basic concept of colloidal chemistry; Ion exchange reaction in soil; Pesticides: classification, environmental contamination and fate of pesticides in soil.

**Unit 5: Atmospheric Environment** **25 hrs**

Origin, composition and structure of the atmosphere; Meteorological fundamentals: Radiation and heat budget, temperature, pressure, wind, humidity, water vapour, clouds, fog, precipitation; Atmospheric stability; Adiabatic diagrams-slide and parcel method; Turbulence and diffusion; Scales of meteorology; Application of micro-meteorology to vegetated surfaces, urban areas, human beings, animals and airport; Application of meteorological principal to transport and diffusion of pollutants; Scavenging process; Effects of meteorological parameters on pollutants and vice versa; Wind roses; Temperature inversion; Lapse rate; Concept of weather and climate, Weather forecasting; Climate change: Introduction and impacts; Greenhouse effect; Atmospheric circulation; Weather and seasons; Monsoon; Extreme weather events: Thunderstorms, tornadoes, hurricanes and El Nino/ ENSO.

**Unit 6: Environmental Earth Science** **25 hrs**

Relationship between geology and environmental science; Conceptual framework of earth as a closed system; Introduction to geological time scale; Mountain building process; Internal structure of earth; Earth materials (rocks and minerals): Classification, types, composition, formation and abundance; Earth processes: Endogenic and exogenic; Tectonism; Volcanism; Earthquake; Geological agents of change: Wind, water and ice; Landslide and mass wasting.

Soil Science: Concept and relation with environment; Chemical and mineralogical composition of soil; Process and factors affecting soil genesis; Properties of soil: Physical, chemical and biological; Humus: Nature, properties and formation; Soil profile and types; Soil types of Nepal.

**References:**


1. Bailey, R.A., Clark, H.M., Ferris, J.P., Krause, S. and Strong, R.L. (2005). Chemistry of the Environment. Academic Press (Imprint of Elsevier), California.
2. Critchfield, H. J. (2013). General Climatology, 4th Edition. PHI Learning Pvt. Ltd., New Delhi.
3. Cunningham, W.P. & Cunningham, M.A. (2004). Principles of Environmental Science: Inquiry and Applications, 2nd Edition. Mc Grow Hill, Boston.
4. De, A. K. (2010). Environmental Chemistry, 17th edition. New age international publishers.
5. Keller, E. A. (1985). Environmental Geology. Charles E. Merrill Publishing Company, Bell and Howell Company, Columbus, Ohio.
6. Kormondy, E. J. (1996). Concepts of Ecology. Prentice-Hall of India, New Delhi.
7. Lal, D. S. (2013). Climatology, Revised Edition. Sharda Pustak Bhawan, Allahabad.
8. Mahapatra, G. B. (2008). Textbook of Physical Geology. CBS Publishers and Distributors, India, 326 p.
9. Miller, Jr. G. T. and Spoolman, S.E. (2009). Living in the Environment: Concepts, Connections, and Solutions, 16th Edition. Brooks/Cole, Cengage Learning.
10. Odum, E. P. and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition. Saunders Company, USA.

11. Reineck, H. E. & Singh, I. B. (1990). Depositional Sedimentary Environments with Reference to Rerrigenous Clastics. Pringer-Verlag, Berlin Heidelberg.
12. Richard T. (2008). Environment Science, Towards a Sustainable Future. PHI (p) Limited, India.
13. Santra, S.C. (2004). Environmental Science. New Central Book Agency (p) Ltd., India.
14. Sharma, P.D. (2015). Ecology and Environment, 12th Revised Edition. Rastogi Publications, Meerut, India.
15. Spiro, T.G. and Stigliani, W.M. (2002). Chemistry of the Environment. Prentice-Hall of India, New Delhi.
16. Upreti, B.N. and Dhital, M.R. (1996). Landslide Studies and Management in Nepal. ICIMOD, 87p.

**Course Title: Introductory Environmental Science** **Working hours: 180**
**Course No: ENV 102** **Full marks: 50**
**Nature of Course: Practical (Compulsory)** **Pass marks: 20**

1. Sampling techniques for biological analysis:
   - Vegetation sampling
   - Animals
2. Measurement of population and community parameters: density, frequency, abundance, dominance, community composition, similarity index, species-area-curve, minimum number of sampling units, species diversity and IVI of vegetation and animals by different methods.
3. Determination of total biomass of plants (tree by non-harvest method and herbs by harvest method).
4. Determination of total biomass of animals.
5. Biological analysis of soil from grassland/cropland/forest ecosystems.
6. Determination of Temperature, Transparency, pH, Conductivity, Dissolved Oxygen (DO), Hardness, Alkalinity, Chloride.
7. Study of topographic map and interpretation for geo-environmental study.
8. Identification of rocks and common minerals in hand specimen.
9. Analysis of weather parameters (temperature, precipitation, humidity).
10. Estimation of missing weather data (temperature, precipitation, humidity).
11. Estimation of optimum number of rain gauge station.
12. Measurement of dust fall/total suspended particulates by using trap method.
13. Construction of wind rose.

**Field Visit**

1. Visit nearby forest /grassland ecosystem to enumerate floral and faunal diversity.
2. Visit human settlement area for socio-cultural study.
3. Study of rock/minerals and soil profile.
4. Visit nearby meteorological station to acquaint with the weather recording instruments.

# B.Sc. I Year
# Geology

Subject: Fundamentals of Geology, Crystallography and Mineralogy, Structural Geology
Nature of course: Theory Course No.: GEO101
Full marks: 100 Total period: 150
Pass marks: 35

## Fundamentals of Geology

Total marks: 40 Total period: 62

| Main Topics | Contents | Period | Marks |
|---|---|---|---|
| Introduction | The science of geology, scope, its various branches, method of study, application of geology in mineral resource, infrastructure developments, disaster mitigation. | 4 | 12 |
| Minerals | Definition, processes of formation, and classification of minerals | 4 | |
| Rocks | Classification of rock, rock cycle | 4 | |
| Earth's interior | Probing e Earth's interior, internal structure of the Earth, Earth's major internal boundaries, the crust, mantle and core, lithosphere and asthenosphere, pressure, temperature and seismic wave velocities inside the earth. | 4 | 16 |
| Earthquake | Earthquakes and faults; elastic rebound theory, seismic waves; seismograph, magnitude and intensity of earthquakes, world distribution of earthquakes, forecast and prediction of earthquakes | 4 | |
| Introduction to Plate tectonics | Continental margins, ocean basin floor, mid ocean ridge, Ocean trenches; earlier theories on geosynclines and continental drift; global plate systems, seafloor spreading and subduction zones; theories on coral reef development | 8 | |
| Isostasy | Gravity and continental crust. | 2 | 16 |
| Geological structures | Primary structures: Bedding, cross-laminations, ripple marks. Secondary structures: Faults, Folds, Foliation, Joints | 4 | |
| Weathering and mass wasting | Earth's external processes, weathering, soil formation, the soil profile, types and causes of mass wasting | 6 | |

| | | | |
|---|---|---|---|
| Geological work of running water | Runoff and discharge, geological importance of running water, process of stream erosion and deposition, floods | 4 | |
| Groundwater and its geological activities | Groundwater movement, water table, aquifers and aquicludes, wells, springs, geologic work of groundwater, | 4 | **16** |
| Glaciers and glaciations | Types of glaciers, glacier erosion and transportation, landforms associated with glaciers | 4 | |
| Geological work of sea and ocean | Geological work of sea and ocean and associated landforms | 4 | |
| Geological work of wind | Wind erosion, transportation, and deposition, eolian landforms | 4 | |

## Crystallography and Mineralogy

**Total marks: 30** **Total period: 44**

| **Main Topics** | **Contents** | **Periods** | **Marks** |
|---|---|---|---|
| Introduction to crystallography | Definition of crystals, Crystal symmentry elements, crystal face, Bravais law, law of constancy of interfacial angles, Crystallographic axes | 2 | 16 |
| Internal order in crystals | Symmetry operations, unit cell, lattice; Thirty-two point groups and their symmetry elements; Bravais lattices, screw and glide symmetries, concept of space group and international space notation | 4 | |
| Morphology of crystals and Crystal systems and classes | Axial ratios, parameter system of Weiss, Miller indices, forty-eight forms, combination of forms;<br><br>Crystal systems: Classes and forms of Triclinic, monoclinic, orthorhombic, hexagonal, tetragonal and isometric systems | 8 | |
| Crystal growth and twining | Growth of crystals from solution and from a melt under controlled conditions, crystal growth in open fractures, solution cavities, or vesicles, Twining in crystals, different types of crystal twins, causes of twining in crystals, twin laws. | 2 | |

| | | | |
|---|---|---|---|
| Introduction to mineralogy and physical properties of minerals | Definition of mineral, scope of determinative mineralogy<br><br>Scalar properties–colour, lustre, and streak, their definition and varieties with examples, specific gravity, determination of specific gravity of pure mineral grains by sink and float method, fluorescence and phosphorescence, magnetic properties–ferromagnetic, paramagnetic, and diamagnetic minerals. | 6 | 16 |
| Crystal chemistry of minerals | Vector properties–cleavage, parting, and fracture, their definitions, mineral examples, hardness–definition, Moh's scale of hardness, determination of hardness of minerals, crystallinity and forms of minerals– crystalline, cryptocrystalline, and amorphous, habit of minerals– elongated, tabular, flattened, and equant forms of crystalline and cryptocrystalline aggregates–type examples and use in identification.<br><br>(a) Concept of crystal structure of minerals, Crystal structures and lattices of cubic system; dimorphism, polymorphism, and pseudomorphism, isomorphism and solid solutions. | 6 | |
| Chemical properties of minerals | Minerals as a chemical system; native elements, sulphides, halides, oxides, silicates, titanates, phosphates, arsenates and vanadates, nitrates, borates and uranates, sulphates and chromates, tungstates and molybdates, oxalates and hydrocarbons. Rock-forming (silicate) minerals and their classification. | 4 | |
| | Introduction to economic minerals of Nepal | 4 | |
| Introduction to optical mineralogy | Elements of optics, optics of isotropic medium– refractive medium, Snell's law; critical angle; anisotropic media, polarisation and interference of light, Polaroid, polarising microscope–construction and use, magnification and resolving power, construction and use of mica and gypsum plates and quartz wedge, pleochroism and birefringence, optical indicatrices – uniaxial and biaxial indicatrices, behaviour of light in uniaxial and biaxial crystals, optic sign, optical properties of minerals – form, cleavage, fracture, and parting, refractive index and relief, Bécké line and its use, twining, colour, and pleochroism, pleochroic forms of common minerals, properties under crossed polarisers – | 4 | **12** |

| | | | |
|---|---|---|---|
| | interference colour, twining, and extinction angle, anomalous interference colours, Michael Lévy chart and its use in determining thickness, path difference, birefringence, and order of interference colour, interference figures, optic sign of anisotropic medium, dispersion of optic axes in biaxial crystals. | | |
| Mineral Genesis & Mineral classification | Formation of minerals by different endogenous and exogenous processes. Rock-forming (silicate) minerals and ore-forming (non-silicate) minerals. Silicate Classifications. Physical and optical character, mode of occurrence and important rock-forming minerals. | 4 | |

## Structural Geology

**Total marks: 30** **Total period: 44**

| Main Topics | Contents | Periods | Marks |
|---|---|---|---|
| Introduction | Introduction: Definition, scope of structural geology, concepts of detailed structural analysis: descriptive, kinematic, and dynamic analysis. | 4 | 12 |
| Geological map and cross-section | Geological map and cross-section, orientation of a line (trend and plunge) and a plane (dip and strike), use of a geological compass in measuring orientation of a line and a plane. | 4 | |
| Stereographic projection | Introduction to stereographic projection and its application in structural geology, plotting a line and a plane, finding the intersection of two planes, apparent and true dips. | 4 | |
| Stress and strain | Concepts of stress and strain, their definitions, stress in two dimensions, Mohr circle and its use. | 4 | |
| Unconformity | Bedding, conformity, and unconformity, types of unconformity, recognition of various unconformities in maps and cross-sections. | 2 | 16 |
| Intrusive contacts | Main features of intrusive contacts, sills and dykes, batholiths. | 2 | |
| Diapirs | Main features of diapirs and salt domes. | 2 | |

| | | | |
|---|---|---|---|
| Primary structures | Types of primary sedimentary and igneous structures and their application in structural geology, cross-cutting relationships and younging directions. | 4 | |
| Folds | Definition, classification of folds: anticline and syncline, antiform and synform, cylindrical and non-cylindrical folds, drag folds, criteria of recognition of folds in the field. | 6 | |
| Faults | Definition, classification of faults: strike slip, normal, and reverse faults, thrust faults, horst and graben, criteria of recognition of faults in the field. | 6 | 16 |
| Joints | Definition and classification of joints, study of joints in the field. | 4 | |
| Foliation and lineation | Cleavage, schistosity, and foliation, lineations and their classification, relationship of foliation and lineation with other structures in the field. | 3 | |
| Concepts of field geology | Topographic and geological map reading, use of geological compass, methods of plotting geological data on the maps and preparation of cross-sections. | 3 | |

**Text and Reference books**

**Fundamentals of Geology:**


Brian J. Skinner, Stephen C. Porter and Jeffrey Park, 2004, 5th Edition. Dynamic Earth: An introduction to Physical Geology. John Wiley and Sons. Inc.

Dahal, R.K., 2006. Geology for Technical Students. Bhrikuti Academic Publications.

Donald Duff, 2004. Holme's Principles of Physical Geology, Routledge, UK.

E. J. Tarbuck and F.K. Lutgens, 2005. Earth - An introduction to Physical Geology (8th Edition). Pearson Prentice Hall, New York

J. E. Sanders, 1981. Principles of Physical Geology, John Wiley and Sons, New York.

Paudyal, K.R., 2005. Geology for Civil Engineers. Oxford International Publications.

Strahler and Minzt, Physical Geology, Harper and Raw, New York (recent issue).

Tamrakar, N.K and Acharya, K.K., 2012. Environmental Earth Science. Dikshyanta Prakashan, Kirtipur, 398p.

Tamrakar, N.K. and Bajracharya, R., 2011. Handbook of Engineering Geology. Budha Academic Enterprises Pvt. Ltd., Kathmandu, 260p.

**Crystallography and Mineralogy**

H. H. Read, Rutley's Elements of Mineralogy (26th ed). CBS Publishers and Distributors.

L. G. Berry and Brian Mason, Mineralogy (2nd ed or latest) 2000, CBS Publishers and Distributors.

L. P. Paudel, 2011. Study of Minerals and Rocks in Thin Sections. Geo-Science Innovations (P.) Ltd.

N. K. Tamrakar, 2011, Practical Mineralogy. Central Department of Geology, Tribhuvan University.

P. R. Joshi, H. R. Khan, D. R. Khadka and D. K. Napit, 2004. Mineral resources of Nepal, Published by Department of Mines and Geology, Lazimpat, Kathmandu.

S. M. Rai, 2011. Study of Minerals and Rocks in Hand Specimens. Tara Rai, Kathmandu Nepal.

W. E. Ford, 2005, Dana's Textbook of Mineralogy (4th ed or latest edition). Wiley Eastern Limited.

**Structural Geology:**

B. E. Hobbs, W.D. Means and P. E. Williams, 1976. An Outline of Structural Geology. John Wiley and Sons, New York.

M. P. Billings, 1984, Structural Geology (3rd Ed.), Prentice-Hall of India Pvt. Ltd.

N.W. Gokhale, 1996. Theory of Structural Geology. Satish Kumar Jain for CBS Publishers and Distributors, New Delhi, India.

# B.Sc. I Year

# Geology

Subject: Fundamentals of Geology, Crystallography and Mineralogy, Structural Geology

Nature of course: Practical
Full marks: 50
Pass marks: 20

Course No.: GEO102
Total period: 180

## Fundamentals of Geology

**14 hrs**

**Lab 1**: Study of geomorphic features using contour maps, and preparation of topographical profiles.

**Lab 2**: Study of structural block diagrams.

**Lab 3**: Study of some common igneous, sedimentary and metamorphic rocks

## Crystallography

**28 hrs**

**Lab 1**: Study of space lattice models..

**Lab 2**: Study of crystal systems, crystallographic axes, interfacial angle, and measurement with a contact goniometer.

**Lab 3**: Study of forty-eight crystal forms.

**Lab 4**: Study of symmetry elements of thirty-two classes.

**Lab 5**: Construction of forms and stereographic projections of normal classes of the Triclinic and Monoclinic Systems.

**Lab 6:** Construction of forms and stereographic projections of normal classes of Orthorhombic And Hexagonal Systems.

**Lab 7:** Construction of forms and stereographic projections of normal classes of the Tetragonal and Isometric Systems.

## Mineralogy

**68 hrs**

**Lab 1**: Study of physical properties of minerals. Crystal habit, hardness, cleavage, crystal form, streak and luster of quartz varieties, k-feldspars, plagioclase, micas, amphibole, pyroxene, Al-silicates, tourmaline, olivine, garnet.

**Lab 2**: Introduction of petrological microscope: Mechincal parts, optical parts, adjustment of microscope.

**Lab 3**: Observation of minerals in plane-polarized light: External morphology, cleavage, fracture, relief, color, pleochroism.

**Lab 4**: Observation of minerals in crossed-nicols: Isotropic or anisotropic, Extinction, interference color, birefringence.

**Lab 5**: Identification of essential rock-forming minerals in thin-section (Colourless minerals): Quartz, Feldspars, Pyroxene (Enstatite), Muscovite.

**Lab 6:** Identification of essential rock-forming minerals in thin-section (Colourless minerals): Calcite, Olivine, Kyanite, Sillimanite, Garnet.

**Lab 7**: dentification of essential rock-forming minerals in thin-section (Coloured minerals): Biotite, Chlorite, Pyroxnene (Hypersthene), Amphiboles.

**Lab 8**: Identification of essential rock-forming minerals in thin-section (Coloured minerals): Tourmaline, Staurolite, Epidote.

## Structural Geology

**68 hrs**

**Lab 1:** Drawing of various geological structures and determination of their history of formation from block diagrams.

**Lab 2:** Study of geological maps: outcrop pattern of horizontal, inclined and vertical beds. Rule of V's. Inliers and outliers true and apparent dip of beds, true and apparent thickness, width of outcrop, horizontal and vertical thickness of beds. Relation between true thickness and width of outcrop.

**Lab 3:** Study of geological maps: determination of strike, true dip, and apparent dip of beds from geological maps measurement of thickness and width of outcrop from geological maps, completion of outcrops in geological maps.

**Lab 4:** Study of geological maps: Preparation of topographic profile, consequences of horizontal and vertical scale exaggeration in the profile. Preparation of geological cross-sections of horizontal, inclined, vertical, and folded beds. Geological map interpretation

**Lab 5:** Three-point problems and determination of attitude of beds.

**Lab 6**: Stereographic projection: principle of projection of a line and a plane, projection of inclined, horizontal, and vertical lines, projection of horizontal, inclined, and vertical planes.

**Lab 7**: Determination of intersection line of two planes; determination of apparent and true dips from given data, plotting trend, plunge, and pitch of a line.

Tribhuvan University
Institute of Science and Technology
Course of Study for Four Year Mathematics

**Course Title:** Calculus
**Course No. :** MAT 101
**Level :** B.Sc.
**Nature of Course:** Theory

**Full Marks:** 75
**Pass Mark:** 26.25
**Year:** I
**Lecture:** 150 Hrs.

**Course Description**
This course is designed for first year of Four years B.Sc. program. The main aim of this course is to provide knowledge of Calculus.

**Course Objectives**: The objective of this course is to acquaint students with the concepts of Calculus and differential equations and their applications. It aims at enabling students to build knowledgebase in Calculus.

## Course Contents

**Unit 0. Review of Elementary Calculus:** Functions, Graphs, Evaluations of limits, Continuity, Discontinuity, Test of continuity and properties of continuous functions. [10 Lectures]

**Unit 1. Tangents and Normals:** Tangents and normals, Subtangents, Subnormal and their lengths, Derivatives of arc length, Polar equations of subtangents and subnormal, Angle between radius vector and tangent, Length of perpendicular from pole on tangent, Pedal equations and Angle between two curves.
[10 Lectures]

**Unit 2. Higher Order Derivatives and Mean Value Theorems:** Higher order derivatives, Following theorems (without proofs): Rolle's theorem, Langrange's theorem Cauchy Mean Value theorem, Maclaurin's theorem and Taylor's theorem and their applications in solving problems. [15 Lectures]

**Unit 3. Application of Derivatives:** Indeterminate forms, L'Hospital's rule (without proof), Asymptotes, Types of asymptotes, Asymptotes of algebraic curves, Curve tracing techniques, Standard curves and their tracing, Curvature, Chord of curvature, Curvature at origin, Center and circle of curvature.
[15 Lectures]

**Unit 4. Partial Differentiations and Maxima and Minima of Functions of 2 and 3 Variable:** Basic ideas of limits and continuity of functions of 2 and 3 variables, Partial derivatives and their geometrical interpretation, Higher order partial derivatives, Homogeneous functions, Euler's theorem (proof for 2 variables only), Total differentials, Extreme values, Stationary points, Criteria for maxima and minima, Subsidiary conditions, Lagrange's method of undetermined multipliers. [15 Lectures]

**Unit 5. Integration and Definite Integrals:** Integration concepts, Integration techniques and standard formulae, Integration of rational functions and hyperbolic functions, Integration as the limit of a sum, Definite integral and fundamental theorem of integral calculus (without proof), properties of definite integral.
[10 Lectures]

**Unit 6. Beta and Gamma Functions and Reduction formulae:** Improper integrals, Beta and Gamma functions and their properties, Reduction formulae. [8 Lectures]

**Unit 7. Rectification and Quadrature, Volume and Surface Area of Solid of Revolution:** Rectification notion, Length formulae, Idea of quadrature and area formula, Volume and surface area of solid of revolution. [10 Lectures]

**Unit 8. Double Integrals:** Double and iterated integrals in rectangular coordinates, Changes of variables in double integrals( to polar coordinates and curvilinear coordinates), Computing area and volume using double integrals, Application of double integrals in mechanics: mass and static moments of a lamina, centre of gravity, moments of inertia of a lamina. [10 Lectures]

**Unit 9. Vector Calculus:** Vector Fields, Gradient Fields, Line Integrals, Line Integrals in Space, Line Integrals of Vector Fields, The Fundamental Theorem for Line Integrals, Independence of Paths, Conservation of Energy, Green's Theorem, Extended Version of Green's Theorem, Curl and Divergence, Vector forms of Green's Theorem. [10 Lectures]

**Unit 10. Vector Calculus (Contd.):** Parametric Surfaces and their Areas, Surface Integrals, Surface Integrals of Vector Fields, Stoke's Theorem, The Divergence Theorem. [10 Lectures]

**Unit 11. Differential Equations of the First Order and the First Degree:** Introduction, standard form, Variables-separable equations, Homogeneous equations, Equations reducible to homogeneous equations, Non-homogeneous equation of the first order, Exact differential equation, Condition for exactness, Integrating factors first order, Exact differential equation, Condition for exactness, Integrating factors and techniques, Linear differential equations and equations reducible to linear forms. [15 Lectures]

**Unit 12. Linear Differential Equations with Constant Coefficient:** Linear equations with constant coefficients, Linear equations solvable using symbolic operators, Symbolic operation techniques, Particular integrals and complementary function, Homogeneous linear equations, Equations reducible to homogeneous form. [12 Lectures]

**Text books**


1. M.B. Singh and B.C. Bajracharya; Differential Calculus, Sukunda Pustak Bhandar, Kathmandu, 1995.
2. G.D. Pant and G.S. Shrestha; Integral Calculus and Differential Equations, Sunita Prakashan, Kathmandu 1994.
3. James Stewart, Calculus Early Transcendentals, Cengage Learning, 7th Edition Metric Version, 2015.


**Reference books**


4. Anton, Bivens and Davis, Calculus, Wiley, 7th Edition, 2012.
5. D.A. Murray; Introductory Course in differential Equations, Oriental Longman.
6. T.M. Apostal; Calculus Vol I & II, Wiley Eastern Ltd, New Delhi, 1986.
7. S.M. Maskey; Calculus, Ratna Pustak Bhandar, Kathmandu, 2008.

# Tribhuvan University

Institute of Science and Technology

Course of Study for Four Year Mathematics

**Course Title:** Analytical Geometry and Vector Analysis **Full Marks:** 75
**Course No. :** MAT 102 **Pass Mark:** 26.25
**Level :** B.Sc. **Year:** I
**Nature of Course:** Theory **Lectures:** 150 Hrs.

**Course Description**: This course is designed for first year of Four years B.Sc. program. The main aim of this course is to provide knowledge of Analytical Geometry and Vector Analysis.

**Course Objectives**: The objective of this course is to acquaint students with the basic concepts of Analytical Geometry and Vector Analysis. It aims at enabling students to build good knowledgebase in the subject of Analytical Geometry and Vector Analysis

**Unit 1. Transformation of Coordinates:** Introduction to polar, cylindrical and spherical coordinates, Transformation, Rotation, Process involving combination of translation and rotation of axes, Invariants in orthogonal transformation. [10 Lectures]

**Unit 2. Conic Sections and their properties:** Introduction, Conic section as a locus of a point and as a section of a 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, Equation of a hyperbola referred to the asymptotes as coordinate axes.
[20 Lectures]

**Unit 3. Polar Equation of a Conic:** Polar equation of a conic section with focus being a 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. [10 Lectures]

**Unit 4. General Equation of the Second Degree:** General equation of the second degree and the conic representation by them, Nature of the conic, Center 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.
[10 Lectures]

**Unit 5. Coordinates in three space and Plane:** Review of coordinates 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 intersection of the two planes, Condition for representing a pair of planes by the homogeneous equation of the second degree [10 Lectures]

**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 lies, Intersection of three planes. [12 Lectures]

**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. [8 Lectures]

**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 and right circular cone, Cylinder and enveloping cylinder, Right circular cylinder. [13 Lectures]

**Unit 9. Central Conicoids:** Conicoids and central conicoids, Standard equation of the 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 six normals, Genereal 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, Diametrical plane, Conjugate diameters and diametrical planes of a ellipsoid, Properties of conjugate semi-diameters.

[15 Lectures]

**Unit 10. Product of three or more vectors:** Multiplication of three vectors, scalar triple product, Applications and geometrical meanings of scalar triple product, Properties of scalar triple product, Condition of coplanarity of three vectors, Vector triple product, Scalar product of four vectors and vector product of four vectors, Reciprocal system of vectors. [10 Lectures]

**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 a scalar product and vector product of two and three vectors. [10 Lectures]

**Unit 12. Gradient, divergence and Curl, and Expression Formulae:** Scalar point function, Vector point function, Scalar field, Vector field, Vector operators, Gradient scalar field, Gradient polar coordinates, Condition of 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 formulae involving the first order and the second order differential operator [12 Lectures]

**Text books**


1. Y.R. Sthapit and B.C. Bajracharya; A Text Book of Three Dimensional Geometry, Sukunda Pustak Bhandar, Kathmandu.
2. M.B. Singh and B.C. Bajracharya; A Text Book of Vector Analysis, Sukunda Pustak Bhandar, Kathmandu
3. M.R. Joshi; Analytical Geometry, Sukunda Pustak Bhandar, Kathmandu


**Reference books**


1. S. Narayan; Analytical Solid Geometry, S. Chand and Co.
2. Lalji Prasad, Vector Analysis, Paramoung Publication 1986.
3. S.L. Loney; Elements of coordinate Geometry, MacMillan Books co. NY 1984
4. J.T. Bell; An Elementary Treatise of Coordinate Geometry of Three Dimensions, MacMillan Book Co. NY 9846

# Tribhuvan University
# Institute of Science and Technology
# 2016 (Revised version)

***Structure of four year B. Sc. Meteorology course***

| Year | Theory | FM | Practical | FM |
|---|---|---|---|---|
| First | General Meteorology and Climatology (50+50) MET 101 | 100 | General Meteorology and Climatology Practical MET 102 | 50 |

# First year

## General Meteorology and Climatology

Course Title: General Meteorology and Climatology

Course Number: MET 101 Full Marks: 100

Nature of Course: Theory Pass Mark: 35

**Course Objectives:**

The General Meteorology and climatology course is designed to provide basic knowledge on introductory matters of Meteorology and climate science. In addition, the physical causes of the climate and its variation in both space and time are provided.

### Group A: General Meteorology (Theory)

**Atmospheric composition, mass and structure:** Total atmosphere, Variations with height, Variations with latitude and season, Variations with time 2 hrs

**Mass of the atmosphere:** total pressure, vapor pressure 1 hr

**The layering of the atmosphere:** Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere and magnetosphere 2 hrs

**Solar radiation and the global energy budget**: Solar radiation, Solar output, Distance from the sun, Altitude of the sun, Length of day 2 hrs

**Surface receipt of solar radiation and its effects:** Energy transfer within the earth–atmosphere system, Effect of the atmosphere, Effect of cloud cover, Effect of latitude, Effect of land and sea, Effect of elevation and aspect, Variation of temperature with height 4 hrs

**Terrestrial infrared radiation and the greenhouse effect** 1 hr

**Heat budget of the earth** 1 hr

**Atmospheric energy and horizontal heat transport:** The horizontal transport of heat, Spatial pattern of the heat budget components 2 hrs

**Atmospheric moisture budget** 2 hrs

**The global hydrological cycle** 1 hr

**Humidity:** Moisture content, Moisture transport 1 hr

**Evaporation and Condensation** 2 hrs

**Precipitation characteristics:** Forms of precipitation, Precipitation characteristics: Rainfall intensity, Areal extent of a rainstorm, Frequency of rainstorms, The world pattern of precipitation, Regional variations in the altitudinal maximum of precipitation, Drought 3 hrs

**Acid precipitation** 1 hr

**Air stability and instability** 1 hr

**Atmospheric instability, cloud formation and precipitation processes:**

Condensation nuclei, Cloud types, Global cloud cover 3 hr

**Adiabatic temperature changes** 1 hr

**Formation of precipitation:** Bergeron–Findeisen theory, Coalescence theories, Solid precipitation 3 hrs

**Precipitation types:** 'Convective type' precipitation, 'Cyclonic type' precipitation, Orographic precipitation 2hrs

**Thunderstorms and its types** 2 hrs

**Mesoscale convective systems** 2 hrs

**Atmospheric motion: principles** 2 hrs

**Laws of horizontal motion:** The pressure-gradient force, The earth's rotational deflective (Coriolis) force, The geostrophic wind, The centripetal acceleration**,** Frictional forces and the planetary boundary layer 5 hrs

**Divergence, vertical motion and vorticity:** Divergence, Vertical motion, Vorticity

3 hrs

**Local winds:** Mountain and valley winds, Winds due to topographic barriers, Land and sea breezes 3 hrs

**Planetary-scale motions in the atmosphere and ocean** 4 hrs

**Variation of pressure and wind velocity with height:** The vertical variation of pressure systems**,** Mean upper-air patterns, Upper wind conditions, Surface pressure conditions 6 hrs

**The global wind belts:** The trade winds, The equatorial westerlies, The mid-latitude (Ferrel) westerlies, The polar easterlies 8 hrs

**The general circulation:** Circulations in the vertical and horizontal planes**,** Variations in the circulation of the northern hemisphere 7 hrs

**Text Book:**

- R.G. Barry and R.J. Chorley, Atmosphere, Weather and Climate, Holt, Rinehart and Winston, Inc

## Group B: Climatology (Theory)

**Introduction to the climate system**: Atmosphere, Ocean and land surface, atmospheric temperature, atmospheric composition, weather and climate, Definition and scope of climatology, sub-division of climatology, Factors affecting climate. 10 hrs

**Precipitation:** Precipitation process, Ice-crystal theory, Collision-coalescence theory, Forms of precipitation, Types of precipitation, Seasonal variation of precipitation, Diurnal variation of precipitation. 8 hrs

**Heat exchanges in the atmosphere**: Solar radiation, insolation, terrestrial radiation, heat exchange process, the energy budget of the atmosphere, the effect of radiation at the earth's surface, temperature difference between land and sea surface, albedo 12 hrs

**Air Masses:** Definition and Characteristics, source region, air mass modification, classification of air mass 7 hrs

**Classification of climate, their type and distribution**: Need and objectives of classification, basis of classification, Koppen's classification, Thornthwaites classification, Tropical rainforest climate, savanna climate, tropical monsoon climate, Sahara type climate, low-latitude steppe climate, middle-latitude steppe climate, middle-latitude desert climate, Mediterranean climate, china type of climate, temperate oceanic climate, humid continental climate, hot summer climate, humid continental mild summer climate, taiga climate, Tundra climate, ice-cap climate, high land climate. 20 hrs

**Climate of Nepal**: East West variation, orographic variation, western disturbances, Convection in pre and post monsoon, summer monsoon. 12 hrs

**Climate Change and its Impacts:** Introduction, Green House Gases (GHGs), anthropogenic change of climate, Impact of climate change in Nepal. 6 hrs

**Text Books**

- Dennis L. Hartmann, 1994, Global Physical Climatology, International Geophysical Series, Academic Press

- Lal, D.S., Climatology, Sharda Pustak Bhawan, Allahabad, India, Revised and enlarged edition 2001

**Reference Books**

- Sellers. W. D., Physical climatology, University of Chicago Press.
- Conrad, V. and Pollack, L., W., Methods in Climatology, Second edition, HARVARD University Press, Massachusetts, 1962.
- Chritchfield, H. J., General Climatology, Prentice Hall of India Private Limited, New Delhi, 1975.

# General Meteorology and Climatology Practical

**Course Title:** General Meteorology and Climatology Practical

**Course Number:** MET 102 Full Marks: 50

**Nature of Course:** Practical Pass Mark: 20

## Group A: General Meteorology (Practical)

**Practical 1**: Meteorological observatory- site selection and types using WMO practice

**Practical 2:** Introduction of Stevenson screen

**Practical 3:** Minimum maximum thermometer for temperature measurements

**Practical 4:** Dry bulb and wet bulb temperature (Psychrometer) for dew point determination

**Practical 5:** Measurement of precipitation

**Practical 6:** Sunshine recorder for diurnal hours

**Practical 7:** Anemometer and wind vane for wind speed and direction measurements

**Practical 8:** Measurement of Pressure by using Kew Patten's Barometer

**Practical 9:** Measurement of Pressure by using and Fortin Barometer.

**Practical 10:** Introduction of AWS

**Practical 11:** Measurement of evaporation.

**Practical 12:** Identification of clouds using cloud atlas.

**Practical 13:** Meteorological station visit and report preparation (3 days)

## Group B: Climatology (Practical)

**Practical 1:** Determine the principle climatic types to which each of them belongs by using koppen climatic classification method.

**Practical 2:** The rain fall of station A from 1981 to 2000 is given, (a) find out the magnitude of rain fall with probability of 50% and 25% (b) what will be the probability corresponding to rainfall of 1460mm.

**Practical 3:** Given below is the mean temperature of January of station 'A' from 1981 to 2010. Calculate the moving average (5 years running mean). Plot year Vs mean in the same graph. Comment the two graphs.

**Practical 4:** Compare potential evapotranspiration (PET) estimated by the Thronthwaites method and evaporation obtain by pan and relate them with seasonal precipitation with the given data of a station.

**Practical 5:** Computation and interpretation of annual average, standard deviation, and coefficient of variation (rainfall and temperature) of a given station of Nepal.

**Practical 6:** Computation of moving average and interpretation of monthly climatological summary

**Practical 7:** Compute and plot rainfall standard anomaly of given series for the period 1971-2010 and interpret.

**Practical 8:** Compute and plot temperature standard anomaly of given series for the period 1971-2010 and interpret.

**Practical 9:** Computation of water balance parameter using Thornthwaite method

**Practical 10:** Computation of energy balance parameter using Thornthwaites method

**Practical 11:** Compute the linear trend of given data (temperature and rainfall)

**Practical 12:** Learning a thermodynamic diagram (Skew-T LogP, t-phi gram)

**Practical 13:** Plot the sounding data and determine significant levels

**Practical 14:** Interpretation of Satellite IR, Water vapor images of different case

**Tribhuvan University**
**Institute of Science and Technology**

# Course of Study for Four Year B. Sc. Microbiology

**December, 2016**

# General Microbiology

## Description of the Course

**Course Title:** General Microbiology
**Course No:** MB 101 (Major)
**Nature of the Course**: Theory

**Full Marks**: 100
**Pass Marks**: 35
**Year**: I
**Total Lecture Hours:** 150

## Course Objectives

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

a) understand the concept of microorganisms, history of microbiology, classification schemes and the nomenclature of microorganisms, scope and applications of microbiology
b) know handling methods, growth, physiology, metabolism, genetics of microorganisms
c) understand basics of bacteriology, virology, mycology and parasitology

## Course Contents

**History and development of microbiology** **4hrs**

Development of microbiology with reference to modern era, important discoveries, theories of spontaneous generation and germ theory of disease (Louis Pasteur, Robert Koch)

**Classification and nomenclature of microorganisms** **15hrs**

Classification schemes of living organism, differential characteristics of prokaryotic and eukaryotic microorganism. General principle of nomenclature, three and five kingdom concepts, basic understanding of classification of bacteria, viruses, fungi and protozoa, classification, nomenclature and characterization of bacteria according to Bergey's Manual of Systematic Bacteriology

**Scope and applications of microbiology** **7hrs**

Harmful and beneficial microorganism; applied microbiology (medical, public health, agricultural, food, microbial biotechnology, environmental, industrial, pharmaceutical microbiology)

**Morphology of bacteria** **10hrs**

Structure of bacteria, morphology and fine structure of cell organelles, differences between gram negative and gram positive bacteria

**Growth and physiology of bacteria** **8hrs**

Nutritional types of bacteria (photolithotrophic, chemolithotrophic, photoorganotrophic, chemoorganotrophic), entry of nutrients, passive and active transport, bacterial growth, growth curve, factors affecting growth

**Isolation, enumeration and culture of bacteria** **10hrs**

Types of bacteriological culture medium, techniques for isolation and enumeration of bacteria (streak plate technique, pour plate technique, spread plate technique, membrane filtration, most probable number method, direct microscopic count), biochemical tests of bacteria, methods of culture of aerobic and anaerobic bacteria, culture preservation methods

**Metabolism** **15hrs**

Introduction to metabolism, regulation and energy involvement in glycolysis (Embden Mayerhoff Paranas pathway), glycogenesis, glycogenolysis, TCA cycle, pentose phosphate pathway, Entner Doudoroff's pathway, phosphoketolase pathway, fermentative pathways and electron transport system

**Microbial genetics** **15hrs**

Structure and function of prokaryotic DNA, genetic code, plasmids, concepts of bacterial genetics and role of RNA & DNA; bacterial recombination (transformation, conjugation and transduction), types and importance of mutation

**Microscopy and different techniques of handling of microorganisms** **8hrs**

Microscopes (light, stereo, dark field, phase contrast, electron, fluorescence), types of staining and nature of dyes/stains, different types of staining methods for microorganisms, aseptic techniques in microbiology

**Techniques in control of microorganisms** **12hrs**

Principles, procedures and applications of disinfection and sterilization-temperature, irradiation, ultrasonication, filtration, chemicals, antibiotics and chemotherapeutic agents

**Host parasite interaction** **10hrs**

Normal microbial flora of human body, concept of host parasite relationship, concept of immunity

**Introduction to virology** **12hrs**

General structure (size, symmetry and shape) of virus, classification schemes, viral genetics, detection, enumeration (plaque assay, haemagglutination test, quantitative PCR, neutralization test), cultivation of viruses

**Introduction to parasitology** **12hrs**

Origin, morphology and classification of parasites (blood, tissue, intestinal parasites, soil transmitted helminths and nematodes), techniques of detection, enumeration and identification of protozoan and helminthic parasites

**Introduction to mycology** **12hrs**

Origin, morphology and medical classification of fungi. Techniques of isolation, morphological identification, culture and enumeration of yeast and mold

## Recommended Readings

**Text books**


1. Collins CH, Patricia M, and Lyne JM (1995). Collins and Lynes Microbiological Methods 7th edition. Grange, Butter Worth, Oxford.
2. Cappucino JG and Sherman N (1996). Microbiology, A Laboratory Manual 4th edition. Benjamin Cumings Inc. California.
3. Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill.
4. Madigan MT, Martinko JM and Parker J (2012). Brock Biology of Microorganism, 11th edition Prentice Hall International Inc. London.


**Reference books**


1. Atlas RN (1984). Microbiology: Fundamental and Applications. Memillan Co.
2. Greenwood D, Richard CD, John S and Peuther F (1992). Medical Microbiology, 16th edition. ELBS, Churchill living stone.

# General Microbiology Practical

## Description of the Course

**Course Title**: General Microbiology Practical
**Course No:** MB 102 (Major)
**Nature of the Course**: Practical

**Full Marks**: 50
**Pass Marks**: 20
**Year:** I
**Total Lecture Hours:** 180

## Course Objective

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

a) develop practical skills on basic microbiological procedures for handling, culture, isolation and identification of microorganisms.

## Course Contents

**To operate and learn working principle of:** Microscope.
**To operate and learn working principle of:** Hot air oven, autoclave, incubator, UV safety hood and spectrophotometer.
**To perform staining of bacteria:** Simple staining, gram's staining, negative staining, flagella staining, spore staining and capsule staining, Ziehl Neelson staining
**To perform the biochemical tests of bacteria:** Catalase test, oxidase test, urease test, sugar fermentation, indole test, MR tests, VP test, citrate test, TSI test, nitrate reduction test, starch hydrolysis, lipid hydrolysis, protein hydrolysis
**To prepare microbiological culture media**: Nutrient agar, MacConkey agar, blood agar, potato dextrose agar, broth media
**To perform isolation and enumeration of bacteria by** Streak plate technique, spread plate technique, pour plate technique, MPN and MF method
**To determine the size of bacteria by** Micrometry technique
**To determine the motility of bacteria** Hanging drop method
**To measure the bacterial growth and calculate the generation time**
**To study effect of temperature, pH, salt concentration, sugar concentration on microbial growth**
**To perform yeast and mold count and morphological identification of fungi**
**To perform culture of** anaerobic bacteria
**To perform antibiotic susceptibility test by** Kirby Bauer disc diffusion method

**Tribhuvan University**
**Institute of Science and Technology**

# Physics

**Course Title:** Mechanics, Thermodynamics, Statistical Physics, Electricity and Magnetism **Year :** I

**Course Code:** PHY101 **Full Marks:** 100
**Nature of Course:** Theory **Pass Marks:** 35
**Duration:** 150 hours

**Course Objectives**

At the end of this course the student should be able to acquire sufficient basic knowledge in physic and apply this knowledge for higher studies and research in physics

## MECHANICS [50]

**Course Contents:**

1. **Review of Laws of Motion: 1.1** Dynamics of a particle, General equations of motion, Types of forces, Conservation laws, Work-Energy theorem, Conservative forces, 1.2 Motion of a body near the surface of the earth, Linear restoring force, Potential energy curve, Non-conservative forces. [3 hours]
2. **Linear and Angular Momentum: 2.1** Conservation of linear momentum, Centre of mass, Collision of two particles, 2.2 Deflection of a moving particle by a particle at rest, Rocket, Angular momentum and torque, 2.3 Motion under central force, Areal velocity, 2.4 Examples of conservation of angular momentum. [5 hours]
3. **Gravitational Potentials and Fields: 3.1** Central Forces, Inverse square-law of force, 3.2 Gravitational field and potential, Velocity of escape, 3.3 Potential and field due to a thin spherical shell and due to a solid sphere, Gravitational self energy, 3.4 Gauss's and Poisson's equation for gravitational field, 3.5 Kepler's laws of planetary motion, 3.6 Deduction of Newton's law of gravitation from Kepler's Laws. [7 hours]
4. **Dynamics of Rigid Bodies: 4.1** Equations of motion for a rotating rigid body, 4.2 Theorems on moment of inertia (M.I.), M.I. of a rectangular lamina, Solid uniform bar of rectangular cross-section, Circular disc, Solid cylinder, Solid sphere and spherical shell, 4.3 Kinetic energy of a rotating and rolling bodies, 4.4 Motion of a body rolling down an inclined plane, 4.5 Reduction of two body problem to a single body problem. [6 hours]
5. **Harmonic Oscillator: 5.1** Simple harmonic motion (S.H.M.) and harmonic oscillator, 5.2 Examples of harmonic oscillator, Simple pendulum, Compound pendulum, 5.3 Mass-spring system, 5.4 Torsional pendulum, 5.5 Helmholtz resonator, 5.6 Oscillation of two particles connected by a spring ,N-coupled oscillators, 5.7 Damping force, Damped and forced harmonic oscillator, 5.8 Power dissipation, Quality factor, 5.9 Power absorption. [8 hours]
6. **Wave Motion: 6.1** General equation of wave motion, 6.2 Equation of plane progressive harmonic wave, 6.3 Particle velocity and wave velocity, 6.4 Energy density for a plane progressive wave,

6.5 Intensity of wave and spherical waves, 6.6 Transverse waves in stretched strings, Modes of vibration, 6.7 Longitudinal waves in rods and gases, 6.8 Flow of energy in stationary waves. [7 hours]

7. **Elasticity: 7.1** Relations connecting various elastic constants, 7.2 Angle of twist and angle of shear, 7.3 Twisting couple on a cylindrical rod or wire, 7.4 Work done in twisting a rod or wire, 7.5 Bending of beams, Bending moment, 7.6 Cantilever, 7.7 Beam supported at its ends and loaded in the middle. [8 hours]
8. **Fluid Mechanics - Viscosity: 8.1** Kinematics of moving fluid, 8.2 Equation of continuity, 8.3 Bernoulli's theorem and its applications, 8.4 Viscous fluids, Streamline and turbulent flow, Critical velocity, 8.5 Reynold's number, 8.6 Poiseuille's equation, Capillaries in series and parallel. [6 hours]

## THERMODYNAMICS [35]

**Course Contents:**

9. **Thermodynamic Fundamental Concepts: 9.1** Thermodynamic systems, Thermal and thermodynamic equilibrium, Equation of state, Thermodynamic processes, 9.2 External and internal work, Internal energy, Quasi-static, Isothermal, Adiabatic, Isobaric and isochoric processes. [3 hours]
10. **Laws of Thermodynamics and Their Application: 10.1** Zeroth law, First law of thermodynamics, Second law of thermodynamics, 10.2 Carnot's theorem, 10.3 Absolute scale of temperature, 10.4 Entropy changes in reversible and irreversible processes, Principle of increase of entropy, 10.5 Entropy and second law, 10.6 Third law of thermodynamics and its applications. [6 hours]
11. **Thermodynamic Relations**: 11.1 First and second latent heat equations, 11.2 Triple point, Thermodynamic potentials, 11.3 Helmholtz's function, Enthalpy, 11.4 Gibb's function, 11.5 Maxwell's thermodynamic relations, Phase transition, 11.6 Clausius-Clapeyron equation. [6 hours]
12. **Concept of Ideal and Real Gases: 12.1** Concept of ideal and real gases, 12.2 Joule expansion, Joule's law for perfect gas, 12.3 van der Waals equation, Critical constants of van der Waals gas, 12.4 Joule-Thomson expansion, Porous plug experiment, 12.5 Constancy of enthalpy, Adiabatic expansion. [5 hours]
13. **Production of Low Temperature: 13.1** Thermodynamics of refrigeration, Refrigeration cycle, Co-efficient of performance, 13.2 Cooling in Joule-Thomson expansion, Regenerative cooling, Cascade cooling, 13.3 Boyle's temperature of inversion, 13.4 Critical temperature and their relations, 13.5 Liquefaction of Helium and its properties. [4 hours]
14. **Transport Phenomenon: 14.1** Molecular collisions, Collision cross-section, Molecular diameter, Mean free path, 14.2 Transport phenomenon, Transport of momentum - viscosity, 14.3 Transport of energy - thermal conductivity, 14.4 Transport of mass - diffusion, 14.5 Brownian motion, Einstein's theory of Brownian motion. [5 hours]
15. **Black Body Radiation: 15.1** Total energy density, Spectral energy density, 15.2 Emissive power, Absorptive power, Kirchoff's law, 15.3 Pressure of radiation, Pressure of diffusive radiation, Stefan-Boltzmann's law , 15.4 Spectrum of black body radiation, Wien's displacement law, 15.5 Planck's radiation law, Rayleigh-Jean's law. [6 hours]

## STATISTICAL PHYSICS [15]

**Course Contents:**

16. **Classical statistical physics: 16.1** Phase space, Microstate, Macrostate, 16.2 Ensemble, Constraints and accessible states, 16.3 Thermodynamic probability, 16.4 Fundamental postulates of statistical mechanics, 16.5 Division of phase space into cells, 16.5 Boltzmann's canonical distribution law, 16.6 Maxwell's distribution law of velocities, 16.7 Maxwell-Boltzmann statistics, 16.7 Law of equipartition of energy. [10 hours]
17. **Introduction to Quantum Statistical Physics: 17.1** Bose-Einstein statistics, 17.2 Fermi-Dirac statistics, 17.3 Black body radiation, 17.4 Electron gas in metals, 17.5 Fermi energy. [5 hours]

## ELECTRICITY AND MAGNETISM [50]

**Course Contents:**

18. **Elementary Vector Analysis: 18.1** Gradient of a scalar, Divergence and curl of a vector in cartesian coordinates, 18.2 Divergence in polar coordinates, 18.3 Gauss's, Stoke's and Green's theorems, 18.4 Laplacian in polar co-ordinate system, 18,5 Laplace's and Poisson's equation. [5 hours]
19. **Electrostatic Potential and Field: 19.1** Coulomb's law, Electric Potential energy of a system of charges, Electric field strength, Electric flux, 19.2 Gauss's law and it's applications, 19.3 Electric potential and the line integral of the electric field, 19.4 Equipotential surface, Potential and field due to an electric dipole, Potential due to an infinitely long charged wire, Potential and field due to an uniformly charged disc, 19.5 Force on a surface charge, 19.6 Method of electrical images. [7 hours]
20. **Electric Fields in Dielectrics: 20.1** A dipole in an electric field, Polar and non-polar molecules, 20.2 Dielectric polarization, Electric field due to a polarized dielectric (three electric vectors), 20.3 Gauss's law in dielectric, Energy stored in an electric field in the presence of dielectric, Boundary conditions on field vectors, Molecular field in a dielectric, 20.4 The Clausius-Mossotti relation, Polar molecules, 20.5 The Langevin Debye formula. [6 hours]
21. **Magnetic Fields of Moving Charges: 21.1** Magnetic field and the magnetic flux, 21.2 Biot-Savart's law and its applications, 20.3 Lorentz force, Ampere's circuital law and its applications, Curl **B** and div **B,** 20.4 Magnetic vector and scalar potentials, 20.5 Magnetic dipole, 20.6 Force between current carrying parallel wires. [6 hours]
22. **Magnetic Properties and Fields: 22.1** The absence of isolated magnetic poles, 22.2 Magnetic dipole moment of current loop and angular momentum, Magnetization, 22.3 Langevin's theory of diamagnetism and paramagnetism, 22.4 Theory of ferromagnetism, 22.5 Energy loss due to hysteresis, 22.6 Magnetic susceptibility and permeability, Ferrites. [6 hours]
23. **Electromagnetic Inductions: 23.1** Faraday's law, Skin effect, 23.2 Moving coil ballistic galvanometer, Search coil, Flux meter, Earth inductor, Self and mutual induction, 23.3 Reciprocity theorem of mutual inductances, Self inductance of a solenoid, Toroid and two long parallel wires, 23.4 Energy stored in magnetic field, Transformer. [4 hours]

24. **Varying Currents: 24.1** Charging and discharging of a condenser through a resistance, 24.2 Rise and decay of current in LR & LC circuit, 24.3 Charging and discharging of a capacitor through inductance and resistance. [3 hours]
25. **Alternating Current Circuit: 25.1** The complex number method for AC analysis, Impedance, Reactance and admittance, 25.2 LCR circuits, Phase diagrams, Sharpness of resonance, 25.3 Quality factor, Power factor. [4 hours]
26. **Maxwell's Electromagnetic Equations: 26.1** The displacement current, Maxwell's equations and their use in propagation of electromagnetic wave, 26.2 Poynting vector, Derivation of Gauss's theorem, 26.3 Faraday's law, Lenz law, 26.3 Biot-Savrat's law and Ampere's circuital law, 26.4 Energy of a charged particle in an electromagnetic field, 26.5 Reflection and refraction of electromagnetic waves at the interface between two media, 26.6 Plane wave solution of Maxwell's equations, The wave equation, 26.7 Plane electromagnetic waves in isotropic dielectric and in conducting media. [9 hours]

**Text Books:**


1. *Mathur D. S. (Revised by P. S. Hemne)* – **Mechanics,** S. Chand and Company, Revised Ed. (2012)

2. *Singhal S. S., Agarwal J. P., Prakash S.* - **Heat, Thermodynamics and Statistical Physics**, Pragati Prakashan, Meerut, 21st Ed. (2009)

3. *Reitz J. R., Milford F. J., Christy R. W.* **- Foundations of Electromagnetic Theory**, Narosa Publishing House, New Delhi, 3rd Ed. (1998)


**Reference Books:**


1. *Upadhyaya J. C.* – **Mechanics,** Ram Prasad and Sons, Agra, 4th Ed (1994)

2. *Verma M. K.* **- Introduction to Mechanics,** University Press (India) Pvt. Ltd., 1st Ed. (2008)

3. *Sears F. W., Salinger G. L.* **- Thermodynamics, Kinetic Theory and Statistical Thermodynamics**, Narosa Publishing House, New Delhi, 3rd Ed. (1998)
4. *Lal Brij and Subrahmanyam N.* **- Heat and Thermodynamics**, S. Chand and Company, New Delhi, 16th Ed. (1994)

5. *Reif F.* - **Fundamentals of Statistical and Thermal Physics,** McGraw Hill, Delhi (1985)

6. *Kittel C., Kroemer H.* **- Thermal Physics,** CBS Publishers, New Delhi, 2nd Ed. (1987)

7. *Arora V. P., Saxena M. C., Prakash S.* **- Electricity and Magnetism**:, Pragati Prakashan, Meerut, 18th Ed. (2007)

8. *Laud B. B.*– **Electromagnetics,** Wiley Eastern Limited, 2nd Ed. (1992)

9. *Griffiths D. J.* **- Introduction to Electrodynamics**, PHI India, New Delhi, 3rd Ed. (2002)

# Tribhuvan University

## Institute of Science and Technology
## Physics

**Course Title:** Physics Laboratory
**Course Code:** PHY102
**Nature of Course:** Practical

**Year:** I
**Full Marks:** 50
**Pass Marks:** 20
**Duration:** 180 hrs

**Course Description:**

Physics Laboratory (General) Practical course consists of three sections: (a) Mechanical Experiments, (b) Heat & Thermodynamics Experiments, and (c) Electricity & Magnetism Experiments. Students have to perform at least 15 experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. Students should complete at least 20 experiments in the first year. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

**Course Objectives:**

1. To provide students with skill and knowledge in the experimental methods.
2. To make them able to apply knowledge to practical applications.
3. To make them capable of presenting their results/conclusions in a logical order.

## B.Sc. First Year Lab Works [180]

1. To determine the value of acceleration due to gravity by using Bar Pendulum.
2. To determine the value of acceleration due to gravity by using Kater's pendulum.
3. Perform the experiment 1 and 2 and compile a dataset of acceleration due to gravity of your laboratory in a single set. Show the histogram and calculate the standard deviation and standard error. Interpret the result.
4. To determine the moment of inertia of a flywheel.
5. To determine the angular acceleration of a flywheel.
6. To determine the radius of gyration by of Bar Pendulum.
7. To determine the Young's modulus of the material by bending beam method.
8. To determine of modulus of rigidity of wire by Maxwell's vibration needle.

9. To study the conservation of momentum using Newton's Cradle.
10. To determine the surface tension of liquid by Jaeger's method.
11. To determine the coefficient of viscosity of water by Poiseulle's method.
12. To find the co-efficient of thermal conductivity of a bad conductor by Lee's method.
13. To find the co-efficient of thermal conductivity of insulating material (such as porcelain, wood, or Styrofoam) using Thermocouples and a Fluke 52 digital thermometer.
14. To determine the mechanical equivalent of heat by Callender and Barne's constant flow method.
15. To determine the sensitivity and constant of Ballistic galvanometer.
16. To determine the capacitance by Ballistic galvanometer.
17. To determine the high resistance by the method of leakage.
18. To determine the low resistance by Carey Foster bridge.
19. To determine the magnetic field using search coil.
20. To determine the impedance of LCR series circuit.
21. To determine the time constant for RL, RC and LCR circuit.
22. To determine the efficiency of an electric kettle (or heating element) under varying input voltages.
23. To determine the capacitance of a capacitor by ac bridge (de-Sauty's method).
24. To determine the inductance of an inductor by Maxwell inductance-capacitance bridge.
25. To determine the coefficient of mutual inductance of two coils.

**Text Books:**


1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)
2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)


**Evaluation Scheme:**

1. Student must perform three hours laboratory work twice a week to complete PHY102 lab works.
2. PHY102 will be examined for the duration of six hours in two different three hours sessions.
3. The practical exam will be graded on the basis of the following marking scheme:

| | | | |
|---|---|---|---|
| Record file: | 20% | Experiment: | 50% |
| Error Analysis: | 10% | Viva: | 20% |

# Statistics

**4 year B.Sc.**

| Year | Subjects | Theory/Practical | Full Marks | Total |
|---|---|---|---|---|
| I | Fundamentals of Statistics (STA 101) | Theory | 100 | |
| | Fundamentals of Statistics (STA 102) | Practical | 50 | 150 |

**Tribhuvan University**
**Institute of Science & Technology**

Course Title: Fundamentals of Statistics — Full Marks: 100
Course Code: STA 101 — Pass Marks: 35
Level: B.Sc. — Total Number of Periods: 150
Year: I
Nature of the Course: Theory

**Course objectives:**

To impart the knowledge of descriptive statistics, correlation, regression, theoretical as well as the applied knowledge of probability and some probability distributions

**Group A**

**1. Introduction to Statistics** **[5]**

Meaning of Statistics as a Science; Importance of Statistics; Scope of Statistics in the field of physical Sciences, Biological Sciences, Medical Sciences, Industry, Economics Sciences, Social Sciences, Management Sciences, Information Technology, Agriculture, Insurance, Education and Psychology.

**2. Population and Sample** **[8]**

Types of Characteristics; Scales of measurement; qualitative, quantitative, discrete and continuous variables, entities; Types of Data: (i) primary data, secondary data and their sources (ii) cross-sectional data, time series data, failure time data, panel data; Notion of a statistical population: finite population, infinite population, homogeneous population and heterogeneous population; Notion of sample, random sample and non-random sample; methods of sampling (description only): simple random sampling with replacement (SRSWR) and without replacement (SRSWOR).

## 3. Presentation of Data [6]

Organization of Data: Data mining, editing, coding and data management; assessing the quality of the data; Classification and Tabulation : Raw data and its classification, Discrete frequency distribution, construction of class interval (Sturge's rule), continuous frequency distribution, inclusive and exclusive methods of classification, open end classes, cumulative frequency distribution and relative frequency distribution; tabulation, construction of bivariate frequency distribution. Diagrammatic Presentation of Data: Simple bar diagram, multiple bar diagram, sub-divided bar diagram, pie-chart (review). Graphical Presentation of Data: Histogram, frequency curve, frequency polygon, ogive curves stem and leaf chart, range chart; Check sheet, Pareto diagram

Problems and illustrative examples

## 4. Measures of Central Tendency and Dispersion [17]

Concept of measures of central tendency; mathematical properties of arithmetic mean, weighted arithmetic mean, trimmed mean, formula for computation of mode and median (with derivation) graphical method, harmonic mean, weighted harmonic mean geometric mean, weighted geometric mean, order relation between arithmetic mean, geometric mean, harmonic mean (proof for n = 2), problems focusing on theoretical aspects, empirical relationship between mean , median and mode, choice of appropriate average

Concept of measures of dispersion, different methods of measuring dispersion, absolute and relative measures of dispersion, minimality property of mean deviation, minimality property of mean square deviation(with proof), variance and standard deviation, mathematical properties of standard deviation, effect of change of origin and scale in standard deviation, combined variance(derivation for 2 independent groups), generalizations for n groups, coefficient of variation(C.V.), theoretical problems of measures of dispersion; empirical relationships, five number summary; box plot, normal probability plot; Lorenz curve, Ginni coefficient

Problems and illustrative examples

## 5. Moments, Skewness and Kurtosis [12]

Raw moments ($m_r'$) for grouped and ungrouped data; moments about an arbitrary constant for grouped and ungrouped data $m_r(a)$; Central moments ($m_r$) for grouped and ungrouped data; Effect of change of origin and scale; Relations between central moments and raw moments (up to $4^{th}$ order).

Concept of skewness of frequency distribution; positive skewness, negative skewness, symmetric frequency distribution, Bowley's coefficient of skewness : Computation of coefficient of skewness using Bowley's formula and its interpretation, interpretation using Box plot; Karl Pearson's coefficient of skewness; Measures of skewness based on moments $(\beta_1, \gamma_1)$, Concepts of kurtosis; leptokurtic, mesokurtic and platykurtic frequency distributions; measures of kurtosis using partition values; Measures of kurtosis based on moments $(\beta_2, \gamma_2)$

Problems and illustrative examples

## 6. Introduction to Correlation [12]

Bivariate data, bivariate frequency distribution, correlation between two variables, positive correlation, negative correlation, scatter diagram to explore the type of correlation, covariance between two variables: Definition, computation, effect of change of origin and scale; Karl Pearson's coefficient of correlation (r): Definition, computation for grouped and ungrouped data and interpretation, assumptions for Karl Pearson's correlation coefficient, theoretical problems

Properties (with proof): (i) $-1 \leq r \leq 1$, (ii) Effect of change of origin and scale

Spearman's rank correlation including tied cases

Problems and illustrative examples

## 7. Regression Analysis [15]

Concept of regression, lines of regression, fitting of lines of regression by the least squares method, interpretation of slope and intercept, concept of linearity

Regression coefficient ($b_{yx}$, $b_{xy}$): Definition, computation, properties (with proof).

(i) $b_{yx}b_{xy} = r^2$ , (ii) $b_{yx}b_{xy} \leq 1$, (iii) $b_{yx} = r\frac{\sigma_y}{\sigma_x}$, $b_{xy} = r\frac{\sigma_x}{\sigma_y}$ ,

(iv) Effect of change of origin and scale, (v) Angle between the two lines of regression

Mean residual sum of squares, Residual plot and its interpretation for assessing the goodness of fit of the regression line, explained and unexplained variation, coefficient of determination; concept of multiple regression

Problems and illustrative Examples

## Group B

## 8. Introduction to Probability [20]

Review of set operations; Concepts in probability: deterministic and random experiments; Definitions of terms: trial and event, outcome, sample space, equally likely, mutually exclusive, exhaustive and favorable cases, sure and impossible events, independent and dependent events; Definitions of probability: mathematical (classical), statistical (relative frequency) and subjective with their merits and demerits; Combinatorial analysis and combinatorial probability examples, algebra of events and probability; Properties of probability and basic theorems: Additive and multiplicative theorems, Boole's inequality; Axiomatic definition of probability, geometrical probability and Bertrand's paradox; Conditional probability, pair-wise and mutual independence, Bayes theorem, prior and posterior probabilities, sensitivity, specificity, predictive value positive and predictive value negative of a diagnostic test

Problems and illustrative examples

**9. Random Variables** **[10]**

Concept of a random variable, types of random variables: Discrete and continuous random variables; Probability distribution of a random variable: probability mass function and probability density function, distribution function and its properties; Functions of random variables, examples of linear and nonlinear transformations.

Problems and illustrative examples

**10. Theory of Mathematical Expectation** **[15]**

Mathematical expectation of a random variable (discrete and continuous) and its function, properties of mathematical expectation of random variables, addition and multiplicative theorems of expectation, covariance and correlation, conditional expectation, conditional variance, variance of a linear combination of random variables; Moments of random variables: Raw and central moments, uses of moments, obtaining measures of location (averages), dispersion, skewness and kurtosis of a given probability distribution; Generating functions: Moment generating function, probability generating function, cumulant generating function and characteristic function with their properties.

Problems and illustrative examples

**11. Probability Distributions** **[30]**

Discrete distributions: Bernoulli trial, binomial and Poisson distributions, their mass functions, distribution functions, moment generating functions, characteristic functions, moments, properties, distribution fittings; Continuous distributions: Rectangular and normal distributions: their probability density functions, distribution functions, moment generating and characteristic functions, properties and uses, normal distribution as an approximation of binomial and Poisson distributions, standard normal distribution, distribution fittings.

Problems and illustrative examples

**References:**


1. Miller and Fruend (2007). *Modern Elementary Statistics*, Pearson Publishers.
2. Snedecor and Cochran (1980). *Statistical Methods*, Oxford and IBH Publishers
3. Gupta S.C. and Kapoor V.K.(2012). *Fundamentals of Mathematical Statistics,* Sultan Chand and Sons, New Delhi
4. Shrestha H.B., *Statistics and Probability: Concepts and Techniques*, EKTA Books. Latest Edition.
5. Sthapit Azaya, Yadav Rashinder, Khanal Shankar. (2012). *Fundamentals of Statistics*, Asmita Publication, Kathmandu, Nepal
6. *Sukubhattu*, N. P. (2063 BS). *Probability Theory and Statistical Methods*, 2nd edition, Asmita Publications, Kathmandu
7. Daniel, W.W (2000). *Biostatistics: A foundation for analysis in the health sciences*, 7th edition, John Wiley and sons, INC

**Tribhuvan University**
**Institute of Science & Technology**

Level: B.Sc.
Year: I
Course Title: Fundamentals of Statistics
Course Code: STA 102 Full Marks: 50
Nature of the Course: Practical Pass Marks: 20
Total Number of Periods:180

**Pre-requisites:** Knowledge of the topics in theory, and the laboratory with well-equipped computers facility should be arranged..

**Course objectives:**

- To develop computational skills in descriptive statistics and probability
- To apply theoretical knowledge in practical numerical problems
- To make students familiar for handling statistical software for data analysis

**Practical problems**

| S.No. | Title of the practical problems | No. of practical problems |
|---|---|---|
| 1 | Arrangement of raw data pertaining to discrete and continuous variables into the proper format for further statistical analysis using appropriate codes (if necessary) (Also use MS EXCEL Spread sheet) | 1 |
| 2 | Preparation of frequency distribution, cumulative frequency distribution, histogram, frequency curves, stem and leaf plot, box and whisker plot(Also use MS EXCEL Spread sheet and any statistical software such as SPSS, STATA etc. whichever convenient) | 1 |
| 3 | Diagrammatical presentation of data(Also use MS EXCEL Spread sheet) with problems based on simple diagram, subdivided bar diagram, Pie diagram etc. | 1 |
| 4 | Problems using Pareto Diagram | 1 |
| 5 | Computation of measures of central tendency (ungrouped and grouped data) Use of an appropriate measure and interpretation of results and computation of partition values (Also using MS EXCEL spread sheet and any statistical software such as SPSS, STATA etc. whichever convenient). | 1 |
| 6 | Computation measures of dispersion (ungrouped and grouped data) and computation of coefficient of variation. (Also using MS EXCEL spread sheet and any statistical software such as SPSS, STATA etc. whichever convenient) | 1 |

| S. No. | Title of the practical problems | No. of practical problems |
|---|---|---|
| 7 | Computation of raw and central moments | 1 |
| 8 | Measures of skewnwss and kurtosis using method of moments | 1 |
| 9 | Measures of Skewnwss using Box and whisker plot. (Also using MS EXCEL spread sheet and any statistical software such as SPSS, STATA etc. whichever convenient). | 1 |
| 10 | Scatter diagram, correlation coefficient (ungrouped data) and interpretation. Compute manually and check with computer output. | 1 |
| 11 | Fitting of lines of regression (Results to be verified with computer output) | 1 |
| 12 | Fitting of lines of regression and computation of correlation coefficient, Mean residual sum of squares, residual plot. (Also using MS EXCEL spread sheet and any statistical software such as SPSS, STATA etc. whichever convenient) | 1 |
| 13 | Combinatorial analysis and combinatorial probability | 2 |
| 14 | Geometrical probability | 1 |
| 15 | Conditional probability and Bayes theorem including sensitivity, specificity, predictive value positive and predictive value negative | 3 |
| 16 | Functions of random variables with linear and non linear transformations | 2 |
| 17 | Obtaining descriptive statistics of probability distribution | 2 |
| 18 | Fitting probability distributions in real data (Binomial, Poisson and Normal) | 3 |
| | **Total number of practical problems** | **25** |

## Subjects : 2nd year

1. Botany
2. Chemistry
3. Environmental Science
4. Geology
5. Mathematics
6. Meteorology
7. Microbiology
8. Physics(Only Practical Paper Rivision)
9. Statistics
10. Applied Statistics-compulsory
11. Zoology

**Tribhuvan University**

**Institute of Science and Technology**

**4 Years B. Sc. Botany Course of Study**

Course Title : **Diversity, Structure, Function and Development of Angiosperms (Angiosperms, Physiology, Cytology and genetics, Embryology and Anatomy)**

Course No: BOT 201 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Year: II year Lecture: 150

**Course Objectives (BOT 201 & BOT 202)**

- To introduce the concept of internal and external organization in higher plants
- To highlight the impact of environment on structure and functions\
- To study physiological processes in plants.

## Unit I. Angiosperms 35

**Principles and Practices**

1. **Introduction**: General features of angiosperms; Definition of taxonomy and systematics; Basic components of taxonomy (Identification, Description, Nomenclature and Classification); Aims and scope of taxonomy……..……..……...…….……1

2. **Plant morphology in relation to taxonomy**
   *Morphological structural terminology of angiosperms applied as taxonomy evidence focusing representative species- Teaching materials- Charts.*

   General terminology of vegetative parts: Roots (types); Stems (durations, habits and types of both general and modified stems); Leaves (parts, venation, phyllotaxy, types, shapes, margins, apex, base, surface, etc.); Stipules (types)……..……..……3

   General terminology of reproductive parts: Inflorescences (types); Bracts (types); Flowers (parts, nature, position of ovary, placentation); Fruits (parts, types) …….…....4

3. **Plant collection and Herbarium techniques**

   Introduction and importance of herbarium (K, K-W, E, BM, Cal, TI, KATH, TUCH); Materials needed for collecting specimens; Methods of collecting specimens; Recording field data ……1

   Preparing herbarium specimens: Procedures for pressing; Drying; Mounting; Labeling; Storage; Preserving specimens…….……..…… 1

   Ethics for collecting specimens at field; Handling herbarium specimens; …….…….. 1

4. **Nomenclature and Classification**

Define rank and taxa; Ranking of taxa in taxonomic hierarchy (recognized by International Code of Nomenclature such as kingdom, division, class, order, family, genus and species as principal ranks and subphylum, subclass, suborder, subfamily, etc., as secondary ranks)…….....…… 1

Binomial nomenclature; International Code of Nomenclature (ICN); Principles and application of the Code of Nomenclature (scientific name, author citation, nomenclature type/ type method, priority of publication, conservation of names, name changes, basionym, synonym, valid publication, rejection of names)……..……..…….. 1

5. **Principles of classification**

   History and development of classification systems of angiosperms giving examples of systems in Pre-Darwinian Classification (Theophrastus, Carlous Linnaeus, A.P. de Candolle, G. Bentham and J.D. Hooker) and Post Darwinian system (Adolf Engler and Karl Prantl, John Hutchinson, Arthur Cronquist, etc.) System based on Darwin concept……...….. 1

6. **Major classification systems of angiosperms with merits and demerits:**
   **Artificial system**-Carlous Linnaeus 1753, introduction, contributions, concept and outline classification……..….. 1

   **Natural system**-George Bentham and Joseph Dalton Hooker 1862-1883, introduction, concept, outline classification up to Cohorts (recent Orders) giving one family as an example in each order, merits and demerits ……..…….……... 1

7. **Phylogenetic system: Earlier system** (Engler and Diels 1936 – refinement of Engler and Prantl's system by Engler and Diels): Introduction, concept, outline classification up to major orders showing evolutionary trends, merits and demerits …….……..... 1
8. **Contemporary system: Recent phylogenetic system** (Cronquist system1988): Introduction, concept and characteristic features of classification of up to subclass showing evolutionary trends……..…….…….. 1
9. **Basic concept of Angiosperm Phylogeny Group** (APG): Background and concepts of APG 1998; APG II 2003; APG III 2009; Showing clades and eudicots of APG II 2003……..……. 1

10. **Systematic Study:** Describing distinguishing features (each subclass, order and family); Classification (Arthur Cronquist's system, 1988); Range of vegetative structure (habit, stem, leaf); Reproductive (inflorescence, flower, fruit) structures; Economic importance (consider local species too) and Phylogeny (affinity) of following representative families of Magnoliophyta (angiosperms): **Magnoliaceae, Ranunculaceae, Moraceae, Caryophyllaceae, Malvaceae, Rosaceae, Lamiaceae, Araceae, Cyperaceae, Orchidaceae** ……...…….. 16

## Unit II. Plant Physiology 50

1. Water Relations of Plants: Water availability in soil; water potential; movement of water: diffusion, osmosis; transport of water in plants: absorption by roots, root to shoot transport, transpiration (mechanism and factors affecting transpiration), cohesion-tension theory of ascent of sap; water stress: effects and plants' response. 8

2. Plant Nutrients: Nutrient availability in soil; nutrient absorption by root; macro and micronutrients: roles in plant and symptoms of deficiencies; hydroponics. 5

3. Plant Development: Growth and differentiation; Tissue culture and organogenesis; Polarity; Photomorphogenesis; Photoperiodism; Seed physiology: Seed germination and mobilization of reserved food, seed dormancy, vernalization; senescence. 12

4. Plant Hormones: Concept of hormone; physiological roles of auxins, gibberellins, cytokinnins, ethylene, abscissic acid, and brassinosteroids; commercial uses of plant hormones. 8

5. Metabolism: Anabolism and Catabolism; Photosynthesis: Radiant energy, ultrastructure of chloroplast, photosynthetic pigments, mechanisms (light reaction, and dark reaction/CO2 assimilation – C3, C4 and CAM), factors affecting photosynthesis; photorespiration; respiration: ultrastructure of mitochondria, anaerobic and aerobic respiration, glycolysis, Kreb's cycle, respiratory chain; chemiosmotic mechanism of ATP synthesis. 17

**Unit III. Cytology and Genetics 30**

1. Cytology: structural organization of prokaryotic and eukaryotic cells; Ultrastructure and function of cell organelles; cell inclusions; physical and chemical nature of chromosomes; cell division: cell cycle, karyokinesis (amitosis, mitosis and meiosis) and cytokinesis. 12

2. Genetics: Physical structure, type and functions of nucleic acids (DNA and RNA); DNA replication; gene structure, gene expression and regulation in prokaryotes and eukaryotes. Mendelian genetics: Mendel's laws of inheritance, gene interactions (incomplete dominance, co-dominance, epistasis), linkage and crossing over, sex linked inheritance. Sources of genetic variation: gene and chromosomal mutation (chromosomal aberrations, euploidy, aneuploidy and polyploidy). Concept of plant breeding (hybridization). 18

**Unit IV. Embryology 15**

1. Structure and development of microsporangium, microsporogenesis and the male gametophyte; structure and development of megasporangium, megasporogenesis and the female gametophyte; pollination and fertilization; development and types of endosperm; embryogenesis in typical dicot and monocot plants; polyembryony; apomixes; experimental embryology; palynology: introduction and its scope

**Unit V. Plant anatomy 20**

1. Tissues and tissue system: structure and functions of meristematic and permanent tissues (simple, complex and special tissues); shoot apical meristem (histological organizations in monocot and dicot stem); root apical meristem (histological organization in monocot and dicot root); theories of apical meristem differentiation. 7

2. Primary structures and functions: epidermis: uniseriate and multiseriate, epidermal appendages and their morphological types; primary structure of typical dicot stem, root and leaf; primary structure of typical monocot stem, root and leaf; cambium: origin, structure and functions. 6
3. Secondary structures and functions: Origin and structure of secondary xylem and phloem; secondary growth in dicot stem and root; anomalous secondary growth (dicot- Boerhaavia, Nyctanthes and Achyranthes; monocot- Dracaena); annual and growth rings; dendrochronology (concept and application); heart wood and sapwood; periderm; wound healing; leaf abscission; nodal anatomy; floral anatomy. 7

**Text Books**

Pandey BP 2011. College Botany (Vol. 3). S. Chand & Co. Ltd, New Delhi, India.

***Suggested Readingss***


1. Harris, J. G. & Woolf Harris, M. 2001. *Plant Identification Terminology — an Illustrated Glossary*, 2nd edn. Spring Lake Publishing, Spring Lake, Utah.
2. Lawrence, G.H.M. 1951. *Taxonomy of Vascular Plants*. Macmillian, New York.
3. Naik, V.N. 1991. *Taxonomy of Angiosperms*. Tata McGraw Hill Publishing Company Limited, New Delhi.
4. Simpson, Michael G. 2006. *Plant Systematics*. Elsevier Academic Press, New York (online pdf version available).
5. Woodland Dennis W. 1997. *Contemporary Plant Systematics*. Barrien Springs, Michgian, United States of America.


**Plant physiology**


Devlin RM. Plant Physiology. Affiliated East West Pvt., New Delhi, India.,

Jain V. K. 2012. Fundamentals of plant Physiology. S. Chand & Co. Ltd, New Delhi, India.

Noggle GR and GJ Fritz. Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd, New Delhi, India.

Salisbury TB and C Ross. Plant Physiology. Wordsworth Publishing Co., London, UK


**Cytology and Genetics**


Bhamrah HS and K Juneja. Cytology and Genetics. Amol Publication, New Delhi, India.

Gardner EJ, MJ Simmons and DP Snustad. Principles of Genetics. John Wiley and Sons Inc., New York Singleton, USA

Mohanan, K. V. 2010. Essential of Plant Breeding. PHI learning Pvt. Ltd. New Delhi, India.

Rastogi SC. Cell Biology. Tata McGraw-Hill Publishing Company Ltd. New Delhi.

Sinha U and S Sinha. Cytogenetics, Plant breeding and Evolution. VIkas Publishing House Pvt. Ltd. New Delhi, India.

Srivastava, S and Tyagi, Recent Advances in Genetics. Amol Publication, New Delhi, 1994

**Embryology**

Bhojwani SS and SP Bhatnagar. The Embryology of Angiosperms. Vikas Publishing House, New Delhi, India.

Pandey AK. Introduction to Embryology of Angiosperms. CBS Publishers and Distributors, New Delhi, India.

**Anatomy**

Eames AJ and LH MacDaniels. An Introduction to Plant Anatomy. Tata McGraw-Hill Publishing Company Lt., New Delhi, India.

# Botany
# Second Year

Course Title : **Diversity, Structure, Function and Development of Angiosperms (Angiosperms, Physiology, Cytology and genetics, Embryology and Anatomy)**
Course No: BOT 202 Full Marks: 50
Nature of the Course: Practical Pass Marks: 20
Year: II year Work load : 180 Hrs

**Angiosperm**

6. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: (10 families - Magnoliaceae, Ranunculaceae, Moraceae, Rosaceae, Lamiaceae, Malvaceae, Caryophyllaceae, Araceae, Cyperaceae and Orchidaceae) Two plants in each practical class. (eg. Magnoliaceae) Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose.

7. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Ranunculaceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

8. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Moraceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

9. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Rosaceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

10. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Lamiaceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

11. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Malvaceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

12. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Caryophyllaceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

13. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Araceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

14. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Cyperaceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

15. Description of flowering plants by using semi-technical terms in the following families focusing locally available materials: Orchidaceae (Most diagnostic features of each family after describing the specimens and following Cronquist system 1988 for classification purpose).

16. Preparation of herbarium specimens of local plants using standard size of herbarium paper sheets (29X41.5cm or 11.5" X 16.5"), at least 20 herbarium specimens representing related families.

17. Field visit to observe vegetation and flora of a specified area. Days and location as mentioned in the curriculum

(*Students are suggested to submit three-five material for all the lower groups in the practical exams*)

**Physiology**

1. To study the movement of the chloroplast under the microscope.
2. To determine water potential of algal cells by plasmolysis method.
3. To study of effects of various environmental factors upon the rate of transpiration using a potometer.
4. To demonstrate that xylem is a conducting tissue.
5. To study the distribution of stomata and the shape of the guard cells.
6. To demonstrate root pressure.
7. To study the effect of different light colours on the rate of photosynthesis.
8. To perform the aerobic respiration by Ganong's respiroscope.
9. To perform anaerobic respiration in germinating seeds.
10. To distinguish $C_3$ and $C_4$ plants on anatomical basis.
11. To study the effect of light on the dark grown seedling of *Vicia faba* (photomorphogenesis).
12. To demonstrate the effect of auxins on elongation of maize coleoptile.
13. To demonstrate polarity in germinating seed.
14. To demonstrate polarity in rooting from stem.
15. To study dormancy in seeds of various weed species.

**Cytology and Genetics**

1. To study the different stages of mitosis in onion root tip.
2. To study behavior of chromosomes during meiosis in pollen mother cells.

**Embryology**

1. To study the TS of anther (permanent slide).
2. To study dicot embryo (Permanent slide).
3. To study of monocot embryo (Permanent slide).
4. To study embryo sac (Permanent slide).
5. To study various types of ornamentation in the pollen wall.
6. To estimate pollen viability of various cultivated species.

**Anatomy**

1. To study anatomical structure of typical dicot and monocot stem.
2. To prepare permanent slides of stem showing anomalous structure (*Boerhaavia, Nyctanthese, Achyranthus, Dracaena*).
3. To study the annual rings of tree species (*Abies, Pinus*).

**Tribhuvan University**

**Institute of Science and Technology**

**4 Years B. Sc. Chemistry Course of Study**

**(Revised–2073)**

The structure of the course for the 4 Years B. Sc. Chemistry will be as follows:

**2nd Year:**

| Subjects | Course No. | Full Marks | Pass Marks |
|---|---|---|---|
| Basic Chemistry II | CHE-201 | 100 | 35 |
| Basic Chemistry Practical II | CHE-202 | 50 | 20 |

**Four Year B. Sc. Chemistry Course of Study**

**(Revised–2073)**

**Course Title**: Basic Chemistry II **Full Marks**: 100

**Course No.**: CHE 201 (major) **Pass Marks**: 35

**Nature of the Course**: Theory **Year**: II

Lecture : 150

**Course Objectives**:

- 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 forms.
- To provide mechanistic approaches of organic reactions.

## Group A: Inorganic Chemistry

**Refining and purification of metals:** Applications of the following processes in the refining, separation and extraction of metal; ion exchange chromatography, solvent extraction, oxidative refining, parting process, zone refining, Mond's process. **5 hrs**

**Comparative study of s- & p- block elements and their important compounds:-** General group trends, electron configuration, atomic radii, ionization potential, electron affinity, electronegativity, inert pair effect, general properties of the elements, the occurrence and isolation of the elements, factors influencing the choice of extraction process, comparative study of s and p block elements and their important compounds.

**Alkali metals:** Solubility in $NH_3$, hydration energy and mobility of ions, R-Li, chlor-alkali industry and its application, crown and crypt ethers.

**Alkaline earth metals:** Be-anomalous behavior, $CaH_2$, Grignard's reagent, chlorophyll, biological properties of Ca and Mg.

**Gr III:** Principle of extraction of Al, alums, $BF_3$, Borax, $2e^-$ 3 centred bond, halides of Al, aluminum alkyls, cement, inert pair effect (Gr III, IV,V)

**Gr IV:** Structure and allotropy of the element, difference between C, Si and other remaining elements.

Carbon clusters: Fullerene (preparation, structure and applications).

Carbides, carbonyls, silicon carbide, silicates, freons, internal π bonding using d orbital (structure of $(CH_3)_3N$ and $(Si\ H_3)_3N$).

**Gr V:** Nitrogen cycle, liquid ammonia as solvent, phosphate fertilizers, halides, role of phosphate esters in biological process.

**Gr VI:** Acid rain, Pπ - dπ bonding, difference between oxygen and other elements, thionyl chloride, tetra sulfur tetra nitride, reactivity and oxidizing property of halogen.

**Gr VII:** Prechloric acid, isolation of fluorine, electropositive character of iodine

**Gr 0:** Isolation of noble gases, clathrate compounds, uses of noble gases. **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 valancy, complex formation with reference to 3d-block elements, general introduction of first transition (3d) second transition (4d) and third transition series, comparison of the elements of 3d series with 4d and 5d transition series in terms of (i) electronic configuration (ii) reactivity of element (iii) stability of oxidation state (iv) highest oxidation state and (v) stability of complexes, 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 compounds of 3d- block elements ($TiO_2$, $TiCl_4$, Zeigler-Natta catalyst, vanadates, $V_2O_5$, $CrO_2Cl_2$, $K_2CrO_7$, ferrocene, nickel carbonyl), bioinorganic chemistry of iron, chromium and copper. **14 hrs**

**Preparation, properties, bonding and structure of the following:** Oxides and oxyacids of phosphorous (structure and application only) hydrazine, hydroxylamine, hydrazoic acid, hydrogen peroxide, ozone, sodium thiosulphate, peracids of sulphur, potassium permanganate, potassium dichromate. **11 hrs**

## Group B: Organic Chemistry

**Cyclic aliphatic compounds**: Nomenclature, industrial source, preparation, reactions, reactivity of cyclopropane and cyclobutane by comparing with alkanes, stability of cycloalkanes–Baeyer's strain theory, Sachse and Mohr prediction and Pitzer's strain theory, factors affecting stability of conformations, conformational structure of cyclobutane, cyclopentane and cyclohexane, equatorial and axial bonds. **5 hrs**

**Aromaticity**: Concepts of aromaticity, antiaromaticity and non-aromaticity, structure of benzene, resonance structure and orbital picture of benzene, stability of benzene (resonance energy), Huckel's rule and its application to benzenoid (benzene and naphthalene) and non benzenoid (cyclopropenylcation, cyclopentadienyl anion and tropylium ion), general mechanism of electrophilic

substitution, mechanism of nitration, sulphonation, halogenations, Friedel Craft's alkylation and acylation, theory of reactivity and orientation, effect of substituent groups, ring activating and deactivating groups with examples, effect of halogen on electrophilic aromatic substitution, electrophilic substitution in naphthalene. **9 hrs**

**Aldehydes and ketones:** Nomenclature of aliphatic and aromatic carbonyl compounds, structure of carbonyl group, synthesis of aldehydes and ketones, physical properties (keto- enoltautomerism, reactivity of carbonyl group in aldehydes and ketones), nucleophilic addition reactions, oxidation, reduction, Clemmensen reduction, Wolf Kishner reaction, base and acid catalyzed halogenation reactions, addition of Grignard's reagent, planning a Grignard's synthesis, limitation of Grignard's synthesis, base and acid catalyzed halogenation of ketones, aldol condensation, dehydration of aldol products, use of aldol condensation in synthesis, cross aldol condensation, Wittig reaction, Claisen condensation, Cannizarro's reaction, Perkin reaction, analysis of aldehydes and ketones with 2,4-DNP test, Tollen's test, Fehling's test, Schiff test and Haloform test with equations, spectroscopic analysis. **12 hrs**

**Carboxylic acids:** Structure and Nomenclature, Industrial source, Methods of preparation by carbonation of Grignard regents, Hydrolysis of nitrile, amides and esters, Preparation of aromatic acids by oxidation of side chain, hydrolysis of benzotrichlorides and Kolbe reaction, Physical properties, hydrogen bonding, dimmeric association, acidity strengths (relative differences in the acidities of aromatic and aliphatic acids), Effect of substituent in acidity, Chemical properties: (reaction involving H, OH and COOH groups), Salt formation, Anhydride formation, Acid chloride formation, Amide formation, introduction to polyamide and ester formation with mechanism), Reduction to alcohols, Carbanion in organic synthesis, Active methylene compounds such as Malonic acid synthesis of carboxylic acid, Acetoacetic ester synthesis of ketones, decarboxylation of β-keto acid and malonic acid, Synthetic application of acetoacetic esters (Preparation of monocarboxylic acid and dicarboxylic acids) and malonic acid esters (Preparation of monocarboxylic acid and dicarboxylic acid and α,β-unsaturated carboxylic acids), spectroscopic analysis of carboxylic acid. **14 hrs**

**Amines:** Structure, nomenclature, classification, industrial source, preparation, physical properties, industrial source preparation, reduction of nitro compounds, amminolysis of halides, reductive amination, Hofmann rearrangement, structure and basicity, effect of substituent on basicity of aromatic amines, ring substitution in aromatic amines, reactions of amines with nitrous acid, reactions of diazonium salt (azo coupling, Sandmeyer reaction), reactions of hydrazo compounds (benzedine rearrangement), reactions of diazomethane, synthesis of phenol, diazonium salt (replacement by –H), synthesis using diazonium salts, synthesis of azo-compounds, spectroscopic analysis of amine.

**7 hrs**

**Phenols:** Structure, nomenclature, physical properties, salts of phenols, industrial source, preparation, reactions, acidity of phenols, Fries rearrangement, ring substitution, Kolbe's reaction, Riemer-Tiemann reaction, formation of aryl ethers. Gattermann synthesis, chelation, spectroscopic analysis of phenol. **3 hrs**

**Group C: Physical Chemistry**

**Colloidal Chemistry**: Colloidal state of matter, lyophilic and lyophobic colloids, preparation, purification and properties (kinetic, optical and electrical properties) of colloids, Helmholtz and diffuse layer in colloids, zeta potential, precipitation of sol, gold number, Hardy-Schultz law, association of colloids, emulsion and gels, soap and detergents, cleansing actions of soap & detergents **10 hrs**

Photochemistry & Catalysis**:** Thermo-chemical and photochemical reactions, Grothus Draper law, Stark Einstein law of photochemical equivalence, primary and secondary processes in photochemical reaction, quantum yield, reason for high and low quantum yields, Lambert- Beer's law and its application, photochemical processes: fluorescence, phosphorescence, chemiluminescence and photosensitization.

Types of catalysis, poisons, promoters and inhibitors, Criteria of catalysis, activation energy and catalysis, theories of catalysis: intermediate compound formation and adsorption theories, general acid base catalysis, enzyme catalysis. **10 hrs**

Electrochemistry:

***Electrolytic Conductance****:* Review on the electrolytic conductance, Kohlraush law of independent migration, ionic conductance and ionic mobility, conductivity water, Hittorf's rule, transference number, determination of transference number by moving boundary and Hittorf's methods, some applications of conductance measurements: determination of (a) solubility products of sparingly soluble salts, (b) degree of ionization and ionization constant of weak acids and (c) ionic product of water, conductometric titration: involving neutralization and precipitation reactions, advantages of the conductometric titration

***Electrochemical Cells****:* Review on electrochemical cells, Nernst's equation and derivation of emf of a cell under non-standard conditions, reference electrodes, standard hydrogen electrode and secondary reference electrodes, measurement of standard electrode potential, electrochemical series, representation of electrochemical cell, calculation of equilibrium constant of a cell reaction from standard emf of a cell, potentiometer for measurement of emf of a cell, applications of emf measurements: determination of pH using glass, quinhydrone and antimony-antimony oxide electrodes, potentiometric titrations, ion-selective electrodes. **15 hrs**

Thermodynamics**:** Adiabatic expansion of an ideal gas (TV-relation, PV-relation and PT relation), comparison between isothermal and adiabatic expansion, work done in reversible adiabatic expansion, Joule's Thomson effect, inversion temperature, second law of thermodynamics: different statements of the law, Carnot's cycle, thermodynamic efficiency, entropy and its mathematical derivation from Carnot's cycle, physical significances of entropy: entropy and unavailable energy, entropy and probability (qualitative), entropy and randomness. Entropy changes of a system, surrounding and universe, entropy change in isothermal and adiabatic processes, relation between enthalpy change and entropy change, entropy change during expansion of an ideal gas, Free energy and work function and their significances, criteria of spontaneity and equilibrium in terms of entropy and free energy, related numericals **15 hrs**

**Tribhuvan University**

**Institute of Science and Technology**

**4 Years B. Sc. Chemistry Course of Study**

**Course title**: Basic Chemistry Practical II **Full Marks**: 50
**Course No.**: CHE 202 (major \ minor) **Pass Marks**: 20
**Nature of the course**: Practical **Year**: II

**Course Objectives:**

- To handle and manipulate chemical apparatus and materials safely.
- To record accurately and clearly the result of experiments.
- To apply appropriate chemical principle and make generalizations and predictions from chemical facts, observations and experiment data.

**Experiments on Inorganic Chemistry**

**Gravimetric Analysis**:- Quantitative estimation of barium and sulphate ions as barium sulphate, iron as ferric oxide (Mohr salt). **21 hrs**

**Qualitative analysis of simple inorganic salt mixture containing 2 cations and 2 anions**:- $Hg^{+}$, $Pb^{++}$, $Ag^{+}$, $Cu^{++}$, $Hg^{++}$, $As^{+++}$, $Sb^{+++}$, $Sn^{++}$, $Bi^{+++}$, $Cd^{++}$, $Al^{+++}$, $Zn^{++}$, $Mn^{++}$, $Fe^{+++}$, $Co^{++}$, $Ni^{++}$, $Cr^{+++}$, $Ca^{++}$, $Ba^{++}$, $Sr^{++}$, $Mg^{++}$, $K^{+}$, $NH_4^{+}$, $NO_3^{-}$, $Cl^{-}$, $Br^{-}$, $I^{-}$, $SO_4^{--}$, $CO_3^{--}$, $PO_4^{---}$. **27 hrs**

**Spot test analysis**. **12 hrs**

**Experiments on Organic Chemistry**

**Preparative Organic Chemistry:-** Single step preparation involving the following types:- Methylation of phenol using dimethyl sulphate, Esterification of acids, Acetylation of phenols, Benzoylation of amines, Nitration of nitrobenzene, Reduction of nitro compounds, Oxidation of Toluene or benzadehyde, Preparation of osazone and preparation of methyl orange. These experiments should involve basic organic experiment techniques such as hot filtration, distillation under reduced pressure, filtration under partial vacuum, etc. (Above reactions will be useful in identification of organic compounds and preparation of their derivatives). **60 hrs**

**Experiments on Physical Chemistry**

1. To determine the surface tension of detergent and soap solution by drop number method and compare their cleansing action.
2. To determine the precipitation values and precipitation power of monovalent and bivalent cations for arsenic sulfide sol.
3. To carry out conductometric titration between strong acid and strong base.

4. To carry out conductometric titration between weak acid and strong base.
5. To calibrate the pH meter and measure the pH using glass electrode.
6. To determine the pH of a given solution using quinhydrone electrode.
7. Determination of heat of neutralization of strong acid and strong base.
8. Determination of heat of hydration of sodium sulphate. **60 hrs**

**Text Books: for theoretical course CHE 201**


1. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edition, John Wiley and Sons. Inc. 2007.
2. F. A. Cotton, G. Wilkinson & C. Gaus, *Basic Inorganic Chemistry*, 3rd Edition, John Wiley & Sons (Asia), Pvt., Ltd., 2007.
3. M. L. Sharma & P. N. Chaudhary, *A Textbook of B. Sc. Chemistry* (Volume II), 2nd Edition, Ekta Books Nepal, 2007.
4. D. F. Shriver & P. W. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, 2010.
5. R. T. Morrison, R. N. Boyd & S. K. Bhattacharjee, *Organic Chemistry*, 7th Edition, Prentice-Hall of Pearson, 2012.
6. J. March, *Advanced Organic Chemistry*, 4th Edition, Wiley Eastern Ltd., India, 2005.
7. Jonathan Clayden, *Organic Chemistry*, 2nd Edition, Oxford University Press, India.
8. S. H. Maron & C. Prutton, *Principle of Physical Chemistry*, 4th Edition, Oxford & IBH Publ. Co., 1992.
9. P.W. Atkins & J.D. Paula, *Elements of Physical Chemistry*, 4th Edition, Oxford University Press, 2010.


**Reference Books: for theoretical course CHE 201**


1. R. D. Madan, Satya Prakash, *Modern Inorganic Chemistry*, S. Chand & Company Ltd., 1994.
2. A. Sharpe, *Inorganic Chemistry*, 2nd Edition, ELBS & Longman, Singapore, 1986, (recent edition).
3. K. N. Upadhyaya, *A Textbook of Inorganic Chemistry*, 2nd Edition, Vikash Publishing House Pvt., Ltd., 1995
4. C. Agrawal, *Modern Inorganic Chemistry*, Wiley Eastern, New Delhi, 1981, (available recent edition)
5. James, E. Huheey, Ellen A. Keiter & Richard L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*, Addison Wesley Publishing House.
6. W.K. Li, *Problems in Structural Inorganic Chemistry*, Oxford University Press, India.
7. I. L. Finar, *Organic Chemistry*, Vol. I & Vol. II, Prentice Hall, London, (available recent edition).
8. F. Carey & R, Giuliano, *Organic Chemistry*, McGraw-Hill 8th edition, 2010.
9. Streitweiser & Heathcock, *Introductory Organic Chemistry*, Wiley and Sons, New York, 1981
10. S. Bahal & A. Bahal, *A Textbook of Organic Chemistry*, S. Chand Publication, New Delhi, India, 2012.
11. T. W. Graham Solomons, *Organic Chemistry*, (latest edition), John Wiley and Sons, New York.
12. G. M. Loudon, *Organic Chemistry*, Fourth Edition, Oxford University Press, India.
13. R. A. Bansal, *A Textbook of Organic Chemistry*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1993 (available recent edition)

14. C. Norman, *Principles of Organic Synthesis*, 2nd Edition, Chapman and Hill. London, 1978, (recent edition)
15. Warren, *Organic Synthesis*, The Disconnection Approach, Wiley, New York, 1982. (available recent edition)
16. House, *Modern Synthesis Reactions*, 2nd Edition, W. A. Benjamin. New York, 1972
17. A. S. Negi & S. C. Anand, *A Textbook of Physical Chemistry*, New Age International Ltd., New Delhi, 1999.
18. K. L. Kapoor, *Text Book of Physical Chemistry*, Vols I to V, 3rd Edition, Macmillan India Ltd., 2001.
19. D. Alberty, *Physical Chemistry*, 6th Edition, Wiely Eastern Ltd., New Delhi, 1992.
20. P. Atkins & J.D. Paula, *Atkin's Physical Chemistry*, 9th Edition, Oxford University Press, 2009.
21. D. Alberty, *Physical Chemistry*, 6th Edition, Wiely Eastern Ltd., New Delhi, 1992.
22. D. S Pahari, *Physical Chemistry*, Vol.1 & II, New Central Book Agency(p) Ltd, India, 2007.
23. M. K Sthapit & R. R. Pradhananga, *A Text book of Physical Chemistry*, Tajeju Prakashan, Nepal, 2008.
24. Arun Bahl, B. S. Bahl & G. D. Tuli, *Essentials of Physical Chemistry*, S. Chand and Company Ltd., New Delhi, 2012.
25. M. L. Sharma & P. N. Chaudhary, *A Textbook of B. Sc. Chemistry*, Vol 1, 2nd Edition, Ekta Books, Nepal, 2007.

**Text Books: for practical course CHE 202**

1. A. I. Vogel, *A Text Book of Quantitative Inorganic Analysis*, Including Elementary Instrumental Analysis, ELBS & Longman, 1969, (Preferably available recent edition).
2. A. I. Vogel, *A Text Book of Qualitative Inorganic Analysis*, ELBS & Longman, 1969, (recent edition).
3. R. L. Shriner, R. C. Fusion & D. Y. Cartin, *The Systematic Identification of Organic Compounds, A Laboratory Manual*, John Wiley and Sons, Inc. New York, 1986. (Preferably available recent edition).
4. K. N. Ghimire, M. R. Pokhrel & K. P. Bohara, *University Experimental Inorganic Chemistry*, Quest Publication, Kirtipur, Kathmandu, 2008.
5. Moti Kaji Sthapit & R. R. Pradhananga, *Experimental Physical Chemistry*, Taleju Prakasan, Kathmandu, 1998.
6. N. M. Khadka, S. D. Gautam & P. N. Yadav, *A Core Experimental Chemistry for B.Sc.*, Heritage Publication, Kathmandu, 2016.

**Reference Books: for practical course CHE 202**

1. Gurdeep Raj, *Advanced Practical Inorganic*, 10th Edition, Goel Publishing House, Meerut, 1994.
2. A. I. Vogel, *A Textbook of Practical Organic Chemistry*, Including Qualitative Organic Analysis, Longmans, 1958, (Preferably available recent edition)
3. A .I. Vogel, *A Textbook of Practical Organic Chemistry*, Including Qualitative Organic Analysis, Longmans, (Latest Edition).
4. F. G. Mann & B. C. Saunders, *Practical Organic Chemistry*, Orient Longman, 1986, (recent edition).

5. D. P. Shoemaker & C. W. Garland, *Experiments in Physical Chemistry*, McGraw Hill, Kogakusha Ltd, Tokyo, 1967.
6. B. D. Khosla, A. Guali & V. C.Garg, *Senior Practical Physical Chemistry*, 5th Edition, R. Chand & Co., New Delhi, 1987.
7. J. N. Gurtu & R. Kapoor, *Advanced Experimental Chemistry* (Vol I-III), S. Chand & Co. New Delhi.
8. S. K. Agrawal & Keemti Lal, *Advanced Inorganic Chemistry*, Pragati

A. Rajbhandari (Nyachhyon) and S. Pradhananga (Shrestha), *Inorganic Salt Analysis*, 5th Edition, Rajbhandari-Pradhananga Publication, Kathmandu, 2013.

## Environmental Science

## SECOND YEAR

**Course Title: Fundamentals of Environmental Science** **Lecture hours: 150**
**Course No: ENV 201** **Full marks: 100**
**Nature of Course: Theory (Compulsory)** **Pass marks: 35**

### Objectives

The broad objective of the course is to familiarize the students with fundamentals of environmental science. The specific objectives of the course are as follows:

- To enrich students understanding on basic concept of fundamental environmental science
- To make students familiar with concept and scope of limnology and ecological values of freshwater environment
- To give the students knowledge of hydrological phenomenon, its processes and climate of Nepal
- To acquaint with the role of microorganisms in environment
- To enhance students' understanding on broader aspect of environmental science linking it with geology and biotechnology, and
- To make students familiar about environmental survey and analytical techniques

### Unit 1: Limnology 25 hrs

Concept, importance, scope, its relationship with other disciplines and history of limnological study with focus to Nepal; Wetlands: Concept, types, roles, threats and conservation; Freshwater environment: Definition, types and limiting factors, morphometry of freshwater bodies, physico-chemical properties of freshwater, ecological classification of freshwater organisms; Freshwater biodiversity: Microbes, macrophytes, macro-invertebrates, fishes, amphibians, reptiles, birds and mammals; Physico-chemical and biological water quality index; Comparative study of lentic and lotic environment; Ecological, economic and cultural importance of freshwater environment; Land-water interactions; Impacts of dam on lacustrine and riverine ecosystems; Freshwater habitat degradation, fragmentation and loss; Protecting, sustaining and restoring of freshwater environment.

### Unit 2: Hydrology 25 hrs

Hydrological cycle: Phases, interaction with ground water and surface water, stocks and fluxes in the global cycle; Precipitation: Forms of precipitation, effective precipitation; Analysis and interpretation of rainfall data; Snow hydrology: Snowfall and measurement, properties; Metamorphism, sublimation and deposition; Movement of water through snow, water quality aspects of snow; Introduction to glaciers, remote sensing in snow hydrology study; Infiltration: Infiltration process, factors affecting

infiltration capacity; Estimation by hydrologic budget, Horton's, Kostiakov's, Darcy's and Philip equation methods; Evaporation and evapotranspiration: Factors affecting evaporation and evapotranspiration, control of evaporation and evapotranspiration; Estimation of evapotranspiration by Blaney-Criddle, Thornthwaite and Penman's methods; Stream flow: Components of runoff, factors affecting runoff, environmental effects of surface runoff and their mitigation; Introduction to stream simulation model; Hydrological prediction: probability of hydrologic event, distribution functions; Frequency analysis, analysis of hydrologic time series, reconstruction of hydrologic data; Flood forecast technique, extreme flood event estimation method; Ground water: zonation and occurrence of ground water; Aquifer parameters, Darcy's law; Ground water level and environmental influences; Hydro-geological investigation; Ground water quality.

**Unit 3: Climatology** **25 hrs**

Climatology: Definition, scope and types; Concepts of weather and climate, insolation and heat budget; Characteristics of atmosphere; Features of monsoon; Jet stream: temperature, pressure and wind field, types and location, importance in Nepalese ecology, agro climatology, urban climatology, aviation climatology, environmental and economic importance of the monsoon; Classification of climate: objectives of the classification, basis of the classification, Koppen's classification, Thornthwaite classification, climates of Nepal, climatic pattern, spatial and temporal patterns of climatic parameters in Nepal, rainfall and temperature variation with east-west, north-south, intraregional variations in Nepal, Climate types: tropical climate, temperate climate, highland climate, tundra climate, ice caps climate; Forecast: Long and short range weather forecast; Dendro-climatology and its techniques to reconstruction of past climatic environment, case study examples of Nepal.

**Unit 4: Environmental Geology and Environmental Survey** **25 hrs**

Introduction to environmental geology and its concepts; Human modification of nature; Geological criteria of land use planning and decision making for waste disposal and infrastructural developments: roads, tunnels, bridges and foundation; Dams and reservoirs: Geotechnical consideration and environmental impacts; Land capability mapping; Instability of hill slopes and landslides; Geological aspects of environmental health: Trace elements and human health, chronic diseases and geologic environment; Physiographic, geomorphic and tectonic division of Nepal Himalaya and major hazards associated with these zones, mitigation measures.

Environmental survey: Definition and concept, objective, importance and scope; Introduction and types of map, topographical and geological maps; Topographic surveying: Concepts, inventory and mapping, methods of topographic surveying, methods of representing relief; Contours: concepts and characteristics, methods of locating and interpolation; Concept and application of Remote Sensing (RS), RS and uses of aerial photographs; Geographic Information System (GIS), Global Positioning System (GPS) in relation to environmental monitoring; Methods of resources surveying: land, water, forest, mines.

**Unit 5: Environmental Microbiology** **25 hrs**

Concept and historical development of environmental microbiology; Major microbes: Viruses, bacteria, cynobacteria, actinomycetes, protozoans, fungi, and algae; Factors affecting the growth of microorganisms; Distribution of microorganisms: Air, water, soil and food; Microbial interaction in environment; Techniques used for the estimation of microbial population; Application of microbes in environment.

**Unit 6: Agriculture and Biotechnology** **25 hrs**

Introduction and types of agriculture; Agricultural practices in Nepal: conventional and modern agriculture, environmental consequences; Participatory approach of modern agriculture; Sustainable agriculture: agro-ecological practices; Pesticides: first and second generation; Agrochemical pollution; Integrated Pest Management (IPM); Alternative method of pesticides uses; Sustainable Soil Management (SSM); Land reform; Agricultural policy in Nepal; Impact of globalization in agriculture.

Sustainable soil management techniques; SSMP in mid-hills of Nepal; Farmer to farmer diffusion model, strength, challenges & opportunities of F-F; Soil conservation and watershed management modules: low cost soil and water conservation, integrated soil conservation, watershed management activities, strategies and promotion scale up;

Biotechnology: Introduction, principles and concepts; Detoxification of environmental pollutants; Degradation of high concentrated toxic pollutants: Halogenated, non-halogenated, petroleum, hydrocarbons, metals; Biotransformation of metals, biodegradation of solid wastes; Microbial technology for waste treatment: biotechnological remedies for environmental pollution; Decontamination of groundwater systems, subsurface environment, reclamation and bioremediation concepts; Production of proteins; Biofertilizers; Composting and vermi-composting; Biogas technology; Genetic application: concept of DNA technology, construction of microbial strains, protoplast fusion technology, applications; Ex-situ conservation: Seed bank, gene bank, tissue culture; Environmental effects, safety and ethics.

**References:**


1. Adoni, A.D. (1985). Workbook on Limnology, Pratibha Publishers, Sagar, India.
2. Agarwal, K.M., Sikdar, P.K., Deb, S.C. (2005). A Text Book of Environment, Macmillan India Limited.
3. Chhetry, D.K. (2012). Environmental Toxicology. Uma Silwal Karki, Kathmandu.
4. Critchfield, H.J. (2013). General Climatology. PHI Learning Pvt. Ltd., New Delhi.
5. Dahal, R.K. (2006). Geology for Technical Students, 1st Edition. Bhrikuti Academic Publications, Kathmandu.
6. Dubey, R.C. (2013). A Textbook of Biotechnology, S. Chand and Company P. Ltd., New Delhi

7. Frey, D.G. and Fry, F.E.J. (1963). Fundamentals of Limnology. Toronto University Press, Canada.
8. Lal, D.S. (2013). Climatology, Revised Edition. Sharda Pustak Bhawan, Allahabad.
9. Punmia, B.C., Jain, A.K, and Jain A.K. (2005). Surveying Vol. Surveying Vol. II, 16th publication. Laxmi publications (P) Ltd, New Delhi.
10. Rami J. P. and Reddy (2008). A Text Book of Hydrology, University Science Press.
11. Shiva, V. and Bedi, G. (2002). Sustainable Agriculture and Food Security, Sage Publication, New Delhi.
12. Valdiya, K.S. (1987). Environmental Geology, 1st edition, Tata McGraw-Hill Limited, New Delhi.

**Tribhuvan University**

**Institute of Science and Technology**

**Course Title: Fundamentals of Environmental Science** **Working hours: 180**
**Course No: ENV 202** **Full marks: 50**
**Nature of Course: Practical (Compulsory)** **Pass marks: 20**

1. Study of macrophytes and macroinvertebrates communities from lentic and lotic environment (sampling methods, sampling sites, density, distribution pattern, composition, biomass and species diversity).
2. Qualitative and quantitative estimation of various types of phyto and zooplankton from lentic and lotic environment (sampling methods, selection of sampling sites, density and composition).
3. Instrumentation and working principle: compound microscope, hot air oven, autoclave, incubator, biological safety cabinet, water bath and related instruments.
4. Analysis of bacterial population (staining, enumeration).
5. Study on grain size of sediments.
6. Application of Geological Compass.
7. Rock Mass Classification.
8. Study on map reading technique and GPS tracking method.
9. Estimation of Potential evapo-transpiration by Penman, Blaney-Criddle and Thornthwaite method.
10. Study on classification of temperature and precipitation zone of Nepal.
11. Study of infiltration of water through soil curve.
12. Estimation of soil loss using universal soil loss equation.
13. Drawing and analysis of hydrograph, unit hydrograph, base flow and rating curve.
14. Measurement of river discharge (surface float, current meter, weir, and bucket method).

Analyze flood frequency and estimate extreme flood events.

# B.Sc. II Year

# Geology (GEO.201)

Subject: Petrology, Paleontology & Historical Geology, and Sedimentology — Full marks: 100
Course No.: GEO.201 — Pass marks: 35
Nature of course: Theory — Total period: 150

## Petrology

Total marks: 40 — Total period: 62

| Main Topics | Contents | Period | Marks |
|---|---|---|---|
| ***(a) Igneous Petrology*** | | | |
| Introduction | Nature and scope of petrology, difference between petrology and petrography, General classification of rocks: igneous, sedimentary and metamorphic, general characteristics of igneous, sedimentary and metamorphic rocks. | 2 | 24 |
| Magma | Magma: Definition, composition, physico-chemical constitution, primary magma, magmatism in different tectonic environments. | 2 | |
| Evolution of magmas | Magma differentiation: fractional crystallization, other differentiation mechanisms, Magmatic mixing and assimilation. | 2 | |
| Forms and structures of igneous rocks | Intrusive igneous rocks: intrusive rocks and their relation to geological structures, intrusive forms, method of emplacement of intrusive rocks. Extrusive igneous rock: their structures and forms | 4 | |
| Textures and microstructures of igneous rocks | Crystallinity, granularity, crystal shapes and mutual relations among minerals, glasses. | 2 | |
| Crystallization of silicate melts | Unary and binary systems. Phase relations and textures, Ternary systems: Simple and complex, the effects of pressure on melting and crystallization of magma. | 4 | |
| Classification and description of igneous rocks | The IUGS classification system, chemical classification, characteristics of common igneous rocks: plutonic and volcanic, description of common igneous rocks. | 4 | |
| Formation of magma | Formation of magma: Rift zones, melting processes: partial melting, observations at the Mid-Oceanic Ridges. | 2 | |

| | | | |
|---|---|---|---|
| Igneous rocks in different tectonic settings | Igneous rocks at continental margins: Ophiolite suite, calcalkaline and tholeiite groups, plutonic rocks: batholiths related to subduction zones.<br>Continental igneous rocks: gabbroic layered intrusions, anorthosite, alkali basalt and nephelinite, carbonatite, kimberlite and related rocks. | 2 | |
| ***(b) Metamorphic Petrology*** | | | |
| Metamorphism | Definition, types of metamorphism: regional, contact, burial, cataclastic, progressive, retrograde, inverse. | 2 | 20 |
| Metamorphic rocks | Definition, recognition in the field, distribution and nomenclature, structures and textures of metamorphic rocks.<br><br>Shape of minerals, growth and mutual relation of minerals, petrographic descriptions of slate, phyllite, schist, gneiss, amphibolite, marble, quartzite, hornfels, serpentinite, granulite and eclogite.<br><br>Control of metamorphism: pressure, temperature and composition in metamorphism. | 4 | |
| Metamorphic processes | Initiation of metamorphism, contact metamorphism, metamorphism of igneous rocks, submarine metamorphism, porphyroblasts, preferred orientation, metamorphic differentiation: compositional gradient, temperature gradient, differentiation by deformation, metamorphic reactions, the upper limit of metamorphism. | 4 | |
| Metamorphic zones | Index minerals, zones in contact metamorphism, isograds: Definition, dependence on temperature and pressures. | 2 | |
| Metamorphic facies and graphic representation | Definition of facies, evolution of concept of metamorphic facies. major metamorphic facies, phase rule, relationship of zones, grades and facies, graphic representation of ACF, AKF and AFM diagrams. | 4 | |
| Mineralogical phase rule | Invariant, bivariant reaction, invariant point and their significance (Triple point of $Al_2SiO_5$ and those in metamorphism of argillaceous rocks).<br><br>Mineral variation related to initial rock composition: Carbonate rocks, mud rocks, mafic igneous rocks and tuffs, ultramafic rocks. | 4 | |
| ***(c) Sedimentary Petrology*** | | | |
| Introduction | Distribution of sedimentary rocks in time and space, formation of sediments, sediments and climate, tectonic setting of sediment accumulations. | 2 | 18 |

| | | | |
|---|---|---|---|
| Sedimentary textures | Size of sedimentary particles, Shape of sedimentary particles, concept of textural maturity. | 4 | |
| Sedimentary structures | Erosional, depositional and synsedimentary deformational structures and their significance. | 4 | |
| Classification of Sedimentary rocks | Classification based on texture and composition, genetic classification; Definitions, texture and structures, composition, and classification of sandstones, conglormerates, mudrocks, limestones and dolostones.<br>Introduction to other sedimentary rocks: evaporites, bedded cherts, bedded phosphate rocks, bedded iron deposits. | 6 | |
| Diagenesis of sediments | Diagenetic stages and regimes, diagenetic processes: compaction, cementation, dissolution, replacement, recrystallization, authigenesis. | 2 | |

## Paleontology and Historical Geology

Total marks: 30 Total class hours: 44 hrs

| Main Topics | Contents | Periods | Marks |
|---|---|---|---|
| Introduction | Aim, scope and objectives of paleontology, fossils and fossilization, index fossil, types of fossils, their mode of preservation, Importance of fossils, life through geological ages, organic evolution, evolution of life, Species: definition, concept and method of nomenclature, functional morphology | 6 | 16 |
| Invertebrate Fossils | Classification, geographical and geological distributions, morphology, Evolution and Evolutionary trend, Phylum Protozoa (*Foraminfera)* Coelenterate (*Anthozoa*), Arthropoda (*Trilobite*), Brayozoa, Brachiopod, Mollusca (*Bivalve, Gastropod, Cephalopoda*), Echinodermata (*Echinoidea)*, Hemichordata (*Graptoloidea*), Introduction of animal microfossils and applications (Radiolaria, diatom,Ostracoda/ Conodont), Introduction to trace fossils and their applications. | 10 | |
| Vertebrate Fossils and Paleobotany | Geological history through time of the following vertebrate groups: *Fishes, Amphibians, Reptiles, Aves and Mammals, Equidae, Proboscides and Hominidae*<br>Plant fossils: Plant life through time (*Psilopsida, Lycopsida, Sphenopsida and Pteropsida*) Gondwana flora, Evolution of Angiosperms.<br>Introduction to plant microfossils (pollen and spores, diatoms) and applications. | 4 | 14 |
| Introduction to | Scope, aim, method of study, development of historical geology, problem of historical geology, the interrealtion of | 2 | |

| | | | |
|---|---|---|---|
| Historical Geology | historical geology to other geological sciences, the geological time scale. | | |
| Origin of the Earth and life | Origin of solar system, evolution of the Earth, development of the atmosphere, hydrosphere and biosphere, theory of origin of life, the first sign of life on the Earth, index fossils. | 4 | |
| Time on rock record | Introduction to relative and absolute time, Unit and measurement of geological time, geochronology, relative age determination, time stratigraphic units, introduction of lithostratigraphy, biostratigraphy, magnetostratigraphy and chronostratigraphy, method of correlation. | 4 | |
| The main tectonic unit of the Earth's crust and their evolution | Principal tectonic units of the present continents, the tectonic elements of oceans, tectonic evolution of the earth's crust. | 2 | 14 |
| Principles of paleoenvironment, Paleogeography, Paleotectonics | Introduction to marine and non-marine environments, Study of paleo-environments including the influence of organisms on sediments, methods of paleogeographic reconstruction, epirogenic movement of the crust, the analysis of the geological sections as a method of reconstructing crustal movements, methods of reconstruction of plaeotectonics | 4 | |
| The earliest (Precambrian) history of the earth's crust | The duration of the Precambrian era and the earliest known state of the crust, Development of Archean Cratons, the Precambrian shield rocks, Paleogeography during Precambrian, and Precambrian glaciations. | 4 | |
| Geological history of Phanerozoic eon | Plate position and motion, organic evolution, paleogeography and the crustal movements during the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Palaeogene and Neogene. | 4 | |

# Sedimentology

Total marks: 30 Total class hours: 44 hrs

| Sedimentology | | | |
|---|---|---|---|
| Introduction | Definition of Sedimentology, History and development of sedimentology, Sedimentary rocks in space and time. Scope of sedimentology | 2 | 44 |
| Sedimentary processes | Physical processes: Fluid flow, Reynolds Number, Transport mechanisms: bedload and suspended load transport, transport in solution, Froude Number, Flow regimes and their significance, Flow regime and bed-forms, stream power and water depth, depth-velocity diagram. Subareal and subaqueous transport: Lahar, debris flows, turbidity currents and resulting bedforms | 6 | |
| | Chemical processes: Redox potential, pH, Eh-pH diagram, Geochemical Fence Diagram, Chemical processes of sedimentation: Dissolution, precipitation, formation of nodules and concretions | 6 | |
| | Biological processes: Metabolic process and hard parts generation, baffling and trapping, boring and chipping, pelletization, symbiotic relations among organisms, and microbial processes in generation of sediments. | 4 | |
| Depositional environments | Concept and classification of depositional environment | 2 | |
| | Continental Environments: Depositional settings, introduction to sedimentation processes of Fluvial, Lacustrine, Glacial and Eolian deposits. | 8 | |
| | Transitional Environments: Depositional setting, introduction to sedimentation processes of Deltaic, Estuarine, Barrier Beach Complex, and Tidal deposits. | 8 | |
| | Marine Environments: Depositional settings, introduction to sedimentation processes of Shallow Marine and Deep Marine deposits. | 8 | |

**Text and Reference books**

**Petrology:**


A. R. Philpotts, 2009, (2nd edition). Principles of Igneous and Metamorphic Petrology, Prentice-Hall of India Pvt. Ltd, New Delhi, India.

E. G. Ehlers and H. Blatt, 1987. Petrology: Igneous, Sedimentary and Metamorphic. CBS Publishers & Distributors, New Delhi, India.

F. G. Turner and J. Verhoogen, 1987. Igneous and Metamorphic Petrology, CBS Publisher and Distributors, New Delhi, India.

F. H. Hatch, A. K. Wells and M. K. Wells, 1984. Petrology of Igneous rocks, CBS Publishers and Distributors, New Delhi, India.

F. J. Pettijohn, 1984 (third edition). Sedimentary Rocks, CBS Publishers & Distributors, New Delhi, India.

H. G. F. Winkler, 1987. Petrogenesis of Metamorphic Rocks, Narosa Publishing House, New Delhi-Madras-Bombay, India.

J. D. Collinson and D. B. Thompson, 1989. Sedimentary structures, second edition. CBS Publishers & Distributors, Delhi

L. P. Paudel, 2011. Study of Minerals and Rocks in Thin Sections. GEOS, Kathmandu.

S. M. Rai, 2011. Study of Minerals and Rocks in Hand Specimens. Tara Rai, Kathmandu Nepal.

Sam Boggs, Jr., 1992. Petrology of sedimentary rocks. Macmillan Publishing Company, New York.

W. W. Moorehouse, 1959. Study of rocks in Thin Sections, CBS Publishers and Distributors, India.

**Paleontology**

David M. Raup and Steven M. Stanley, 1985 (2nd edition). Principles of paleontology. CBS Publishers and Distributors, Delhi, India.

E. N. K. Clarkson, 1979. Invertebrate Paleontology and Evolution, Harper and Row, New York.

H. L. Levin, 1999 (Sixth edition). The Earth through time. Saunder College Publishing.

Henry Woods, 1998 (8th Edition). Invertebrate. CBS Publishers and Distributors, Delhi, India.

Rabindra Kumar, 1992. Fundamentals of Historical Geology and stratigraphy of India. Wiley Eastern Ltd, New Delhi, India.

Shrock, R. Robert and Twenhofel, William, H., 1987 (second edition). Principle of Invertebrate Paleontology, CBS Publishers and Distributors, India.

**Historical Geology**

Don L. Eicher and A. Lee McAlester, 1980. History of the Earth, Prentice-Hall, Inc.New Jersey.

Rabindra Kumar, 1992. Fundamentals of Historical Geology and stratigraphy of India. Wiley Eastern Ltd, New Delhi, India.

Roy A. Lemon, 1990. Principles of Stratigraphy, Publisher: Aerill Publishing Co.

**Sedimentology:**

Don L. Eicher and A. Lee McAlester, 1980. History of the Earth, Prentice-Hall, Inc.New Jersey.

Donald R. Prothero and Fred Schwab, 1999. Sedimentary Geology - An introduction to sedimentary rocks and stratigraphy. W. H. Freeman and Company, New York.

Gerard M. Friedman and John E. Sanders, 1978. Principal of Sedimentology, John Wiley and Sons, New York.

H. E. Reineck. and I. B. Singh, 1973. Depositional Sedimentary Environments. Springer-Verlag, Berlin, New York.

M. R. Leeder, 1982. Sedimentology Process and Product, George Allen and Unmin, London.

Maurice E. Tucker, 1996. Sedimentary rocks in the field. John Wiley & Sons, New York.

N. K. Tamrakar, 2011. Practical Sedimentology. Bhrikuti Academic Publication. Kathmandu. Nepal

Publications of Journals of Nepal Geological Society.

Richard A. Devis Jr., 1983 Depositional System (A genetic approach to sedimentary geology). Prentice Hall Inc. Englewod Cliffs New Jersey.

Roy Lindholm, 1999. A practical approach to sedimentology. CBS Publishers & Distributors, Delhi.

S. M. Sengupta, 1994. Introduction to Sedimentology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.

# B.Sc. II Year

# Geology (GEO202)

Subject: Petrology, Paleontology and Historical Geology, and Sedimentology — Full marks: 50
Course No.: GEO202 — Pass marks: 20
Nature of course: Practical — Total period: 180

**Petrology** **60 hrs**

**Lab 1**: Systematic megascopic study of igneous rocks.

**Lab 2**: Systematic megascopic study of sedimentary rocks including textures and structures

**Lab 3**: Systematic megascopic study of metamorphic rocks.

**Lab 4**: Microscopic studies of igneous rocks.

**Lab 5**: Microscopic studies of sedimentary rocks.

**Lab 6**: Microscopic studies of metamorphic rocks.

**Paleontology** **48 hrs**

**Lab 1**: Study of Index fossils from Phylum Protozoa and Coelenterate

**Lab 2**: Study of Index fossils from Phylum Coelenterate

**Lab** 3: Study of Index fossils from Phylum Arthropoda

**Lab 4**: Study of Index fossils from Phylum Brachiopoda

**Lab 5**: Study of Index fossils from Phylum Polyzoa

**Lab 6**: Study of Index fossils from Phylum Mollusca (Class-Pelecypoda)

**Lab 7**: Study of Index fossils from Phylum Mollusca (Class Gastropoda)

**Lab 8**: Study of Index fossils from Phylum Mollusca (Class Cephalopoda).

**Lab 9**: Study of Index fossils from Phylum Echinodermata and Hemichordata.

**Lab 10**: Study of Vertebrate fossils.

**Lab 11**: Study of plant Index fossils through geologic time.

## Historical Geology

**14 hrs**

**Lab 1**: Study of paleogeography, paleoecology and palaeoclimate of the Earth through geological time.

**Lab 2**: Study of paleotectonic (transgression and regression); Study of facies map their relation to sea level changes.

**Lab 3**: Preparation of columnar sections and their correlation (Litho and bio correlation).

**Lab 4**: Study of Geological Time Scale and Location of the Mountain orogengy, active volcanic area, convergent and divergent plate collision in the World Map

## Sedimentology

**58 hrs**

**Lab 14**: Grain size analysis: Sieve analysis of sand and gravel, graphic presentation and interpretation of the data.

**Lab 15**: Grain size analysis: Pipette analysis of silt and clay, graphical presentation and interpretation of data.

**Lab 16**: Grain shape: Measurement of sphericity, form, roundness and surface features of detrital particles.

**Lab 17**: Description and interpretation of sedimentary structures: way up indicators, palaeocurrent indicators and deformation indicators.

**Lab 18**: Palaeocurrent analysis: Stereographic projection, correction of data for tectonic tilt, and construction of a rose diagram

**Lab 19**: Environmental models: Description and interpretation of facies and models of fluvial and lacustrine deposits.

**Lab 20**: Environmental models: Description and interpretation of facies and models of Deltaic and Tidal flat deposits.

# Tribhuvan University

Institute of Science and Technology
Course of Study for Four Year Mathematics

**Course Title:** Linear Algebra
**Course No. :** MAT 201
**Level :** B.Sc.
**Nature of Course:** Theory

**Full Marks:** 75
**Pass Mark:** 26.25
**Year:** II
**Lecture:** 150 Hrs.

**Course Description**

This course is designed for second year of Four years B.Sc. program. The main aim of this course is to provide knowledge of linear algebra.

**Course Objective**

The main objectives of this course structure is to enable the students

(i) To develop in-depth knowledge and good theoretical background in linear algebra;
(ii) To take up higher studies;
(iii) To sustain interest in and promote enjoyment of linear algebra and its applications in various branches of mathematics and physical and social sciences;
(iv) To get associated with teaching in the field related to linear algebra.
(v) To compare with graduates from various other universities in the field of Linear algebra.

**Course Contents**

**Unit 1 System of Linear Equations:** Linear equations, System of linear equations, General systems of linear equations, Gaussian elimination, Elementary replacement and scale operations, Row- equivalent pairs of matrices, Elementary row operations, Reduced row echelon form, Row echelon form, Intuitive interpretation, Application: Feeding Bacteria. [15 Lectures]

**Unit 2 Vectors and Matrices**: Vectors, Linear combinations of vectors, Matrix- vector products, The span of a set of vectors, Interpreting linear systems, Row- equivalent systems, Consisting and inconsistent systems, Kernel or null space of a matrix, Homogeneous equations, Uniqueness of the reduced row echelon form, Rank of a matrix, General solution of a system, Matrix- matrix product, Indexed sets of vectors: Linear dependence and independence, Using the row- reduction process, Determining linear dependence or independence, Application: Linear ordinary differential equations. [15 Lectures]

**Unit 3 Vector Spaces**: n- tuples and vectors, Vector addition and multiplication by scalar, Properties of $\mathbb{R}^n$ as a vector space, Linear combinations, Span of a set of vectors, Geometric interpretation of vectors, Line passing through origin, Lines in $\mathbb{R}^2$ , lines in $\mathbb{R}^3$, Planes in $\mathbb{R}^3$, Lines and planes in $\mathbb{R}^n$, General solution of a system of equations , Applications: Elementary mechanics, network problems, traffic flow. [15 Lectures]

**Unit 4 Linear Transformation**: Functions, Mappings, and transformations, Domain, Co- domain, and range, various examples, Injective and surjective mappings, Linear transformations, Using matrices to define linear maps, Injective and surjective linear transformations, Effects of linear transformations, Effects of transformations on geometrical figures, Composition of two linear mapping, Vector spaces, Theorems on Vector spaces, Various examples, Linearly dependent sets, Linear mapping, Application: Models in economic theory. [15 Lectures]

**Unit 5 Matrix Operations**: Matrix addition and scalar multiplication, Matrix- matrix multiplication, Pre-multiplication and post- multiplication, Dot product, Special matrices, Matrix transpose, Symmetric matrices, Skew-symmetric matrices, Non- commutativity of matrix multiplication, Associativity law for matrix multiplication, Linear transformations, Elementary matrices, More on the matrix- matrix product, Vector- matrix product, Solving systems with a left inverse, Solving systems with right inverse, Analysis, Square matrices, Invertible matrices, Elementary matrices and LU factorization, Computing an inverse, More on left and right Inverse of Non- square matrices, Invertible matrix, Application: Diet problems theorem. [15 Lectures]

**Unit 6 Determinants**: Properties of determinants, An algorithm for computing determinants, Algorithm without scaling, Zero determinant, Calculating areas and volumes, Minors and cofactors, Direct methods for computing determinants, Properties of determinants, Cramer's rule, Planes in $\mathbb{R}^n$ , Computing inverses using determinants. [15Lectures]

**Unit 7 Vector Subspaces**: Introduction, Linear transformations, Revisiting kernels and null spaces, The row space and column space of a matrix, Basis for a vector spaces, Coordinate vector, Isomorphism and equivalence relations, Finite- dimensional and infinite- dimensional vector spaces, Linear transformation of a set, Dimensions of various subspaces, Coordinate vectors, Changing coordinates, Linear transformations, Mapping a vector space into itself, Similar matrices, More on equivalence relations. [15 Lectures]

**Unit 8 Eigen Systems**: Introduction, Eigenvectors and eigenvalues, Using determinants in finding eigenvalues, Linear transformations, Distinct eigenvalues, Bases of eigenvectors, Characteristic equation and Characteristic polynomial, Diagonalization involving complex numbers, Application: Powers of a matrix. [15 Lectures]

**Unit 9 Inner- Product Vector Spaces**: Inner product spaces and their properties, The norm in an inner- product space, Distance function, Mutually orthogonal vectors, Orthogonal projection, Angle between vectors, Orthogonal compliments, Orthonormal bases, Subspaces in inner- product spaces, The Gram- Schmidt algorithm, Modified Gram- Schmidt process, Linear least- square solution. [15 Lectures]

**Unit 10 Additional Topics** : Introduction, Hermitian Matrices and self-adjoint mappings, Self- adjoint mapping, Unitary and orthogonal matrices, The Cayley- Hamilton theorem, Quadratic forms, Permutation matrix, LU-factorization, QR- factorization, Partitioned matrices, solving a system having a 2×2 block matrix, Richardson iterative method, Jacobi iterative method, Gauss- Seidel method. [15 Lectures]

**Text book**


1. Ward Cheney & David Kincaid; *Linear Algebra Theory and Applications*, Jones and Bartlett India Pvt. Ltd.


**Reference books**


2. S. Lang; *Introduction to Linear Algebra*, Second Edition, Springer.
3. R.M. Shrestha & S. Bajracharya; *Linear Algebra, Groups, Rings & Theory of Equations*, Sukunda Pustak Bhavan, Kathmandu .
4. T.P. Nepal, C.R. Bhatta & Ganga Ram D.C. ; *A Text Book on Algebra*, Pradhan Book House Exhibition Road, Kathmandu.
5. H.N. Bhattarai & G.P. Dhakal; *Undergraduate Algebra*, Vidharthi Pustak Bhandar, kathmandu.
6. B.S. Vatssa; *Theory of Matrices*, Wiley Eastern Ltd.

# Tribhuvan University

Institute of Science and Technology

Course of Study for Four Year Mathematics

**Course Title:** Differential Equations **Full Marks:** 75
**Course No. :** MAT 202 **Pass Mark:** 26.25
**Level :** B.Sc. **Year:** II
**Nature of Course:** Theory **Lecture :** 150 Hrs.

**Course Description**

This course is designed for second year of Four years B.Sc. program. The main aim of this course is to provide knowledge of Differential Equations.

**Course Objectives**: The objective of this course is to acquaint students with the basic concepts of differential equation like first order linear and nonlinear differential equations, second order differential equations and higher order linear equations as well as partial differential equation. It aims at enabling students to build good knowledgebase in the subject of ordinary differential equations and partial differential equation.

**Course Contents**

**Unit 1:** Definition and classification of differential equations, Solutions of differential equations, Some mathematical models and direction fields [15 Lectures]

**Unit 2: First Order Linear and Nonlinear Differential Equations:** Integrating factors, Separable equations, Modeling with first order equations, Difference between the linear and nonlinear equations, Autonomous equations and population dynamics, Exact equations and integrating factors, Numerical approximations, Euler's method, Existence and uniqueness theorem, First order difference equations. [17 Lectures]

**Unit 3: Second Order Linear Equations**: Homogeneous equations with constant coefficients,Solutions of linear homogeneous equation, The Wronskian, Complex roots of the characteristic equation, Repeated roots, Reduction of order, Nonhomogeneous equations, Method of undetermined coefficients, Variation of parameters, Mechanical and electric vibrations, Forced vibrations. [15 Lectures]

**Unit 4: Higher Order Linear Equations:** General theory of nth order linear equations, Homogeneous equations with constant coefficients, Method of undetermined coefficients, Method of variation of parameters. [15 Lectures]

**Unit 5: System of First Order Linear Equations:** Introduction, Review of matrices, Linear algebraic equations; Linear independence, Eigenvalues, Eigenvectors, Basic theory of first order linear equations. [15 Lectures]

**Unit 6: Differential Equations of the First Order but not the 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. [8 Lectures]

**Unit 7: Partial Differential Equations of the First Order:** Partial differential equations, Origin of First order partial differential equations, Cauchy problem for first order equations, Linear equations of the first order, Integral surface passing through a given curve, Surfaces orthogonal to a given system of surfaces, Charpit's method, Special types of first-order equations. [20 Lectures]

**Unit 8: Partial Differential Equations of the Second Order:** The origin of second order equation, Linear equations with constant coefficients, Equations with variable coefficients, Nonlinear equations of the second order (Monge's Method). [15 Lectures]

**Unit 9: Partial Differential Equations and Fourier Series:** Two-point boundary value problems, Fourier series, Fourier convergence theorem, Even and odd functions. [15 Lectures]

**Unit 10: Separation of Variables:** Heat conduction in a rod, Other heat conduction problems, Wave equation, Vibration of an elastic string, Laplace's equation. [15 Lectures]

**Text books**


1. Boyce, W. and DiPrima, R.; *Elementary Differential Equations and BoundaryValue Problems*, 9th Ed., Wiley India.
2. Ian Sneddon; *Elements of Partial Differential Equations*, McGraw Hill International Editions.
3. Zafar Ahsan, *Differential Equations and Their Applications*, Second Edition, Printice Hall of India, 2005.


**Reference book**


4. James C. Robinson; *An Introduction to Ordinary Differential Equations*, Cambridge University Press

# Tribhuvan University

# Institute of Science and Technology

# 2016 (Revised version)

***Structure of four year B. Sc. Meteorology course***

| Year | Theory | FM | Practical | FM |
|---|---|---|---|---|
| Second | Physical Meteorology and General Hydrology (50+50) MET 201 | 100 | Physical Meteorology and General Hydrology Practical MET 202 | 50 |

# Second Year

## Physical Meteorology and General Hydrology

Course Title: Physical Meteorology and General Hydrology
Course Number: MET 201 Full Marks: 100
Nature of Course: Theory Pass Mark: 35

### Group A: Physical Meteorology (Theory)

**Course Objectives:**

This course provides basic knowledge of the quantitative treatment of the energy processes in the atmosphere. The relationship between the atmospheric variables is derived in the form of basic equations. Some of the processes going on the atmosphere are treated quantitatively. In General Hydrology this course is providing the general hydrological processes.

**Course content**:

**Meteorological Variables:** Introduction to the conventional measurements of different parameters (Rain gauges, Thermometer, Anemometers, Evaporation pan, Solar radiation, Sunshine duration, Soil temperature, Dry bulb and wet bulb temperature), Automatic Weather Station, Weather Satellite, Radar, Radiosonde and Pilot Balloon. 10 hrs

**The atmosphere**: Physical foundation (Introduction of thermodynamics, radiation, Newton's law), units and dimension, composition of the atmosphere (The composition of dry air, Water vapor in the atmosphere, Carbon dioxide, Interplanetary Gas), Vertical Division of the atmosphere (Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere). 10 hrs

**Atmospheric Pressure**: The nature and units of the atmospheric pressure, the measurement of atmospheric pressure, Mercury barometers, corrections for standard conditions, Aneroid barometers, barographs, Variation of pressure with altitude, Reduction of pressure to standard levels. 10 hrs

**Equation of state:** Variable of state, Derivation of Charles' Law and Boyle's Law, equation of state of an ideal gas, mixture of gases 7 hrs

**Heat and Energy:** specific heat capacity, internal energy, conservation of energy, adiabatic processes, Poisson's equation, entropy and the second law of thermodynamics, Thermodynamics of moist air (equation of state of moist air, changes of phase and latent heat, The Clausius-Clapeyron equation, adiabatic processes of saturated air. 10 hrs

**Moisture variable:** Brief introduction of vapor pressure, absolute humidity, mixing ratio, specific humidity, relative humidity, virtual temperature, dew point temperature, lifting condensation level (LCL), wet-bulb temperature, wet-bulb potential temperature, equivalent temperature and equivalent potential temperature. 7 hrs

**Thermodynamic diagram:** Principle of equal area transformation, the Emagram and the Tephigram. 7 hrs

**Hydrostatic Equilibrium:** Hydrostatic equation, hydrostatic of special atmosphere (the homogenous atmosphere, the isothermal atmosphere, the constant lapse rate atmosphere, the dry adiabatic atmosphere and the US standard atmosphere. 7 hrs

**Hydrostatic stability and convection**: Dry and moist adiabatic lapse rate, the parcel method, the slice method. 7 hrs

**Text Book**

- Hess, S. L., An Introduction to Theoretical Meteorology

**Reference Books**


- George J. Haltiner and Frank L. Martin, Dynamical and Physical Meteorology, McGraw-Hill Book Company.
- Compendium of Physical Meteorology class- IV, WMO, Geneva.
- David G. Andrews, An Introduction to Atmospheric Physics, Cambdrige University Press, 2000.

## Group B: General Hydrology (Theory)

**Introduction:** Definition, and scope of hydrology**,** hydrological cycle and water balance equations**,** development of hydrological study in Nepal 2 hrs

**Precipitation**: Causes, forms and types of precipitation, Measurement of Rainfall (Recording, non-recording, rain data logger, weather radar, totalisers), network design (optimum number of rain-gauge station, ideal location), estimation of missing data (arithmetic, normal ratio, weighted average of four station, interpolation from isohyetal maps, regression method), double mass curve, computation of average rainfall (isohyetal, Thiessen polygon, arithmetic), drought, history and status of precipitation measurement in Nepal. 5 hrs

**Hydrological Losses:** Initial losses (Interception and depression storage) Evaporation process Meteorological parameters (Radiation, Temperature, Vapor pressure, Humidity, Wind), Energy Budget methods and Mass transfer approach (Dalton's law), Evaporimeters, Evapotranspiration, Actual evapotranspiration and Lysimeters, Potential Evapotranspiration (Thornthwaite, Blaney Criddle, Penman's equation), Infiltration, Factors affecting Infiltration, Horton's equation, Infiltration indices (Φ and W), Infiltrometers. 5 hrs

**Surface Runoff :** Drainage basins and its quantitative characteristics, Factors affecting runoff from a catchment, Rainfall - Runoff relationship, Stream gauging (selection of sites, types of gauges and measurement), Stream flow measurement by area velocity method (current meters, and floats), Stream flow computation by slope area method, Development of Rating curve and its uses, Estimation of monthly flows from rainfall. 5 hrs

**Hydrograph:** Hydrograph concept, factors affecting of hydrograph and shape of hydrograph, component of hydrograph, base flow separation, effective rainfall, theory of unit hydrograph, assumption, uses and limitation of unit hydrograph, derivation of unit hydrograph. 5 hrs

**Ground water:** Introduction (zoning of subsurface), occurrence of ground water, types of aquifers, aquifer parameters (porosity, specific yield, specific retention, storage coefficient, permeability, transmissivity) ground water basin, Darcy's law its range validity, field measurement of permeability. 5 hrs

**Snow and Glacial Hydrology:** Introduction of snow and ice, snow measurement and water equivalent, physical properties and metamorphism of snow, densification of snow, snowline, snow albedo, snow avalanche, snow cover delineate and snow cover determination, snow runoff and snow melt, Heat budget on snow, definition and types of glacier and Himalayan glaciers, zones and equilibrium line in a glacier and their importance, glacier formation, mass balance and measurement, , glacier ice and debris, snow accumulation, ablation zone, mass balance of snow, snow and glacier fed rivers of Nepal, glacier lake outburst flood (GLOF) historical background, mechanism of GLOF and mitigation measures, development, identification and prioritization of potentially dangerous glacial lakes, climate and glacier response, remote sensing of glacier and glacial lake. 10 hrs

**Text Books**

- Ven Te Chow, David R. Maidment and Larry W. Mays, Applied Hydrology, McGraw-Hill International Editions.

**Reference Books**


- David Keith Todd, Groundwater Hydrology, Second Edition 1995, John Wiley & Sons.
- H.M Raghunath, Hydrology Principles, Analysis, Design 1997, New Age International Publications
- KN Mutreja, Applied Hydrology, 1986, Tata McGraw-Hill Publication Company Limited.
- Reddy JR Hydrology, 2010, Laxmi Publications
- S Subramanya, Engineering Hydrology, Tata McGraw-Hill Publication Company Limited, 2012.
- Peterson W.S.B. and K.M. Cuffey, 2010, The Physics of Glacier, Elsevier Publication

# Physical Meteorology and General Hydrology

Course Title: Physical Meteorology and General Hydrology

Course Number: MET 202 Full Marks: 50

Nature of Course: Practical Pass Mark: 20

## Group A: Physical Meteorology (Practical)

**Practical 1:** Computation of lapse rate of given data (using radiosonde data), RAOB

**Practical 2:** Estimation of mixing ratio, RH.

**Practical 3:** Estimation of LCL and CCL from tephigram

**Practical 4:** Determination of stability of the atmosphere using various meteorological parameters

**Practical 5:** Plotting of vertical height vs temperature graph from given data and interpret

**Practical 6:** Calculate a weighted average of annual total rainfall of a particular basin for the period of 30 years.

**Practical 7:** Measure the degree of correlation between rainfall, humidity, surface air temperature.

**Practical 8:** Find out the auto correlation of temperature of a given station for 30 years.

**Practical 9.** Estimation of Surface lapse rate using various surface Meteorological data.

## Group B: General Hydrology (Practical)

**Practical 1:** Estimation of missing rainfall data

**Practical 2:** Preparation of rainfall mass curve and hyetograph

**Practical 3:** Isohyetal, Thiessen Polygon method and arithmetic average of rainfall depth

**Practical 4:** Double mass curve Analysis

**Practical 5:** Drought analysis (using precipitation data)

**Practical 6:** Optimum number of raingauge stations

**Practical 7:** Frequency analysis of rainfall

**Practical 8:** Preparation of infiltration capacity curve

**Practical 9:** Calculation of Φ and W

**Practical 10:** Determination of Horton's constant

**Practical 11:** Estimation of evaporation loss from reservoir.

**Practical 12:** Measurement and estimation of evaporation from different method

**Practical 13:** Estimation of potential evapotranspiration from Blaney Criddle and Thornthwaite methods

**Practical 14:** Estimation of potential evapotranspiration from Penman method

**Practical 15:** Preparation of hydrograph, base flow of hydrograph and preparation of Unit hydrograph.

**Practical 16:** Calculation of aquifer parameters (porosity, specific yield, hydraulic conductivity permeability)

**Practical 17:** Measurement of river by using surface float and current meter

**Practical 18:** Preparation of rating curve

**Practical 19:** Relationship between snow albedo and snow ablation

**Practical 20:** Energy balance and mass balance of snow and glacier

# Tribhuvan University
# Institute of Science and Technology
# B.Sc. Mirobiology

## Description of the Course

**Course Title:** Biochemistry and Microbial Biotechnology
**Course No:** MB 201 (Major)
**Nature of the Course**: Theory

**Full Marks**: 100
**Pass Marks**: 35
**Year**: II
**Total Lecture Hours:** 150

## Course Objectives

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

a) understand cell and its functions, and macromolecules of living cells and their metabolism
b) understand concept of biotechnology and genetic engineering, and their applications

## Course Contents

**Living cell and understanding of its biochemical functions** **15 hrs**

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

**Macromolecules and biomolecules of living cells** **20 hrs**

Introduction, functions, classification, structure, important properties of: carbohydrates, amino acids, proteins, lipids, and nucleic acids

Enzymes: nomenclature, classification, functions of enzymes, co-enzymes, cofactor and isozymes, enzyme kinetics, factors affecting regulation of enzymes

**Microbial metabolism** **20 hrs**

Concept of exergonic and endergonic reactions, heterotrophic and autotrophic metabolism, role of ATP intermediary metabolism, heterotrophic generation of ATP in various pathways of carbohydrate metabolism, lipid metabolism, protein metabolism

**Microbial genetics** **20 hrs**

Structure, types and functions of DNA and RNA, replication of DNA, transcription and translation, regulation of gene expressions, lac operon, genetic code

**Concept of biotechnology** **5 hrs**

Definition and history, scope and importance, risk and hazards of biotechnology

**Fermentation process** **15 hrs**

Introduction, solid state fermentation, submerged state fermentation, fermentation industries, beer, ethanol, acetic acids, fermentor designs

**Agricultural microbial biotechnology** **15 hrs**

Introduction, biofertilizer and composting, plant tissue culture, micropropagation and disease free plants, general concept of cell fusion and embryo transfer

**Biotechnology in diary industry** **12 hrs**

Milk and milk products: cheese, yoghurt, ice-cream production, sour milk, skimmed milk, dry powder milk, pasteurization process of milk

**Methods in genetic engineering** **12 hrs**

Introduction, outline of gene cloning, gene cloning procedure, vectors used in recombinant DNA technology, applications and possible hazards of genetic engineering

**Enzyme technology** **16 hrs**

Introduction, source of enzymes, selection of source of enzymes, advantage of microbial enzymes, production and purification of protease, amylase, chitinase and pectinase

## Recommended Readings

**Text books**


1. Nelson DL and Cox MM (2004). Lehninger Principles of Biochemistry, 5th Edition. Freeman Publication.
2. Stryer L (1995). Biochemistry, 4th Edition. W.H. Freeman Company, New York.
3. Creuger W and Creuger A (2000). Biotechnology. A textbook of Industrial Microbiology. Sinaeur Associates.
4. Smith JE (1996). Biotechnology, 3rd Edition. Cambridge University Press.
5. Cassida LE Jr (1996). Industrial Microbiology, New Age Int. Publishers.


**Reference books**


1. Rao KR (1986). Textbook of Biochemistry, 3rd Edition. Prentice Hall of India.
2. Rao RAVSS (1993). A Textbook of Biochemistry, UBSPD Co.
3. Jain JL (2004). Fundamentals of Biochemistry. S Chand and Company Ltd.
4. Dubey RC (2001). Textbook of Biotechnology. S Chand and Company Ltd.

# Tribhuvan University
# Institute of Science and Technology
# B.Sc.Mirobiology

**Course Title:** Biochemistry and Microbial Biotechnology Practical
**Course No:** MB 202 (Major)
**Nature of the Course**: Practical

**Full Marks**: 50
**Pass Marks**: 20
**Year**: II
**Total Lecture Hours:** 180

## Course Objectives

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

a) develop practical skills on preparing solutions, buffers and qualitative and quantitative estimate of biomolecules and basic biotechnological laboratory skills.

## Course Contents

**To prepare solutions of different concentrations:** Molar solutions, normal solutions, ppm (part per million) solutions.

**To prepare buffer solutions:** Measurement of pH using pH meter and indicators, preparation of acetate, phosphate and citrate buffers of different pH.

**To perform qualitative and quantitative estimate of various types of carbohydrates:** Benedict test (for reducing sugars), Molish's test, Barfoed's test, Seliwanoff's test, hydrolysis test (for di and polysaccharides), iodine test for starch, quantitative estimation of reducing sugars by DNS (3,5 dinitrosalicylic acid method), extraction of glycogen from liver

**To estimate lipids:** Determination of the value of fat, saponification value of fat, iodine number of fat, estimation of blood cholesterol level.

**To estimate amino acids and 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

**To analyze different enzymes activities:** Amylase, sucrase, carboxylase, protease, lipase, phosphatase, lactase.

**To use different instruments and techniques for biochemical analysis:** Separation and identification of amino acids by paper electrophoresis, separation and identification of sugars and lipids by thin layer chromatography (TLC), separation and identification of amino acids by paper chromatography, separation of

amino acids by single and double ascending paper chromatography, chicken liver fractionation by differential centrifugation, analysis of protein by SDS-PAGE.

**To detect microorganisms from various plants and their products:** Rhizobium inoculation in different leguminous plants, isolation and characterization of *Rhizobium*, *Azotobacter* and *Mycorrhiza.*

**Screening of microorganisms and production of fermented products:** Screening of wine yeasts, production of alcohol, kinema, estimation of fermentation yield by substrate variation method

**Extraction, purification and estimation of enzymes:** Amylase and protease enzymes of bacteria

**Isolation of bacteria:** Methanogenic bacteria from rumen and compost; actinomycetes from compost and soil

**Tribhuvan University**
**Institute of Science and Technology**

# B.Sc. Physics

| | |
|---|---|
| **Course Title:** Optics, Modern Physics and Electronics | **Year:** II |
| **Course Code:** PHY201 | **Full Marks:** 100 |
| **Nature of Course:** Theory | **Pass Marks:** 35 |
| **Duration:** 150 hours | |

**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, Modern Physics and Electronics and apply their knowledge to learning major courses.

## OPTICS [50]

**Course Contents:**

1. **Wave Nature of Light: 1.1** Nature of light, 1.2 Huygen's wave theory and its application for propagation of waves [2 hours]
2. **Aberration at Spherical Surfaces: 2.1** Refraction through spherical surfaces from Huygen's wave theory, 2.2 chromatic aberrations; astigmatism, coma, curvature, distortion and their elimination, 2.3 Ramsden's and Huygen's eyepieces [7 hours]
3. **Interference: 3.1** Condition for obtaining interference, 3.2 spatial and temporal coherence, 3.3 interference by division of wave front, Fresnel's biprism, Lloyd's mirror, 3.4 division of amplitude, thin and wedge films, Newton's ring, Michelson interferometer, Fabry-Perot interferometer, 3.5 intensity distribution, 3.6 antireflection gratings [10 hours]
4. **Diffraction: 4.1** Huygen's principle, 4.2 Fresnel and Fraunhoffer diffraction, 4.3 Fresnel's diffraction: zone plate, circular aperture, straight edge, disc. 4.4 Fraunhoffer's diffraction: diffraction through a single and double slit, circular aperture and disc, 4.5 dispersive and resolving power of grating, 4.6 microscope and telescope [10 hours]
5. **Polarization: 5.1** Unpolarized plane, circular and elliptically polarized light, double refraction, crystal polarizer, 5.2 Malus law, polarization by reflection and scattering, 5.3 double refraction and Huygen's explanation, production and analysis of polarized light, 5.4 optical activity, 5.5 Laurent half shade polarimeter and its applications [8 hours]
6. **Dispersion and Scattering: 6.1** Dispersion of a Prism, 6.2 Normal and anomalous dispersion, 6.3 Cauchy's equation, scattering of light, 6.4 Scattering by small particles, 6.5 Scattering and Refractive Index, 6.6 Raman Effect [6 hours]

7. **Lasers: 7.1** Spontaneous and stimulated emission, 7.2 conditions for laser action, population inversion, optical pumping, 7.3 Ruby and He-Ne lasers and applications [4 hours]
8. **Holography: 8.1** Basic principles of holography, 8.2 applications [3 hours]

## MODERN PHYSICS [50]

**Course Contents:**

9. **Atomic Structure: 9.1** The nuclear atom, 9.2 Rutherford scattering and its conclusions, 9.3 limitations of Rutherford model of atom, electron orbits, 9.4 atomic spectra, 9.5 the Bohr's atom, energy level diagram and spectra of hydrogen atom, 9.6 Frank-Hertz experiment and limitations of Bohr's model, 9.7 the Sommerfeld atom [8 hours]
10. **Many Electron Atom: 10.1** Electron spin, 10.2 Stern-Gerlach experiment, 10.3 Pauli's exclusion principle, 10.4 shells and subshells of electrons, 10.5 vector atom model, 10.6 LS coupling and s, p, d, f notation [5 hours]
11. **Atomic Spectra: 11.1** Fine structures of H, Na, He and Hg, 11.2 Paschen-Back effect, 11.3 Stark effect, 11.4 normal and 11.5 anomalous Zeeman effect [7 hours]
12. **Particle properties of waves: 12.1** Electromagnetic waves and its interaction with matter, 12.2 absorption, 12.3 photoelectric effect, 12.4 Compton scattering, 12.5 pair production, 12.6 photons and gravity [6 hours]
13. **X-ray Spectrum: 13.1** Characteristic X-ray, 13.2 X-ray diffraction and spectrometer, 13.3 fine structure of X-ray transitions, 13.4 Moseley's law and its application [4 hours]
14. **Nuclear Structure: 14.1** Proton-electron and proton-neutron hypothesis, 14.2 nuclear composition and its properties (mass, charge, density, magnetic and electric properties), 14.3 nuclear stability and binding energy, 14.4 Meson theory of nuclear forces [6 hours]
15. **Nuclear Transformations: 15.1** Radioactivity, law of radioactive disintegration, 15.2 law of successive disintegration, 15.3 half-life, mean life, natural radioactive series, 15.4 alpha, beta and gamma ray spectra, 15.5 absorption of α particles, range, 15.6 straggling and stopping power, 15.7 theory of α decay, 15.8 neutrino hypothesis of β-decay, 15.9 biological effects of ionizing radiation [7 hours]
16. **Particle Detectors and Accelerators: 16.1** Ionization chamber, 16.2 G. M. counter, 16.3 scintillation counter, 16.4 bubble chamber, 16.5 Cerenkov detectors, 16.6 semiconductor detectors, 16.7 linear accelerator, 16.8 cyclotron, 16.9 synchrocyclotron, 16.10 betatron, the 16.11 LHC project [7 hours]

## ELECTRONICS [50]

**Course Contents:**

17. **Network Theorems: 17.1** Superposition Theorem, 17.2 Ideal constant-voltage source, 17.3 Ideal constant current source, 17.4 Thevenin's and Norton's Theorem and their applications, 17.5 maximum power transfer theorem [4 hours]
18. **Semiconductor and Diodes: 18.1** Review of semiconductor, types of semiconductor, 18.3 energy bands in semiconductors, 18.3 Different types of diodes, P-N junction diode, characteristics, 18.4 application of junction diode as half wave and full wave rectifier, 18.5 bridge rectifier, R-C filter, ripple factors, 18.6 zener diode and it's application in voltage regulation circuit [6 hours]
19. **Bipolar Junction Transistors: 19.1** PNP and NPN transistors, transistor input, output and transfer characteristics in different configurations, 19.2 α and β of transistor, 19.3 transistor biasing, load lines, Q-point, optimum Q-point, bias stabilization, stability factor, 19.4 CB, CE, and CC amplifiers and their DC and AC equivalent circuits, 19.5 amplifier gain (voltage, current, power) calculations, 19.6 AC-input and output impendances of different amplifiers, 19.7 phase inversion in CE amplifier [10 hours]
20. **Amplifiers: 20.1** Cascaded amplifiers, 20.2 R-C coupled amplifier, 20.3 overall voltage gain, 20.4 frequency response, 20.5 power amplifiers. [4 hours]
21. **Operational amplifiers: 21.1** Differential amplifiers, ac analysis of differential amplifier, 21.2 differential gain, input impedance, common mode gain, 21.3 common mode rejection ratio (CMRR), 21.4 Operational amplifier, 21.5 inverting and non-inverting mode of Op-Amp [5 hours]
22. **Feedback Amplifier: 22.1** Introduction of feedback and their types, 22.2 Negative feedback and positive feedback, advantages of negative voltage feedback, 22.3 different types of feedback amplifier: voltage-series feedback, 22.4 voltage shunt feedback, current series feedback, current shunt feedback [4 hours]
23. **Oscillators: 23.1** Barkhausen criterion, 23.2 working principle of Hartely, Colpitt's and phase shift oscillators, 23.3 Multivibrators and their working principle. [5 hours]
24. **FET and UJT: 24.1** Field effect transistor, its characteristics, 24.2 FET as an amplifier with infinite input impedance. 24.3 Unijunction transistor and its characteristics, 24.4 UJT as a relaxation oscillator [4 hours]
25. **Digital Electronics and Logic gates: 25.1** Decimal, Binary, Octal and Hexadecimal number of systems and their inter-conversion, 25.2 Addition and subtraction of binary numbers, 25.3 Boolean algebra and de Morgan's theorem, 25.4 OR, AND, NOT, NOR, NAND, X-OR and X-NOR gates NOR and NAND gate as basic building block, 25.5 Half adders and full adders, 25.6 RS, JK, D-flip flops [8 hours]

**Text books:**


1. *Jenkins F. A. and White H. E*. - **Fundamentals of Optics**, McGraw Hill Book Co. Ltd., 4th Edition (2011)

2. *Beiser A., Mahajan S. and Choudhury S. R*. - **Concepts of Modern Physics**, Tata McGraw Hill Education, New Delhi (2011)

3. *Murugeshan R. and Sivaprasad K*. - **Modern Physics**, S. Chand and Company, New Delhi (2012)

4. *Malvino A. P.* - **Electronic Principles**, Tata McGraw Hill Publishing House, New Delhi (1984)

**Reference books:**

1. *Subrahmanyam N. and Lal B*. - **Text Book of Optics***,* S. Chand and Co., Ltd. (1994)

2. *Blatt F. J*. - **Modern Physics**, McGraw Hill International (1992)

3. *Wahr M. R., Richard J. A. and Adir T. W.* - **Physics of the Atom**, Addison Wesley (1984)

4. *Leighton R. B.* - **Principles of Modern Physics**, McGraw-Hill Education (1959)

5. *Theraja B. L.* - **Basic Electronics**, S.Chand & Co.Ltd., New Delhi (2002)

6. Mehta V. K. and Mehta Rohit - **Principles of Electronics**, , S. Chand & co. Ltd., New Delhi (1996)

7. *Malvino A. P.* - **Semiconductor circuit approximation (4th edition),** Tata McGraw Hill Publishing House, New Delhi (1986)

**Tribhuvan University**
**Institute of Science and Technology**

# B.Sc. Physics

| | |
|---|---|
| **Course Title:** Physics Laboratory | **Year:** II |
| **Course Code:** PHY202 | **Full Marks:** 50 |
| **Nature of Course:** Practical | **Pass Marks:** 20 |
| **Duration:** 180 hours | |

**Course Description:**

Physics Laboratory (General) Practical course consists of three sections: (a) Optical Experiments, (b) Nuclear Experiments, and (c) Electronics Experiments. Students have to perform at least 15 experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. Students should complete at least 20 experiments in the second year. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

**Course Objectives:**

1. To provide students with skill and knowledge in the experimental methods.
2. To make them able to apply knowledge to practical applications.
3. To make them capable of presenting their results/conclusions in a logical order.

## B.Sc. Second Year Lab Works [180]

**1.** To determine the wave length of given source of light by Newton's Ring method.

**2.** To determine the wavelength of given source of light using a plane diffraction grating.

**3.** To determine the resolving power of a prism.

**4.** To determine the resolving power of a plane transmission diffraction grating.

**5.** To determine the refractive index of the material of a prism for light of different wavelengths.

**6.** To determine the value of Cauchy’s constants for the material of the given prism using a spectrometer.

**7.** To determine the specific rotation of sugar solution using Laurent half-shade polarimeter

**8.** To determine the charge of an electron by Millikan’s method.

**9.** To determine the specific charge of an electron (e/m) by magnetron tube method.

**10.** To determine the specific charge of an electron (e/m) by Thomson's method.

**11.** To study the characteristics of Geiger Muller (G.M.) counter and its reliability.

**12.** To determine the linear absorption coefficient of β-particles in a matter using a G.M. counter.

**13.** To determine the resonant frequency and quality factor of series LCR circuit.

**14.** To study oscilloscope and calibrate it for the measurement of voltage and frequency.

**15.** Determine the unknown frequency of a given source using Lissajous figure.

**16.** To verify the maximum power transfer theorem.

**17.** To verify the network theorems: Thevenin's theorem and Norton's theorem.

**18.** To study the CB characteristics of a PNP and NPN junction transistor.

**19.** To study the CE characteristics of a PNP and NPN junction transistor.

**20.** To study the CC characteristics of a PNP and NPN junction transistor.

**21.** To study the characteristics of regulated power supply using Zener diode.

**22.** To study the characteristics of regulated power supply by using integrated circuit (IC).

**23.** To study logic gates OR, AND and NOT by using DTL and TTL.

**24.** To study logic gates NOR and NAND by using DTL and TTL.

**25.** To verify NAND and NOR gates are universal gates.

**Text Books:**


1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)
2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)


**Evaluation Scheme**

1. Student must perform three hours laboratory work twice a week to complete PHY202 lab works.
2. PHY202 will be examined for the duration of six hours in two different three hours sessions.
3. The practical exam will be graded on the basis of the following marking scheme:

| | | | |
|---|---|---|---|
| Record file: | 20% | Experiment: | 50% |
| Error Analysis: | 10% | Viva: | 20% |

**Tribhuvan University**
**Institute of Science & Technology**

# Statistics

Level: B.Sc.
Year: II
Course Title: Probability and Inference-I
Course Code: STA 201 Full Marks:100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

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**Course objectives:** To impart theoretical and applied knowledge in probability distributions and statistical inference

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**Group A**

## 1 Probability Distributions

### 1.1 Discrete Distributions: [15]

- Negative binomial distribution (NBD): PMF, MGF, CF, moments, properties and uses, distribution fitting, geometric distribution as a special case of NBD
- Hypergeometric distribution: PMF, moments, properties and uses, distribution fitting
- Negative hypergeometric distribution: PMF and moments (mean and variance only), uses
- Problems and illustrative examples

### 1.2 Continuous Distributions: [20]

- Cauchy distribution: PDF, CDF, MGF and moments (if exists), CF, uses
- Laplace distribution (Double Exponential): PDF, CDF, MGF, CF, moments, uses
- Beta distribution: PDF, CDF, MGF, moments, properties and uses
- Gamma distribution: PDF, CDF, MGF, CF, moments, properties and uses
- Negative Exponential distribution: PDF, CDF, MGF, CF, moments, properties and uses, distribution fitting
- Problems and illustrative examples

## 1.3 Bivariate Distributions [10]

- Notion of bivariate random variable
- Bivariate distributions (discrete and continuous variables): Joint, marginal and conditional distributions, independence of random variables
- Transformations of random variables: Jacobian of transformations, distributions of sum, product and ratio of random variables
- Problems and illustrative examples

### 1.4 Sampling Distributions [30]

- Definition of a random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of the sample mean, proportion and sample variance (with consideration of SRS with/ without replacement) standard errors of sample mean and proportion, independence of sample mean and sample variance
- Estimation of sample sizes for the test of mean, proportion and variance.
- Exact sampling distributions: Canonical definitions of central $\chi^2$, t and F random variables, derivations of the probability distributions of central $\chi^2$, t and F
- Characteristics and properties of central $\chi^2$, t and F distributions, their moments, inter-relations between the distributions
- Applications of $\chi^2$, t and F distribution in statistics
- Problems and illustrative examples

**Group B**

### 2. Theory of Estimation [33]

- Concept of convergence
- Point estimation: Estimation of parameters
- Properties of a "Good" estimator: unbiasedness, consistency, efficiency and sufficiency and completeness
- Likelihood function and its properties
- Methods of estimation: Maximum likelihood estimation of parameters of binomial, Poisson and normal distribution
- Properties of maximum likelihood estimate
- Method of moments, method of minimum chi-square, method of minimum variance and method of least squares
- Cramer-Rao Inequality, Rao-Blackwell theorem, Lehmann Scheff theorem
- Interval estimation: Confidence interval and confidence coefficient, method for obtaining confidence limits, confidence interval of mean, proportion, variance and difference between means, uniformly shortest confidence interval, large sample confidence intervals
- Problems and illustrative examples

**3. Theory of Hypothesis Testing [17]**

- Statistical hypothesis, simple and composite hypotheses, test of statistical hypothesis: null and alternative hypotheses, type I and type II errors, level of significance, critical region, power of the test, one tailed and two tailed tests
- Neyman-Pearson's fundamental lemma, simple null vs. simple alternative hypothesis, most powerful (MP) test and construction of critical region, mean and variance of transformed distribution.
- Problems and illustrative examples

4. **Non-parametric Tests [25]**

- Differences between parametric and nonparametric tests; Nonparametric tests: their advantages and disadvantages over parametric tests
- One-sample test: Binomial test**,** median test, sign test, Kolmogorov–Smirnov test and Anderson-Darling test, Run test, Mann Whitney U test, Kruskal Wallis test
- Paired-sample test: Wilcoxon signed rank test
- Two-sample test: Median test and Kolmogorov-Smirnov test
- *K*-sample test: chi-square test, median test, Cochran's Q test and Friedman two way analysis of variance test
- Problems and illustrative examples

**References:**


1. Gupta S. C. and Kapoor V. K. (2007). *Fundamentals of Mathematical Statistics,* Sultan Chand and Sons
2. Shrestha H. B. (2006). *Statistics and Probability: Concepts and Techniques*, Second Edition, EKTA Books
3. Rohatgi V. K. and Ehsanes Saleh, A. K. MD (2005). *An Introduction to Probability and Statistics*, John Wiley & Sons
4. Mayer, P. L. (1970). *Introductory Probability and Statistical Applications*, second edition Oxford and IBH Publishing Co. Pvt Ltd, New Delhi.
5. Shrestha, H.B., *Statistical Inference*, Ekta Books, Latest Edition
6. Rohatgi, V. K. (1984). *Statistical Inference*, Wiley, New York
7. Hogg R.V and Criag, A.T. *Introduction to mathematical statistics,* 3rd edition, Academic Press, USA
8. *Sukubhattu*, N. P. (2063 BS). *Probability Theory and Statistical Methods,* 2nd edition, Asmita Publications, Kathmandu
9. Gibbons, J.D. and Chakrabarthi, S (1992). *Non-parametric Statistical Inference* (Third Edition)

**Tribhuvan University**
**Institute of Science & Technology**
**Statistics**

Level: B.Sc. | Full Marks: 50
Year: II | Pass Marks: 20
Course Title: Probability and Inference-I | Total Number of Periods:180
Course Code: STA 202 | Nature of the Course: Practical

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**Pre-requisites:** Sound knowledge in the topics of Probability and Inference-I

**Course objectives:**

- To develop computational skills in probability and inference
- To understand and apply theoretical knowledge in practical and numerical problems and thus relate theory with practice confidently

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**Title of the practical problems:**

| S. No. | Title of the practical problem | No. of problems |
|---|---|---|
| 1 | Discrete probability distributions (Negative binomial, hypergeometric and negative hypergeometric) | 3 |
| 2 | Continuous probability distributions (Beta, gamma, negative exponential) | 3 |
| 3 | Joint, marginal and conditional distributions, distributions of sum, product and ratio of random variables | 3 |
| 4 | Sampling distributions of the sample mean and sample variance (random sampling with and without replacement) and standard error of sampling mean and variance ct sampling | 2 |
| 5 | Computation of sample size | 1 |
| 6 | Exact sampling distributions (chi-square, t and F) | 2 |
| 7 | Problems of methods of estimation | 2 |
| 8 | Problem in interval estimation | 1 |
| 9 | Problems in hypothesis testing | 2 |
| 10 | One sample test (Wilcoxon signed rank test , Kolmogorov–Smirnov test and Anderson-Darling test) | 2 |
| 11 | Two sample test (Median test and Kolmogorov-Smirnov test) | 2 |
| 12 | Several sample test Cochran's Q test and Friedman two way analysis of variance test) | 2 |
| | **Total number of practical problems** | **25** |

**Tribhuvan University**
**Institute of Science & Technology**
(**Applied Statistics, Compulsory Paper**)

Level: B.Sc.
Year: II
Course Title: Applied Statistics
Course Code: APS 203 — Full Marks: 50
Nature of the Course: Theory — Pass Marks: 17.5
Total Number of Periods: 75

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**Course objectives:** To impart the knowledge of descriptive as well as inferential analysis exclusively in solving numerical problems in applied set up.

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1. **Methods of Data Summarization:** Review of basic concept of Statistics, Scales of measurement, data distribution, diagrammatical and graphical presentation of data, measures of central tendency, measures of dispersion, measures of skewness, measures of kurtosis. Numerical problems related to physical and biological sciences. **[10]**

2. **Correlation:** Karl Pearson's correlation, Spearman rank correlation, Kendal Tau correlation. Numerical problems related to physical and biological sciences. **[5]**

3. **Methods of Data Modeling:** Principles of Ordinary Least Squares (OLS), linear regression up to three variables, methods of fitting of first and second degree equations, exponential curves, partial and multiple correlations, analysis of residuals, Fisher decomposition of total sum of squares, coefficient of determination and its interpretation. Numerical problems related to physical and biological sciences. **[13]**

4. **Analysis of Categorical Data:** Class frequencies, relation between class frequencies, consistence of data, condition for consistency of data, independence and association of attributes, Yule's method and coefficient of contingency, Yule's coefficient of colligation, Pearson's coefficient of contingency and their interpretation. Numerical problems related to physical and biological sciences. **[8]**

5. **Introduction to Probability:** Basic concept of probability, fundamental rules of probability, marginal, joint and conditional probabilities (Concepts and applications only focusing on numerical problems related to physical and biological sciences) **[5]**

6. **Probability distributions:** Binomial distribution, Poisson distribution, Normal distribution (characteristics and applications without derivation focusing on numerical problems related to

physical and biological sciences) **[6]**

7. **Estimation:** Point & interval estimation, confidence interval for mean and proportion, determination of sample size, relationship of sample size with desired level of error Numerical problems related to physical and biological sciences **[3]**

8. **Hypothesis Testing :** Types of statistical hypotheses – null and alternative hypothesis, type I and type II errors, level of significance, critical value and critical region, concept of p–value and use of p-value in hypothesis testing, steps used in testing of hypothesis, one sample tests for mean of normal population (for known and unknown variance), test for proportion, test for difference between two means and two proportions, paired sample t-test, two independent sample tests for variances of normal populations, relationship between hypothesis testing and confidence interval, one way and two way ANOVA, test of significance of simple correlation and regression coefficients. Numerical problems related to physical and biological sciences **[20]**

9. **Nonparametric tests:** Needs of applying non-parametric tests, short introduction of the alternative tests of parametric tests, Chi-square test for independence of attributes and test for goodness of fit (Focusing on numerical problems related to physical and biological sciences). **[5]**

**References:**


1. Harry Frank & Steven C. Althoen (1995). *Statistics concepts and applications*, Cambridge University Press (Low price edition).
2. Murray R. Spiegel & Larry J. Stephens (2000). *Statistics (Schaum's outlines),* Tata McGraw-Hill Publishing Company Ltd, New Delhi, India
3. Sidney Siegel & N. John Castellan (1988). *Nonparametric Statistics for Behavioral Sciences*, McGraw-Hill Publications
4. S.C. Gupta & V.K. Kapoor (2001). *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi India
5. Shrestha, S.L. (2010). *Statistical Methods, for environment, Biological and Health Sciences*, Ekta Books, Kathmandu, Nepal
6. Sthapit Azaya, Yadav Rashinder, Khanal Shankar, Dangol Prakash(2014). *Applied Statistics*, Ashmita Publication, Kathmandu, Nepal
7. J. N. Kapoor & H.C. Saxena (2001). *Mathematical Statistics*, S.Chand & Company Ltd., New Delhi, India.

# Tribhuvan University
# Institute of Science & Technology
# B.Sc. Zoology Course of Study

**Course Title : Non-chordata and Protochordata**
**Course No**: Zoo101 **Full Marks**: 100
**Nature of the Course**: Theory **Pass Marks**: 35
**Lecture**: 150 **Year** : 1

**Course Objectives:**
At the end of course students will be able to:
- Classify the non-chordates with their examples.
- Know the functional anatomy of typical representative/s of each Phylum.
- Understand polymorphism, parasitism, social life etc. of some non-chordates.
- Know the economic importance of non-chordate animals.
- Know the structures, affinities and development of Protochordates.

## Group A : Lower Non-chordata

**Taxonomy:** Concept, trends, species, keys, characters, procedures and significance of taxonomy. ICZN. Phylogeny of invertebrates. Classification of Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes and Annelida with characters and examples. **(10 hrs.)**

**Protozoa:** Status of protozoa and concept of portista. Locomotion, nutrition, reproduction and osmoregulation in protozoa. Structure and reproduction of *Vorticella*. Structure, life cycle, pathogenicity and control measures of *Leishmania donovani*, *Entamoeba histolytica and Trichomonas vaginalis*. Radiolaria and suctoria. **(14 hrs.)**

**Porifera:** Metazoa and their origin. Organization of bilateria. Structure, reproduction of sponges and embryogeny of *Scypha*. Canal and skeletal systems. Origin and affinities. Economic importance of Porifera. **(7 hrs.)**

**Coelenterata:** Structure, reproduction and development of *Obelia*. Polymorphism. Distribution, types and formation of corals and coral reefs. Coral and dinoflagellate symbiosis and coral bleaching. Human intrusion in coral reefs. Economic importance of Coelenterates. **(12 hrs.)**

**Platyhelminthes**: Body wall, digestive, excretory, reproductive and nervous systems, & sense organs. Structure, life cycle, pathogenicity and control measures of *Fasciola hepatica, Taenia solium* and *Echinococcus granulosus*. Morphological and physiological adaptations of helminth parasites. Larval forms. **(12 hrs.)**

**Aschelminthes:** Body wall, digestive, excretory and reproductive and nervous systems, & sense organs. Structure, life cycle, pathogenicity and control measures of *Ancylostoma duodenale, Enterobius vermicularis*, *Wuchereria bancrofti* and phyto-nematode (*Meloidogyne incognita*). Economic importance of Aschelminthes. **(10 hrs.)**

**Annelida**: Coelom and Nephridia in Annelida. Structure, organ systems, life cycle and parasitic adaptations of *Hirudinaria granulosa*. Introduction to vermicomposting. Classification, structure and affinities of Archiannelida. Adaptive radiation in Polychaeta. Economic importance of annelids. **(10 hrs.)**

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

Classification of Arthropoda, Mollusca, Echinodermata and Protochordata with characters and examples. **(6 hrs.)**

**Arthropoda**: Body wall, digestive, excretory, reproductive and nervous systems, and sense organs. Organ systems of freshwater prawn (*Palaeomon*). Structure, life history and economic importance of *Periplaneta americana*, *Phlebotomus argentipus*, *Culex quinquefasciatus, Aedes aegypti* and *Sitophilus oryzae*. Mouthparts of insects. Metamorphism in insects. Social behavior of insects. Characteristics and affinities of Onychophora. Insect Hormones and Pheromones. Economic importance of Arthropods**.( 25 hrs.)**

**Mollusca**: Foot and Shells in Mollusca. Structure and organ systems of Apple Snail (*Pila globosa),* fresh water mussel: *Lamellidens* (=*Unio*). Pearl and its formation. Dispersal, damage and control measures of African Giant Land Snail (*Lissachatina fulica*). Torsion and detorsion in Gastropoda. Economic importance of molluscs. Diversity of molluscs in Nepal. **(22 hrs.)**

**Echinodermata:** Origin and Evolution Structure, organ systems and development of *Asterias*. Larval forms in Echinodermata. Water vascular system. **(8 hrs.)**

**Minor Phyla**: Salient features of Acanthocephala, Nemartina, Rotifera, Gastroitricha, Mesozoa and Ctenophora. **(5 hrs.)**

**Protochordata**: Origin and Evolution. Structure, organ systems and affinities of *Balanoglossus, Herdmania and Branchiostoma*. Development of *Herdmania*. (9 **hrs.)**

**Text Books (latest eds.):**

Jordan, E.L. & Verma, P.S. Invertebrate Zoology. S. Chand & Co. Pub., 857 pp.
Jordan, E.L. & Verma, P.S., Chordate Zoology & Animal Physiology. S. Chand,New Delhi.
Kotpal, R.L. Modern textbook of Zoology: Invertebrates. Rastogi Pub., Meerut,India.
Kotpal, R.L. Modern textbook of Zoology: Vertebrates. Rastogi Pub., Meerut,India.
Parker, T.J. & Haswell, W.A. A text book of Zoology, Vol.1. The McMillan Press Ltd.London, UK.

**Suggested Readings:**

Barnes, R.D. Invertebrate Zoology. Saunders College Pub.,1089 pages
Dhami, P.S. and Dhami, J.K. Invertebrate Zoology. R. Chand & Co. Pub., NewDelhi, India.
http//:www.archive.org
http://www.biodiversitylibrary.org
Prasad, S.N. Life of Invertebrates. Vikas Publishing House Pvt. Ltd., New Delhi, India.

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# Tribhuvan University
# Institute of Science & Technology
# B.Sc. Zoology Course of Study

**Course Title : Non-chordata and Protochordata**
**Course No**: Zoo102 **Full Marks**: 50
**Nature of the Course**: Pratical **Pass Marks**: 20
**Year** : 1

**Course Objectives:**
At the end of this course students will be able to:
- Identify representatives of different Phyla of Non-chordates and Protochordates.
- Know the pathogenic animals; histology of different organs of non-chordate animals.
- Know the structure of mouth-parts of insects and structure of larval forms of different arthropods.
- Know the basic differences in general anatomy of different animals.

**Techniques:** Collection and preservation of Non-chordates.
**Taxonomy:** Identification of Non-chordates (collection, museum specimens and permanent slides).
**Culture:** Protozoan culture.
**Permanent histological slides**: Sections of *Fasciola, Ascaris, Hirudinaria, Balanoglosus* and *Amphioxus*.

**Slide preparations:**
1. Temporary slide preparation:
   Any cultured organism, Statocyst of prawn, Jaw of snail/slug, Jaw of *Hirudinaria,* Mosquito larva and Nematodes of animals.
2. Permanent slide preparation:
   Radula of snail; mosquito larva; mouthparts of mosquitoes, cockroach, honeybee, house fly and butterfly; *Daphnia/Cyclops/Cypris*.

**Morphology and anatomy (Dissection):**
1. Leech – General Anatomy, Excretory and Reproductive.
2. Prawn - Appendages, Nervous system and Digestive organs.
3. Cockroach – General anatomy, digestive organs, nervous system and reproductive organs
4. Apple snail (*Pila*) – General anatomy and Nervous system.

**Case study and report writing (any one)**
i) Medical diseases
ii) Veterinary diseases
iii) Agriculture pests
**iv)** Faunal survey/ Field trip (one day).

**Practical note book preparation as regular study.**