त्रिभुवन विश्वविद्यालय

# विज्ञान तथा प्रविधि अध्ययन संस्थान

## डीनको कार्यालय

कीर्तिपुर, काठमाडौं, नेपाल

पत्र सङ्ख्या
च.नं. १०२०१८।०८२

विज्ञान तथा प्रविधि अध्ययन संस्थान डीनको कार्यालय कीर्तिपुर २०४५

मिति : ०७५।३।३१

श्री क्याम्पस प्रमुख ज्यू,

.....क्याम्पस

.....

विषय : **पाठ्यक्रम परिमार्जन गरिएको बारे ।**

उपरोक्त विषयमा यस विज्ञान तथा प्रविधि अध्ययन संस्थान अन्तर्गत अध्ययन अध्यापन हुने ४ वर्षे स्नातक (B.Sc.) कार्यक्रमको तेस्रो तथा चौथो वर्षको पाठ्यक्रम परिमार्जन गरिएकोले सो अनुसार शै.स. ०७३।०७४ मा भर्ना हुने विद्यार्थीहरु देखि उक्त पाठ्यक्रम अध्ययन अध्यापन गराउने व्यवस्थाको लागि निर्णयानुसार अनुरोध गर्दछु । परिमार्जित पाठ्यक्रम यस अध्ययन संस्थानको Website : www.tuiost.edu.np बाट Download गर्न सकिने व्यहोरा समेत जानकारि गराउदछु ।

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प्रा.डा. राम प्रसाद खतिवडा
डीन

**बोधार्थ :**
श्री अध्यक्ष ज्यू ,
.....विषय समिति
त्रि.वि. कीर्तिपुर ।

# Tribhuvan University

# Institute of Science and Technology

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

## Third & Fourth Year

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## Effective form 2073 Admission Batches

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## Dean's Office, Kirtipur

## Subjects : III$^{rd}$ year

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

# Plant Biochemistry and Biotechnology

**Course No**: Bot 301 **Full Marks**: 100

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

**Year**: B.Sc. III year **Lectures:** 150

**Objectives**: The general aim of this course is to provide fundamental knowledge of plant biochemistry and biotechnology.

**Unit A: Plant Biochemistry** **75**

1. **Introduction:** a) Plant biochemistry as a science (b) Relationship between plant biochemistry and plant sciences (genetics, cell biology, molecular biology, plant physiology and other branches of bio sciences) **2 hrs**

2. **Bio-molecules** **37 hrs**

   **(a) Water**: molecular structure, properties, water as a solvent; Ionization of water, pH scale, buffer. 6 hrs

   (b) **Functional groups** found in bio-molecules: general concept 3 hrs

   (c) **Carbohydrates**: Definition, classification
   Monosaccharides: classification (based on functional group; based on no of C atoms), Properties (Esterification, oxidation, reduction, osazone formation, cyanohydrin reaction, furfural formation, enolization); derivatives of monosachharides (de-oxy derivatives, acids, alcohols, amino sugars, sialic acid); Biological importance

   Disachharides, Polysaccharides and their biological importance (1+6+3 hrs)

   **(d) Lipids**: Definition, structure of glycerol and fatty acids
   Properties of fatty acids, kinds of lipids (Glycero lipids; lipids without glycerol; complex lipids), properties of lipids, Biological roles of lipids (1+ 4 hrs)

   **(e) Proteins:** Definition, Amino acids and their classification (essential, semi essential and non essential; polar and non polar; acidic, basic or neutral)
   Properties of Amino Acids: Amino acids as zwitterions, Amino acids as electrolytes, Reactions of amino acids (ninhydrin reaction; Sanger's reaction; Edman's reaction, Dansyl Chloride reaction; Phosgene reaction; decarboxylation; Esterification; Acylation)
   Peptide bonds and Polypeptide; Structure of polypeptides- primary/secondary/tertiary and quaternary structures

Classification of proteins, Functions of proteins. (2+5+3+3 hrs)

3. **Enzymes:** Properties and chemical structure, Mechanism of action, Denaturation, Factors affecting enzyme action, Allosteric protein and feedback inhibition. Classification and nomenclature **7 hrs**

4. **Plant pigments:** Structure and functions of chlorophylls, carotenoids, anthocyanins, phycobillins **4 hrs**

5. **Vitamins and their role in plants:** Fat soluble vitamins (A, E and K); Water soluble vitamins (Coenzyme A, Vitamins B1, B2, B6, C, and H) **5 hrs**

6. **Introduction to Bioinformatics** **5 hrs**
   Definition, role of computer in bioinformatics, Branches of bioinformatics, Aim of bioinformatics, Scope and research areas in bioinformatics, Biological data-DNA sequence, protein sequence, macromolecular structure. Databases in bioinformatics, basic bioinformatics tools- Databases search (Entrez, SRS), Blast, Fasta.

**Unit B: Plant Biotechnology** **75**

1. **Overview of Biotechnology** (1+3+10 hrs)= **14 hrs**

**Introduction** : A) Origin and History of biotechnology, B) Scope and importance of biotechnology: a) Biotechnology in Medicine, b) Biotechnology in food industry, c) Biotechnology in agriculture, d) Biotechnology in Fermentation technology e) Biotechnology in environmental engineering; C)Achievements of biotechnology: a) Gene cloning, b) Recombinant DNA technology, c) *In vitro* culture technology, d) Genetically engineered drugs, e) Diagnosis of diseases f) Biosensors g) Biofertilizers h) Mutation Breeding, i) Enzyme technology , j) DNA finger printing, h) Monoclonal antibody

2. **Plant tissue culture technique and application** **(2+3+2+10+15+3) = 35 hrs**

**A. Introduction to plant tissue culture**.

**B. Basic principles and techniques of *In vitro* culture**: Totipotency, Basic requirements for growing plants in vitro: Laboratory organization, composition and selection of nutrient media, sterilization, culture room

**C**. **Types of plant tissue culture and their applications**: a. Seed culture, b. organ culture (Meristem culture, root culture, shoot culture), c. Embryo culture, d. Anther Culture e.

Ovule culture, f. Endosperm culture, g. Callus culture h. Protoplast culture i. cell suspension culture

**D. Cryopreservation :** a. Principles, **Method of cryopreservation**- i) Preparation of material for deep freezing, ii) Cryoprotectors, iii) Freezing programmes, iv) Storage strategies, v) Assessment of successful cryopreservation. b. **Uses of cryopreservation** –i) Cryopreservation of Semen, ii) Cryopreservation of ova and embryo, iii) Maintenance of plant germplasm for long duration, iv) Organ explants, v) Zygotic and immature embryos, vi) Shoot tips, vii) Callus, viii) Cell suspensions x) Protoplasts, c. **Significance of cryopreservation**

**3. Plant- Microbe Interaction** **12 hrs**

**A. Biological Nitrogen fixation**: mechanism and its importance

**B. Symbiotic and asymbiotic organisms for soil fertility and crop improvement**.

**C. Biofertilizers (Symbiotic associations)**: i) Rhizobium- Formation of nodule, Nitrogen fixing organism found in nodules, Structure and function of nodule, Mechanism of Nitrogen fixation by Nodules, Rhizobial biofertilizers, Rhizobium biofertilizers in forest trees. ii) Blue Green Algae (BGA)-Mass production and application of Blue Green Algae, Azolla – anabaena symbiosis, Asymbiotic associations, Non symbiotic nitrogen fixing bacteria, Non symbiotic bacterial biofertilizer- a) Azotobactor, b) Azospirillum, c) Carrier formulation, iii). Frankia biofertilizer, iv) Mycorrhiza-Types of mycorrhiza, benefits from Mycorrhizas to plants, establishment of Mycorrhiza associations in vitro

**4. Gene transfer in plants:** (10+1+3 hrs) = **14 hrs**

**A) Concept of gene cloning:** Basic requirements for gene cloning in plants; gene isolation and cloning; Concept of vectors; marker and reporter genes and their roles in plant transformation; identification and analysis of cloned genes (colony hybridization, immunological detection, PCR, blotting)

**B. Gene transfer techniques in plants**: i) gene transfer methods: (Direct/vector less and indirect/ vector mediated); transformation of mitochondria and chloroplasts iii) GM crops: applications and limitations iv) General concept of molecular farming from transgenic plants, v) ethical issues in plant genetic engineering

**Text and Reference books**

**Plant Biochemistry**

1. Bhattarai, T. 2005. Experiments on Plant Biochemistry and Plant Biotechnology. Bhundipuran Prakashan, Kathmandu
2. Bhattarai, T. 2007. Plant Physiology. Bhundipuran Prakashan, Kathmandu.
3. Jain, J.L. 2004. Fundamentals of Biochemistry. S Chand and Company Ltd. New Delhi
4. Lehninger, A.L., Nelson, D.L. and Cox, M. 2004. Principles of Biochemistry. 4th edition. McMillan Limited, USA (Indian Reprint )
5. Rastogi, S.C. 1993. Biochemistry. Tata McGraw-Hill Publishing Company Ltd. Delhi

**Bioinformatics**

1. Attwood, T.K. and Parry-Smith, D. J. 2001. Introduction to Bioinformatics. Prentice Hall Inc.
2. Ghosh, Z. and Malllick, B. 2008. Bioinformatics –principle and applications. Oxford University Press, India.
3. Mount, D. W. 2001. Bioinformatics Sequence and Genome Analysis. Cold Spring Harboor Laboratory Press, New York.

**Plant Biotechnology**

1. Altman, A. and Hasegawa, P. 2012. Agricultural Biotechnology. Academic Press.
2. Bhojwani S. S. 1990. *Plant Tissue Culture: Applications and Limitations*, Elsevier Science Publishers.
3. Bhojwani S.S. and Razdan, M. K. 1996. *Plant Tissue Culture: Theory and Practice*. Elsevier Science Publishers.
4. Chawala H.S. 2009. *Introduction to Plant Tissue Culture*. Third Edition. Oxford and IBH
5. Crispeels, M.J. and Sadava, D.E. 2006. Plants, Genes and Crop Improvement. American Society of Plant Biologists, USA.
6. Debergh, P.C. and Zimmerman, R.H. 1990. Micropropagation. Kluwer Academic Publ. Dordrecht.
7. Dodds, j.H. and Roberts, L.W. 1995. *Experiments in Plant Tissue Culture* (3rd Edition). Cambridge University Press. Cambridge, UK.
8. Dubey R.C. 2009. A text Book of Biotechnology S Chand and company Limited.
9. Gamborg O.L. and Phillips G.C. 1995. *Plant Cell, Tissue and Organ Culture – Fundamental Methods* (Lab. Manual). Springer-Verlag.
10. Greene J.J. and Rao V.B. 1998. *Recombinant DNA Principles and Methodologies*. Marcel Dekker.
11. Lal R. and Lal S. 1995. *Genetic Engineering of Plants for Crop Improvement*. CRC Press.
12. Pierik R.L.M. 1997. In vitro *Culture of Higher Plants*. Kluwer Academic Publisher, Netherlands.

13. Punia M.S. 1999. *Plant Biotechnology and Molecular Biology*: *A Laboratory Manual*. Scientific Publishers, India.
14. Razdan M. K. 2003. *Introduction to Plant Tissue Culture*. Agritech Publications.
**15.** Satyanarayan U. 2005. *Biotechnology*. 1st ed. Arunabha Sen books and Allied P. Ltd.

# Plant Biochemistry and Biotechnology

**Course No**: Bot 302 **Full Marks**: 50
**Nature of the Course**: Practical **Pass Marks**: 20
**Year**: B.Sc. III year **Lectures:** 75

**Objectives**: The general aim of this course is to provide Practical knowledge of plant biochemistry and biotechnology

## Unit A: Plant Biochemistry

1. Preparation of solutions: Concept of normality, molarity, percentage, ppm (parts per million) and their inter-conversions
2. Preparation of buffers (acetate and phosphate) of different pH; measurement of pH by using pH meter and different indicators
3. Qualitative test of carbohydrates (mono-, di- and polysaccharides)
4. Quantitative estimation of sugars by anthrone method.
5. Qualitative tests of lipids and fatty acids (use of sudan dye; determination of acid value, saponification value and iodine number)
6. Qualitative test of proteins (Ninhydrin test; biuret test; millon's test)
7. Quantitative estimation of proteins
8. Qualitative test of nucleic acids (DNA and RNA)
9. Quantitative estimation of nucleic acids
10. Bioassay of plant hormones
11. Extraction and quantification of different plant pigments using colorimeter/spectrophotometer
12. Effect of different factors on enzyme catalyzed reactions (Substrate concentration; enzyme concentration; temperature, pH, inhibitors)
13. Separation of plant pigments by paper/thin layer chromatography.

## Unit B: Plant Biotechnology

1`.To study about the sterilization Technique

i Heat

ii. Radiation

iii. Chemicals

iv. Filtration

1. Study and operation of an Autoclave
2. Study and operation of A Hot Air Oven
3. Study and operation of Laminar Air Flow Cabinet
4. To perform the surface sterilization in plants (explants) .
5. Preparation of 1 litreMurashige and Skoog (1962)(MS) medium.
6. Preparation of Stock solution for MS medium.
7. Preparation of 1.litre of MS medium using stock solutions.
8. Culture technique in tissue culture: root tip culture, shoot tip culture, meristem culture, Pollen culture, anther culture, embryo culture, and seed culture.
9. Regeneration of plantlets by *in vitro* culture.
10. Isolation and inoculation of *Rhizobium* and *Azetobacter*
11. Extraction of Genomic DNA by CTAB method

# Evolution and Biogeography

| | | |
|---|---|---|
| Course No: Bot 303 | Full Marks: | 50 |
| Nature of the Course: Theory | Pass Marks: | 17.5 |
| Year: B.Sc. III year | Lectures: | 75 |

**Objectives:** The general aim of this course is to provide fundamental knowledge of evolution and biogeography

**Course Contents**

**Evolution (Lectures: 35)**

Unit 1: Basic concepts: (i) Introduction: what is evolution?, basic concepts of micro- and macro-evolution, convergent and divergent evolution, molecular evolution, evolution and adaptation, co-evolution; (ii) History of evolutionary thought (pre-Darwin, Darwin and post-Darwin periods), modern synthesis; (iii) Natural selection and evolution: introduction, types of natural selection **(Lecture: 4+6+3 = 13).**

Unit 2: Variation and evolution: (i) Sources and pattern of variation: sources of variation (recombination, gene flow, mutation); patterns of variation (geographic, ecological and genetic patterns); study of population variation (basic techniques and tools); (ii) Gene pool concept: introduction, gene/allele frequency and change, genetic drift, Hardy-Weinberg Principle and evolution; (iii) Speciation: biological species concept, isolation mechanisms, modes of speciation (allopatric, parapatric and sympatric) **(Lecture: 8+7+7 = 22).**

## Biogeography (Lectures: 40)

**Unit 3: Basic concepts:** (i) Introduction: definition and scope of biogeography, brief history of biogeography, relationship with other sciences; (ii) Biogeographic regions: concept of biomes and biogeographic regions; phytogeographic (floristic) regions of the world [basic characteristics: geographic coverage and major floristic elements) of six kingdoms – Boreal (Holarctic), Paleotropical, Neotropical, South African (Capensic), Australian, and Antarctic] **(Lecture: 3+7 = 10).**

**Unit 4: Historical biogeography**: (i) History of earth: geological time scale, plate tectonics, continental drift; (ii) Modes of biogeographic distribution: dispersalist and vicariance biogeography, endemism; (iii) History of evolution: fossil records and origin of life, concept of molecular clocks for dating the history, phylogenetic inference; (iv) History of biological diversity: rise of flowering plants (early diversification and past interactions), late Cretaceous and Cenozoic changes, Pleistocene glaciations and biological changes **(Lecture: 3+3+6+6= 18).**

**Unit 5: Ecological biogeography:** (i) Current patterns of biodiversity distribution: basic factors, processes and conditions controlling biodiversity distribution; major gradients in biodiversity distribution; (ii) Biodiversity hotspots: introduction and concepts, distribution of hotspot areas around the world; (iii) Island biogeography theory: basic concept, conservation application **(Lecture: 6+3+3 = 12).**

**Selected Readings**

Briggs D. and Walters M. 1997. Plant Variation and Evolution, Third Edition. Cambridge University Press.

Lomolino M.V., Riddle B.R. and Brown J.H. 2006. Biogeography.Sinauer Associates, Inc., Sunderland, Massachusetts, USA (Third edition).

Suggested Further Readings

Cox C.B. and Moore P.D. 2009. Biogeography: an Ecological and Evolutionary Approach. Blackwell Publishing (seventh edition).

Futuyma D. 1997.Evolutionary Biology.Sinauer Associates, Sunderland, MA, USA.

Huston M.A. 1994. Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press, UK.

Katy Human 2006. Biological evolution: An anthology of current thought. The Rosen publishing group, Inc.

MaxtoshiNei and Sudhir Kumar (2000).Molecular Evolution and phylogenetics.Oxford University Press.

Roderic D M Page and Edward C Holmes 1998. Molecular Evolution: A phylogenetic approach. Blackwell Science Ltd.

Stebbins George Ledyard 1971. Process of Organic evolution.Prentice Hall of India.

Takhtajan A. 1986. Floristic Regions of the World.University of California Press.

Whittaker, R.J. and Fernández-Palacios, J.M. 2007. Island Biogeography: Ecology, Evolution, and Conservation, 2nd edn. Oxford University Press, Oxford.

# Medicinal and Aromatic Plants

**Course No**: Bot 304 **Full Marks**: 50

**Nature of the Course**: Theory **Pass Marks**: 17.5

**Year**: B.Sc. III year **Lecture Hours**: 75

**Objectives**: The general objective of this course is to provide basic and applied knowledge on the medicinal and aromatic plants (MAPs) of Nepal

**Course contents**

**Unit 1: Overview and importance:** (i) Introduction: definitions of Non-timber forest products (NTFPs) and medicinal and aromatic plants (MAPs); (ii) historical perspectives and current use: with particular focus on the importance of MAP in traditional medicinal practices (Ayurvedic, Unani, Amchi/Tibetan and homeopathy); (iii) Future prospects: introduction to bioprospecting; MAPs, traditional knowledge and drug development; issues of IPR and biopiracy **(Lecture: 1+3+3 = 7)**.

**Unit 2: Diversity, distribution and trade potentials**: (i) Diversity and distribution patterns and NTFPs and MAPs in various climatic zones of Nepal, factors affecting their distribution; (ii)

Trade potentials of NTFPs and MAPs in Nepal, major trends in NTFPs/MAPs trade, role of NTFPs/MAPs in the promotion of peoples' livelihoods **(Lecture: 3+3 = 6)**.

**Unit 3: Conservation status and sustainable use:** (i) Conservation status of MAPs: major conservation issues and threats, MAPs of Nepal in IUCN RED List, CITES appendices and government protection list; (ii) Conservation and sustainable use: major principles, opportunities and constraints, dimensions of MAP sustainability; (iii) *in-situ* and *ex-situ* conservation strategies, alternatives to wild harvest, eco-certification processes, community-based management; (iv) national policies and programs for the promotion of MAP-sector in Nepal **(Lecture: 2+4+4+2 = 12)**.

**Unit 4: Pharamcognosy**: (i) Concept and scope of pharamcognosy, crude drug production of MAPs; (ii) Overview of techniques for the extraction of major phytochemicals from MAPs, distillation technology for essential oils, quality control; (iii) Herbal cosmetics, potentiality of herbal drugs and herbal based industries **(Lecture: 2+3+3 = 8)**.

**Unit 5. Cultivation technologies of commercially important MAPs:** (i) introduction: Opportunities and constraints in the cultivation and production of MAPs in Nepal; (ii) Importance (traditional and commercial uses), active constituents, distribution, climatic and soil requirements, cultivation technologies (propagation and nursery techniques, transplantation of seedlings and rooted cuttings, irrigation techniques, disease and pest management), harvesting and post harvest (processing and value addition) technologies,and major trade issues of the following commercially important MPAs prioritized by the Government of Nepal for economic development in the lower, mid and high altitudes: *Asparagus racemosus, Azadirachta indica, Neopicrorhiza scrophulariiflora, Paris polyphylla, Phyllanthus emblica, Piper longum, Rheum australe, Sapindus mukorossi, Swertia chirayita, Taxus wallichiana, Valeriana jatamansii, Zanthoxylum armatum* **(Lecture: 1+24 = 25)**.

**Unit 6. Harvesting technologies of commercially important MAPs:** (i) Harvest and post-harvest technologies (harvesting period, and methods of sustainable harvest, processing and value addition), marketing and values chain analysis, major trade issues, active constituents and uses of some commercially important MAPs – C*ordyceps sinensis, Dactylorrhiza hatagirea, Hippophae* spp., *Morchella* sp., *Nardostachys grandiflora* and *Podophyllum hexandrum* **(Lecture: 12)**.

**Unit 7.**Field (herbal farm/herbal industry) visit and report writing **(Lecture: 5)**.

**Suggested Readings**

Agrawal S.S. and Paridhavi M. 2012.*Herbal Drug Technology*. Universities Press (India) Private limited, Hyderabad, India.

ANSAB, 2003.*Commercially Important Non-Timber Forest Products (NTFPs) of Nepal*.Asia Network for Sustainable Agriculture and Bioresources, Kathmandu, Nepal (in Nepali).

Balick M.J. and Cox P.A. 1997. *Plants, People, and Culture: the Science of Ethnobotany*. Scientific American Library, New York, USA.

DPR 2067 B.S. *NepalkoAarthikBikaskalagiPrathamiktaPrapta 30 Jadibutiharuko Pahichan Pustika*.Department of Plant Resources, Ministry of Forest and Soil Conservation, Government of Nepal, Kathmandu.

DPR 2007.*Medicinal Plants of Nepal*.Bulletin of the Department of Plant Resources No. 28.Department of Plant Resources, Ministry of Forest and Soil Conservation, Government of Nepal, Kathmandu.

DPR 2060-2061 B.S. *JadibutiSankalan, Sanrakshan, SambardhanBidhi*. JadibutiParichaya Mala 1-5. Department of Plant Resources, Ministry of Forest and Soil Conservation, Government of Nepal, Kathmandu.

Farooqi A.A. and Sreeramu B.S. 2010.*Cultivation of Medicinal and Aromatic Crops*. Universities Press (India) Private limited, Hyderabad, India.

Ghimire S.K., Pyakurel D., Nepal B., Sapkota I.B. and Parajuli R.R., Oli B.R. 2008.*A Manual of NTFPs of Nepal Himalaya*. WWF Nepal Program, Kathmandu.

Ghimire S.K., Sapkota I.B. Oli B.R. and Parajuli R.R. 2008.*Non-Timber Forest Products of Nepal*. WWF Nepal Program, Kathmandu.

Gurung K. 2009. *Essential Oils in Nepal: a Practical Guide to Essential Oil and Aromatherapy*. Himalayan Bio-Trade Pvt. Ltd., Kathmandu.

Gyawali R. 2013. *Handbook of Pharmacognosy*.NaboditHamroPustakBhandar, Kathamndu.

Handa S.S. 2008. An overview of extraction technique of medicinal and aromatic plants. In: *Extraction Technologies for Medicinal and Aromatic Plants* (Eds. S.S. Handa, S.P. Singh Khanuja, G. Longo, D.D. Rakesh). International Centre for Science and high Technology, Italy.

Jha P.K., Karmacharya S.B., Chettri M.K., Bania C.B. and Shrestha B.B. eds. 2008.*Medicinal Plants in Nepal: an Anthology of Contemporary Research*. Ecological Society (ECOS), Kathmandu.

Manandhar N.P. 2002. *Plants and People of Nepal*. Timber Press. Portland, Oregon.

Rajbhandary S. and Ranjitkar S. 2006. *Herbal Drugs and Pharmacognosy: Monographs on Commercially Important Medicinal Plants of Nepal*. Ethnobotanical Society of Nepal (ESON). Kathmandu.

Thomas Y., Karki M., Gurung K. and Parajuli D. eds. 2002.*Himalayan Medicinal and Aromatic Plants, Balancing Use and Conservation*.Proceedings of the Regional Workshop on Wise Practices and Experiential Learning in Conservation and Management of Himalayan Medicinal plants (December 15-20, 2002, Kathmandu, Nepal).Ministry of Forests and Soil Conservation, His Majesty's Government of Nepal, Kathmandu.

**Tribhuvan University**

**Institute of Science and Technology**

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

**(Revised–2073)**

**Course Title**: General Chemistry I **Full Marks**: 100

**Course No.**: CHE 301 (major) **Pass Marks**: 35

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

**Course Objectives:**

- To explain everyday applications and uses of chemistry.
- To promote studies in the acquisition of knowledge and understanding of chemical patterns and principles.
- To present chemical ideas in a clear and logical form.
- To explain properties, structure and bonding of inorganic compounds.
- To evaluate the environmental & technological implications of chemistry.
- To explain organic reaction mechanisms & basic heterocyclic chemistry.
- To explain the theories & applications of ionic electrochemistry.
- To introduce basic knowledge on principles & applications of spectroscopic techniques.
- To introduce polymer chemistry
- To provide knowledge of third law of thermodynamic and thermodynamic parameters.
- To provide mechanistic approaches of organic reactions.

## Group A: Inorganic Chemistry

**Hydrogen:** Isotopes of hydrogen, general study of hydrides and their classification. **4 hrs**

**Nobles gases and their compounds:** Preparation, properties and structure of xenon fluorides and oxo-compounds (Valence bond treatment, VSEPR treatment, molecular orbital treatment for $XeF_2$). **6 hrs**

**Detailed study of preparation, properties, bonding and structure of the followings:** Boric acid, borates, boron nitride, borazines, boron hydrides, metal borohydrides, silicates, silicones, silanes, and siloxanes, interhalogen compounds, pseudohalogens, pseudohalides. **13 hrs**

**Electronegativity:** Review lecture, electronegativity equalization, recent advances in electronegativity theory, variation of electronegativity, choice of electronegativity system, group electronegativity.

**Electron affinity and ionization energy:** Anomalous ionization energies and electron affinities, alternation of electronegativites in the heavier elements. **11 hrs**

**Chemical fertilizers:** Nitrogen fixation and synthetic fertilizers, importance of chemical fertilizers, nitrogen cycle, main ingredients of plant fertilizers, major and minor nutrients, Haber Bosch process for the manufacture of $NH_3$, nitrogenase, model system for systems absorbing dinitrogen and production of $NH_3$, cyanamide process, manufacture of urea, phosphate fertilizers, environmental impact of chemical fertilizers.

**6 hrs**

**Environmental pollution:** An elementary study of environmental pollution in air, water and soil.

**Air pollution system:** Sources, emission, anthropogenic emissions, (gases and particulate matter), acid rain, smog, depletion of ozone layer.

**Water pollution:** Dissolved oxygen, total alkalinity, biochemical oxygen demand and chemical oxygen demand, eutrophication, classification of water pollutants, control of water pollution.

**Soil pollution:** Introduction, source of soil pollution, acid rain, repeated use of same fertilizers, inadequate drainage system in agriculture field, application of pesticides and radioactive wastes.

**10 hrs**

## Group B: Organic Chemistry

**Organic reactions and methods for determining mechanism**: Types of mechanism, types of reaction, thermodynamic and kinetic requirements for reaction, the Baldwin's rules of ring closure, kinetic and thermodynamic control, the Hammond postulate, microscopic reversibility, methods of determining mechanism, identification of products, determination of the presence of an intermediate, study of catalysis, isotope labeling, stereochemical evidence, rate expression for first and second order reaction, isotope effect. **10 hrs**

**Reactive Intermediates**: Stability, structure, generation and fate of carbocation, carbanion, carbene, nitrene and benzyne, nonclassical carbonium ion, neighboring group participation by $\pi$ and $\sigma$ bonds. **10 hrs**

**Free radicals:** History, characteristics of free radicals (formation, propagation, termination, reactivity, stereochemistry), reactions (fragmentation, substitution, addition, oxidation, reduction), detection of free radicals. **7 hrs**

**Spectroscopy and Structure Determination**: Introduction of the electromagnetic spectrum, infrared spectrum, ultraviolet spectrum, nuclear magnetic resonance (NMR) spectrum: $^{1}$H-NMR spectrum, number of signals, equivalent and non-equivalent protons, chemical shift, peak area and proton coupling, spin-spin coupling, coupling constant, $^{13}$C-NMR spectroscopy: $^{13}$C-NMR chemical shift, $^{1}$H-NMR and $^{13}$C-NMR spectra of hydrocarbons, alcohols, aldehydes, ketones carboxylic acid, amines, phenol, ether and aromatic compounds (simple molecules only) & mass spectrum. **18 hrs**

**Heterocyclic systems**: Structure of pyrrole, furan and thiophene, source of pyrrole, furan and thiophene, electrophilic substitutions in pyrrole, furan and thiophene (reactivity and orientation), saturated five member hetero cycles, structure of pyridine, source of pyridine compounds,

reactions of pyridine, electrophilic substitution in pyridine, nucleophilic substitution in pyridine, basicity of pyridine, reduction of pyridine. **5 hrs**

## Group C: Physical Chemistry

### Electrochemistry:

*Electrolytic conductance:* Failure of Arrhenius theory in case of strong electrolytes, Debye-Hückel theory of interionic attraction for electrolytic conduction (elementary treatment only), activity and activity coefficients, ionic strength, Debye-Hückel limiting law (elementary treatment only).

*Electrochemical cells:* Reversible and irreversible cells, types of reversible electrodes, thermodynamics of reversible electrode and cell, thermodynamic quantities of cell reaction from emf ($\triangle G$, $\triangle H$, $\triangle S$ and $K_{eq}$), chemical cells with and without transference, concentration cells with and without transference, liquid junction potential, applications of emf measurement: determination of activities & activity coefficients, formal & standard electrode potentials, solubility products. **15 hrs**

### Spectroscopy:

*Introduction:* Electromagnetic radiation, atomic and molecular spectra, origin of molecular spectra, classification of molecular spectra.

*Rotational spectrum:* Microwave spectrum, concepts of rigid & non-rigid rotors, energy levels of rigid rotor, selection rules, application of rotational spectra.

*Vibrational spectrum:* Infrared spectrum, energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, effect of anharmonic motion, idea of vibrational frequency of different functional groups.

*Raman spectrum:* Concept of polarizibility, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

*Electronic spectrum:* Introduction, Franck-Condon principle, selection rules, application of electronic spectroscopy. **10 hrs**

### Polymer Chemistry:

Introduction and classification of polymers and copolymers, properties of polymers (crystalline, amorphous, thermoplastic, thermosetting), addition and condensation polymerization, degree of polymerization, average molecular weight of polymers, determination of average molecular weight of polymers by osmometry, light scattering and viscosity measurement methods, solution of macromolecules. **7 hrs**

### Thermodynamics:

Entropy, entropy change in isolated system, dependence of entropy on temperature, volume and pressure, entropy change in ideal gas, entropy of mixing, entropy change in physical and chemical transformation, third law of thermodynamics and its significance, free energy change for a reaction, Gibbs free energy change, properties of Gibbs free energy: variation with temperature (Gibbs-Helmholtz equation) and pressure, calculation of free energy change,

reaction isotherm, thermodynamic criterion of equilibrium, Clapeyron equation, Clausius-Clapeyron equation, thermodynamics equilibrium constant, $K_p$ & $K_c$ for gaseous reactions, variation of $K_p$ and $K_c$ with temperature, thermodynamics of Le-Chatelier's principle (quantitative treatment), related numericals. **18 hrs**

**Course Title**: General Practical Chemistry I **Full Mark**: 50

**Course No.**: CHE 302 (major) **Pass Mark**: 20

**Nature of the Course**: Practical **Year**: III

**Course Objectives:**

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

**Experiments on Inorganic Chemistry**

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

**Complexometric Titration**:

Determination of $Zn^{++}$, $Mg^{++}$, $Ca^{++}$ and total hardness of water using EDTA.

Determination of Ca Hardness of water.

**Spectrophotometric Analysis:** Determination of total iron in ground water.

Determination of dissolved oxygen in a sample of water. **18 hrs**

**Experiments on Organic Chemistry**

**Qualitative analysis of organic compounds**: Systematic qualitative analysis of simple mono functional organic compounds and preparation of their at least one derivative (aldehyde, ketone, carboxylic acid, carbohydrate, phenol, hydrocarbon, amine, nitro, amide and ammonium salt).

**51hrs**

**Experiments on Physical Chemistry**

1. To determine the transition temperature of hydrated sodium sulfate decahydrate by thermometric method.

2. To determine the critical micelle concentration (CMC) of a soap or detergent by surface tension method using a stalagmometer.
3. To determine the molecular weight of a polymer by viscosity measurement.
4. To determine the cell constant of the given conductivity cell.
5. To verify Ostwald dilution law and determine the dissociation constant of the weak acid.
6. To determine the equivalent conductivity of strong electrolyte at infinite dilution by conductance measurement.
7. To verify Nernst equation.
8. To determine the true thermodynamic solubility product of calcium sulfate at room temperature.

**51 hrs**

**Text Books: for theoretical course CHE 301**


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. R. T. Morrison & R. N. Boyd, *Organic Chemistry*, 6th & 7th Edition, Prentice- Hall of India Pvt., Ltd., 2008.
4. I. L. Finar, *Organic Chemistry*, Vol. I and Vol. II, Prentice Hall, London, 1955, (Available recent edition).
5. Streitweiser & Heathcock, *Introductory Organic Chemistry*, Wiley and Sons, New York, 1981.
6. J. March, *Advanced Organic Chemistry*, 4th Edition, Wiley Eastern Ltd., India, 2005.
7. Francis A. Corey & Rechard J. Sundberg, *Advanced Organic Chemistry*, 5th Edition, University of Verginia, Verginia.
8. N. D. Cheronis & J. B. Entrikin, *Identification of Organic Compounds, A Student's Text using Semi-micro Techniques,* John Wiley& Sons, Inc (Latest Edition).
9. R. L. Shriner, R. C Fusion & D. Y. Cartin, *The Systematic Identification of Organic Compounds*, A Hand Manual, John Wiley and Sons, Inc. New York (Latest edition).
10. M. R. Pokhrel & B. R. Poudel, *A Text Book of Inorganic Chemistry*, National Book Centre, Bhotahity, Kathmandu, Nepal, 2013.
11. D. F. Shriver & P. W. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, 2010.
12. Stanley H. Pine, *Organic Chemistry*, Special Indian Edition, The McGraw-Hill Companies, New Delhi, India (Latest Edition).

13. G. T. Miller Jr, *Living in the Environment: An Introduction to Environmental Science*, Wardsworth Publication, California, USA, 1994.
14. A. K. De, *Environmental Chemistry*, New Age International Publishers, New Delhi, India, 2008.
15. S. H. Maron & C. Prutton, *Principles of Physical Chemistry*, 4th Edition, Oxford & IBH Pub. Co., 1992.
16. S. Negi & S. C. Anand, *A Textbook of Physical Chemistry*, New Age International (P) Ltd., New Delhi, 1999.
17. R. P. Rostagi & R. R. Mishra, *An Introduction to Chemical Thermodynamics*, 6th Edition, Vikash Publ. House, India, 1996.
18. 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 CHE 301**

1. A. Sharpe, *Inorganic Chemistry*, 2nd Edition, ELBS & Longman, Singapore, 1986, (Preferably available recent edition).
2. R. D. Madan & Satya Prakash, *Modern Inorganic Chemistry*, S. Chand & Company Ltd., 1994.
3. K. N. Upadhyaya, *A Textbook of Inorganic Chemistry*, 2nd Edition, Vikash Publishing House Pvt., Ltd., 1995.
4. G. Marc Loudon, *Organic Chemistry*, 4th Edition, Oxford University.
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. (Preferably available recent edition).
7. Warren, *Organic Synthesis*, *the Disconnection Approach*, Wiley, New York, 1982. (Preferably available recent edition).
8. House, *Modern Synthesis Reactions*, 2nd Edition, W. A. Benjamin. New York, 1972.
9. R. M. Silverstein, F. X. Webster, D. J. Kiemle & D. L. Bryce, *Spectrometric Identification of Organic Compounds*, 8th Edition, Wiley Student Edition, Wiley India Pvt. Lt., 2015.
10. C. Agrawal, *Modern Inorganic Chemistry*, Wiley Eastern, New Delhi, 1981, (Preferably available recent edition).
11. T. W. Graham Solomons, *Organic Chemistry*, John Wiley and Sons, New York. (Available recent edition).
12. R. A. Bansal, *A Textbook of Organic Chemistry*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1993 (Available recent edition).

13. M. L. Sharma & P. N. Chaudhary, *A Textbook of B. Sc. Chemistry* (Vol. I & II), 2nd Edition, Ekta Books Nepal, 2007.

14. A. K. Bhagi and G. R. Chatwal, *Bioinorganic and Supramolecular Chemistry,* Himalaya Publishing House, Mumbai (Available recent edition).

15. A. K. Bhagi & G. R. Chatwal, *Environmental Chemistry*, Himalaya Publishing House, Mumbai, (Available recent edition).

16. James, E. Huheey, Ellen A. Keiter, Richard L. Keiter & Okhil K. Medhi, *Inorganic Chemistry: Principles of Structure and Reactivity*, Fourth Edition, Dorling Kindersley (India) Pvt. Ltd., 2008.

17. S. Glasstone & D. Lewis, *Elements of Physical Chemistry*, Mcmillan & Co., Ltd.

18. P. Atkins & J. D. Paula, *Atkin's Physical Chemistry*, 10th Edition, Oxford University Press, 2014 (reprinted).

19. A. Bahal, B. S. Bahal & G. D. Tuli, *Essential of Physical Chemistry,* Revised Multicolor Edition, S. Chand & Co. Ltd., New Delhi, 2009.

20. K. L. Kapoor, *Textbook of Physical Chemistry*, Macmillan India Ltd., Vol. I to Vol.V, 3rd Edition, 2001.

21. D. Alberty, *Physical Chemistry*, 6th Edition, Wiley Eastern Ltd., New Delhi, 1992.

22. G. M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Edition D. N. Bajpai, *Advanced Physical Chemistry,* S. Chand & Co., New Delhi.

23. V. K. Jha, *Theoretical Principles of Molecular Spectroscopy*, Kathmandu, Nepal, 2011.

**Text Books: for practical course CHE 302**

1. A. I. Vogel, *A Textbook 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, (Preferably available recent edition).
3. R. L. Shriner, R. C. Fusion & D. Y. Cartin, *The Systematic Identification of Organic Compounds, A Laboratory Manual,* John Wiley and Sons, Inc. New York, 1986. (Preferably available recent edition).
4. B. P. Levitt, ed. Findlay's *Practical Physical Chemistry*, Longman, London, 1973.
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 302**

1. Gurdeep Raj, *Advanced Practical Inorganic Chemistry*, 10th Edition, Goel Publishing House, Meerut, 1994.
2. A. I. Vogel, *A Textbook of Practical Organic Chemistry, Including Qualitative Organic Analysis,* Longmans, (Latest Edition).

3. F. G. Mann & B. C. Saunders, *Practical Organic Chemistry*, Orient Longman, 1986, (Preferably recent edition).
4. D. P. Shoemaker & C. W. Garland, *Experiments in Physical Chemistry*, McGraw Hill, Kogakusha Ltd, Tokya, 1967.
5. B. D. Khosla, A. Guali & V. C. Garg, *Senior Practical Physical Chemistry*, 5th Edition, R. Chand & Co., New Delhi, 1987.
6. J. N. Gurtu and R. Kapoor, *Advanced Experimental Chemistry* (Vol I-III), S. Chand & Co. New Delhi, 1984.
7. J. N. Gurtu and A. Gurtu, *Advanced Physical Chemistry Experiments*, 4th Edition, Pragati Prakashan, 2008.
8. S. K. Agrawal and Keemti Lal, *Advanced Inorganic Chemistry*, Pragati Prakasan, Meerut (Latest Edition).

**Course Title**: Basic Biochemistry (Elective) **Full Marks**: 50

**Course No.**: CHE 303 **Pass Marks**: 17.5

**Nature of the course**: Theory **Year**: III

**Course Objectives:**

- To explain the basic tenets of biochemistry
- To explain the functions of biomolecules in the living organisms

**Biochemistry:** Definition and short history and its application, pH scale and pH of biological fluids, Henderson-Hassel balch equation and its importance; Biologically important buffers. **3 hrs**

**Nucleic acids:** Nucleotides, building blocks of nucleic acids, nucleotides and nucleic acids have characteristic bases and pentoses, phosphodiester bonds link successive nucleotides in nucleic acid , nucleic acids structure, DNA store genetic information, DNA molecules have distinctive base compositionproperties, DNA is a double helix, DNA can occur in different three dimensional form, biosynthesis of DNA (replication), biosynthesis of RNA(transcription), genetic code, mutation (nucleotides and nucleic acid undergo nonezymatic transformation, and mutants, DNA repair, DNA sequencing (Frederic Sanger), recombinant DNA technology, DNA cloning, restriction endonucleases and DNA ligase yield recombinant DNA, clonong vector allow amplification of insert DNA Segments), PCR (polymerase chain reaction amplifies specific DNA biological functions of DNA and RNA, biosynthesis and repair of DNA and mRNA, codon, mutation, DNA sequencing by Frederick Sanger method, DNA cloning, the polymerase chain reaction amplifies specific DNA sequences, its application), DNA polymorphism, genetic diseases, human genome project. **22 hrs**

**Amino acids, peptide and proteins:** Amino acids**:** amino acids share common structural features, amino acid residues in proteins are L-stereoisomers, amino acid can be, amino acids can

be classified by R group, uncommom amino acid also have important functions, amino acids not found in proteins, degradation of amino acids (oxidative deamination, transamination, decarboxylation, functions of pyridoxal phosphate (PLP), biosynthesis of glycine, methionine, serine, and tyrosine, amino acid sequencing (terminal group analysis (Edman-N-terminal sequencing), quantitative estimation of proteins (SDS-PAGE). **15 hrs**

**Enzymes:** Definition, properties, terminologies, coenzymes, cofactors and prosthetic group, enzyme kinetics, Michaelis-Menten equation, transformations of Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee plot, enzyme inhibition(competitive, noncompetitive and uncompetitive), effect of pH, temperature, substrate concentration and incubation time on enzyme action, mechanism of enzyme action(lock and key model and induced fit model), regulation of enzyme activity, enzymes of industrial and clinical diagnostic importance. **12 hrs**

**Carbohydrates**: Glycogenesis, gluconeogenesis, glycolysis, TCA cycle, relation between glycolysis, relation between glycolysis and respiration, pentose phosphate pathway, principle of bioenergetics, electron transport system and oxidative phosphorylation. **8 hrs**

**Lipids**: Definition, classification of lipids (natural lipids, fats, waxes, soaps, phospholipids, glycolipids, steroids), saponification number, iodine value, acid number, rancidity, auto-oxidation (rancidity), fatty acids: saturated and unsaturated fatty acids, metabolism (β-oxidation of fatty acids), biosynthesis of fatty acids (palmitic acid and lipid (tripalmitin, cholesterol biosynthesis, and bile salts derived from cholestrol, theories of fat absorption, prostanoids, eicosanoids, leukotrienes, lipooxygenase and cyclooxygenase pathway. **15 hrs**

**Text Books: for Biochemistry CHE 303**


1. David L. Nelson & Michael M. Cox, *Lehninger's Principle of Biochemistry*, Worth Publishers, New York, USA, 2005.
2. Lubert Stryer, *Biochemistry,* W. H. Freeman and Company, New York, USA, 1975.


**Reference Books: for Biochemistry CHE 303**


1. L. Veerakumari, *Biochemistry,* MJP Publishers, Chennai, India, 2004.
2. A. Mazur & B. Harrow, *Text Book of Biochemistry,* W. B. Saunders Co., Philadelphia, USA, 1971.
3. J. L. Jain, *Biochemistry,* Sultan Chand and Co., 1999.
4. P. K. Kuchel & G. B. Ralston, *Theory and Problems of Biochemistry,* Shaum Series, McGraw Hills Book Company, New York, USA, 1988.
5. T. Devasena, *Enzymology,* Oxford University Press, New Delhi, India, 2010.
6. A. C. Deb, *Fundamentals of Biochemistry,* New central book agency (P) Ltd, India, 2012.
7. A.V. S. S. Rama Rao, *A Textbook Biochemistry,* 7th Edition, UBS Publishers' Distributors Ltd.

8. B. R. Pandey, *An Easy Approach to Basic Biochemistry*, Heritage Publishers & Disstributors Pvt. Ltd., Kathmandu, 2015.
9. S. K. Kalauni, *A Textbook of Basic Biochemistry*, ABC Publication, Kathmandu, 2016.

**Course Title**: Analytical Chemistry (Elective) **Full Marks**: 50

**Course No**.: CHE 305 **Pass Marks**: 17.5

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

**Course Objectives:**

- To explain the basic tenets of analytical chemistry
- To explain the principle and instrumentation of different analytical techniques

**Basic Concept**: Introduction to analytical chemistry, Qualitative and quantitative analysis, Analytical methodology: Sampling, Conversion of analyte to a measurable form, Measurement, Calculation and interpretation of the measurement, The analytical balance. Factors affecting the choice of analytical methods, destructive and non-destructive methods, Choice of analytical methods depending upon sample size: a) macro analysis, b) microanalysis, c) semi-microanalysis d) ultra micro analysis, e) trace analysis, interference, sensitivity and detection limits. **20 hrs**

**General Concept of Statistical Methods in Chemical Analysis:** Errors in chemical analysis, Absolute and relative errors, Accuracy and precision, Types of errors in experimental data, Determinate and indeterminate errors, Systematic errors, Proportional errors, Random errors, Sources of random errors, Distribution of experimental data, Statistical treatment of random error, Significant figures, Confidence limits and reliability of results, Student's t test, Criteria for rejection of result (Q-test), Regression analysis,. **14 hrs**

**Titrimetric Methods of Analysis:** General principle, Requirements for reactions used in titrimetric analysis, Concentration system, Stoichiometric calculations, Aliquots, Introduction to redox, precipitation and complexometric titrations, Calibration of volumetric glasswares. **8hrs**

**Gravimetric Methods of Analysis:** General principle, Stoichiometry of gravimetric reactions, Formation and properties of precipitate, Coprecipitation and purity of precipitates, Post precipitation, Drying and ignition of precipitates, Use of common organic reagents in gravimetric analysis, Applications of gravimetric analysis. **6hrs**

**Separation Methods:** Solvent extraction: Nernst distribution law, Distribution coefficient, Distribution ratio, Applications of solvent extraction. **5hrs**

**Chromatography:** Definition and classification of chromatography, stationary and mobile phase, Paper chromatography, Ion exchange chromatography, Gas chromatography, HPLC, Affinity chromatography, Exclusion chromatography, Column chromatography and thin layer chromatography. **12hrs**

**Instrumental Methods**

Principle, instrumentation and applications of atomic absorption spectroscopy, flame photometry, UV-visible spectrophotometry & polarography.

**10hrs**

**Text Books: for Analytical Chemistry CHE 305**


1. R. A. Day jr & A. L. Underwood, *Quantative Analysis*, 6th Edition, Prentice Hall of India, New Delhi,2009.
2. Douglas A. Skoog, F. James Holler & Timothy A. Nieman, *Principles of Instrumental Analysis*, 5th Edition, Thomson Brooks/Cole, 1998.
3. Willard, Merritt, Dean & Settle, *Instrumental Methods of Analysis*, 6th Edition, CBS Publishers, India, 1986.
4. *Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition,* Pearson Education 2008.


**Reference Text Books: for Analytical Chemistry CHE 303**


1. H. Kaur, *Instrumental Methods of Chemical Analysis*, Second Edition, Pragati Prakashan, Meerut.
2. B. Sivasankar, *Instrumental Methods of Analysis*, Oxford University Press, 2012.
3. A. K. Srivastava & P. C. Jain, *Instrumental Approach to Chemical Analysis*, S, Chand and Company, New Delhi.
4. S. K. Gautam, B. R. Poudel & H. R. Sharma, *Concise Analytical Chemistry*, Natural Book Centre, 2016.
5. B. R. Pandey, *An Easy Approach to Analytical Chemistry*, Heritage Publishers and Distributors Pvt. Ltd., Kathmandu, 2016.

## THIRD YEAR

**Course Title: Environmental Pollution and Management Tools** **Lecture hours: 150**
**Course Code: ENV. 301** **Full marks: 100**
**Year III (Compulsory)** **Pass marks: 35**

**Objectives**

The broad objective of this subject is to acquaint students on the problems of environmental pollution and assess environmental impacts of development projects and help them learn related management tools. The specific objectives of the course are as follows:

The specific objectives are:

- To make students able to understand of emission and transport of various pollutants in air, water, soil, noise and its effects in environment
- To acquaint students with municipal and hazardous solid wastes
- To introduce students in assessing environmental impacts on various steps of project cycle
- To familiarize with the environmental management system

**Unit 1: Environmental Pollution** **10 hrs**

Definition, type, source; Major categories of environmental pollution: Pollution of earth surface (land and water), the pollution of atmosphere; Entry of pollutant in the environment; Transfer, transport and dilution of pollutants.

**1.1 Air Pollution and Aerosols** **20 hrs**

Air pollution: History of air pollution episodes, natural versus polluted atmosphere; Sources; Different types of air pollutants; Criterion and hazardous air pollutants; Effects on human health, plants, animals and materials; Expression units for pollutants concentrations -gaseous and particulates; Concept of air quality index and interpretation; Indoor air pollution: sources, major indoor air pollutants, effects and control; Atmospheric aerosols: Formation, sources, chemical composition, types, vertical variation of aerosol; Radiative effects of atmospheric aerosol; Trans-boundary air pollution; Global issues: Green house effect, atmospheric brown cloud, ozone depletion.

**1.2 Water Pollution** **20 hrs**

Sources of water pollution: Point source and non-point source; Types of water pollution: Groundwater, surface water and marine; Major types of water pollutants; Water quality parameters: physical, chemical and biological; Water treatment: Scope: Processes – aeration, sedimentation, filtration, disinfection, softening; Wastewater treatment: Principle and practice;

Wastewater characteristic; Types and sources, need of treatment; Characteristics of municipal and industrial wastewater; Working mechanisms of primary, secondary/biological and tertiary: Sludge disposal.

**1.3 Noise Pollution** **15 hrs**

Sound and Noise; Properties of sound; Sources of noise; Noise descriptors: Equivalent sound pressure, average day night sound pressure level, sound exposure level, noise number index, percentile level; Sound measurement equipment; Health effects and control measures: source control, path control & receiver control.

**1.4 Soil Pollution** **15 hrs**

Fundamental of soil properties; Field indicators of soil loss; Major sources of soil pollution; Concept about soil quality index and salinity hazard; Effect of soil pollution; Soil pollution control measures.

**Unit 2: Environmental Assessment – Introduction and the Process** **20 hrs**

Project development: Development, development infrastructures and environmental consideration; Tools for the environment inclusion in Development; Initiation of Environmental Assessment; History of Environmental Assessment; Legal Requirement of Environmental Assessment; Components of project cycle; Environmental inclusion on various steps of project cycle; Environmental Assessment related legal aspects in Nepal.

Environment Assessment(EA) and its types; The EA Process; Environmental screening; Scoping to determine the Terms of Reference (TOR); Terms of Reference; Initial environmental examination/environmental impact assessment (differences); Types of impact; Baseline Information (physical, biological, cultural environment/human development); Methods of collecting baseline information; Issues identification; Mechanism to give the weight age for issues; Prioritization of Issues; Project Alternatives Analysis; Potential Impact Identification; Public Involvement in environmental inclusion in development; Steps of Environmental Assessments in Nepal.

**Unit 3: Impacts Assessment Techniques and Mitigation Measures** **15 hrs**

Method of impact identification: Checklist, interaction matrix, overlay mapping, networks, GIS, Task specific computer model, expert system; Impact prediction: Introduction, method of impact prediction, uncertainty of impact prediction, impact ranking and comparison of alternatives; Evaluation and determination of significance; Categorization of impacts; Mitigation measures; Public participation and consultations; Environmental Management Plan; Case studies.

**Unit 4: Environmental Monitoring, Auditing and Governance 20 hrs**

Monitoring: introduction and types of monitoring, monitoring criteria and methodologies, monitoring indicators and monitoring processes; Environmental auditing: introduction, types of audit, timeframe for conducting audit, environment auditing plan.

Environmental Governance: Concept, scope and importance of environmental governance; Sustainable requirement of environmental governance; Environment governance: principle and practices; Environmental governance in Nepal; National legislative framework: Environment Protection Act (EPA), Environment Protection Rule (EPR); Sectoral environmental legislations: National strategy, plans and polices, guidelines, manuals and standards; Legislative framework; International convention and treaties; Major International conventions adopted by Nepal; Environmental justice; Good governance; Capacities of EG (Legal and institutional frame work decision making knowledge, enforcement and incentives, integration mechanism); Concept of EG models (Concept of UNEP, Compliance, Cleaner production).

**Unit 5: Environmental Management System 15 hrs**

Environmental management tools and their application: green productivity (GP), environmental management system (EMS), cleaner production (CP) and life cycle assessment (LCA); Introduction to International Organization for Standardization (ISO) and ISO 14000 series; Historical development of EMS; Introduction and requirements of EMS; Introduction of Quality Management System (QMS).

Stages of EMS implementation; environmental review, identification of significant environmental aspects, documentation requirements of EMS, environmental policy, objectives, targets and programs, operation control, review.

Certification process of EMA; EMS auditing and mechanism for certification in Nepal; case studies.

**References:**


1. Agrawal, K.M., Sikdar, P.K., Deb., S.C. (2005). A Text Book of Environment. Macmillan India Limited.
2. Amacher, Michael C.; O'Neil, Katherine P.; Perry, Charles H. (2007). Soil vital signs: A new Soil Quality Index (SQI) for assessing forest soil health. Res. Pap. RMRS-RP-65WWW. Fort Collins, CO: U.S. Department of Agriculture
3. De, A. K. (2010). Environmental Chemistry, 17th edition. New age international publishers.
4. Environment Protection Act 1997 and Environment Protection Rules, 1997. Ministry of Environment, Science and Technology, Nepal
5. ISO. (2004). International Standard ISO 14001, Reference No. 14001:2004 (E), International Organization for Standardization, Geneva.

6. Khadka, R.B. (1997). EIA Training Manual for Professionals and Managers. Asian Regional Environmental Assessment Program. IUCN, Kathmandu, Nepal.
7. Khadka, R.B., Gorzula, S., Joshi A.R., Guragain, S., Mathema, A.B. (2013). Environmental Impact Assessment: Process, Methods and Practices in South Asia (Bangladesh, Bhutan, India and Nepal), 1st edition. SchEMS and IED/RCBI, New Baneshwor.
8. Lohani B.N., Evans J.W., Robert R., Richard A., and Liang, S. (1997). Environmental Impact Assessment for Developing Countries in Asia: Overview and selected case studies, Volume I & Volume II. Asian Development Bank.
9. Masters, G.M. and Ela, WP. (2013). Introduction to Environmental Engineering and Science, 3rd Edition. PHI Learning Pvt. Ltd, Delhi.
10. Miller, Jr. G. T. and Spoolman, S.E. (2009). Living in the Environment: Concepts, Connections, and Solutions, 16th Edition. Brooks/Cole, Cengage Learning.
11. Najam, A., Papa, M., and Taiyab, N. (2006). Global Environmental Governance - A Reform Agenda, iisd, Denmark.
12. NPC and IUCN (1993). National Environmental Impact Assessment Guidelines. National Conservation Strategy Implementation Project, Kathmandu.
13. Rijal, K. and Sapkota, R.P. (2012). Environmental Management Systems: Concept and Approaches, Printwell Offset Press, Kathmandu, Nepal.
14. Santra, S.C. (2005). Environmental Science, 2nd Edition. New Central Book Agency (P) Ltd, Kolkata.
15. Sapkota, B. (2004). Fundamental of Noise Pollution, Department of Physics, Pulchowk Campus, Lalitpur, Nepal
16. The World Bank. (1999). World Bank Safeguards Policies – Environmental Assessment. Washington, DC: World Bank.
17. Uprety, B.K. (2003). Safeguarding the Resources, Environment Impact Assessment, Process and Practices. Shikhar Samundra Offset, Bagbazar, Kathmandu.

**Course Title: Environmental Pollution and Management Tools** **Working hours: 150**
**Course No: ENV. 302** **Full marks: 50**
**Nature of Course: Practical (Compulsory)** **Pass marks: 20**

1. Study the instrumentation techniques of air pollutants (gravity settling chamber, spectrophotometer, cyclone collector, dynamic precipitator, spray tower, dry venturi scrubber, charcoal absorption tube, electrostatic precipitator, fabric filter etc.).
2. Examine air pollution using:
    a. Natural indicators (e.g. vegetation)
    b. Standard methods or sampling for parameters such as SOx, NOx, etc. as indicator in indoor and ambient air.
3. Study of water pollution using following parameters:
    a. Free Carbondioxide; Dissolved Oxygen (DO); BOD and COD and Heavy metals.
4. Determination of iron by spectrophotometric technique or AAS in groundwater samples.
5. Measure and compare the noise levels in public, residential and business area.

6. Study of physical and chemical characteristics of soil (temperature, pH, moisture, nitrate, phosphate, potassium, organic matter, C: N ratio).
7. Determination of soil pH and conductivity from different agricultural setting.
8. Determination of texture in soil by hygrometric method.
9. Conduct an Environmental Assessment and prepare a report of an ongoing or possible development works (e.g. construction of road, residential complex, hospital, establishment of cottage industries, hydropower plant, landfill site etc.).
   (Field work of at least five days is required for stakeholder/public consultations and data collection - primary and secondary).
10. Develop an ISO 14001 Environmental Management System for an industry (manufacturing/service).

**Course Title: Ecological Restoration and Management** **Lecture hours: 75**
**Course Code: ENV. 303** **Full marks: 50**
**Year IV (Elective - I)** **Pass marks: 17.5**

**Objectives**

The broad objective of this course is to acquaint students on the fundamentals of ecological restoration and management. The specific objectives of the course are:

- To make the students understand the concepts and knowledge of ecological processes and their implications on restoration.
- To provide the students with basic understanding on the applications pertaining to land and wildlife habitats restoration.

**Unit 1: Ecological Processes** **15 hrs**

Ecosystem as an ecological unit; Terrestrial and aquatic ecosystems; Structural components; Functional components: Energy flow, nutrient cycling; Physico-chemical components as limiting factors in ecosystems; Life history pattern of species; Population growth and regulation; Ecosystem productivity; Species interactions; Ecological niches; Plants and animals adaptation to environment; Ecosystem development and succession; Disturbance ecology; Fire as an ecological tool: disturbances, prescribed burning, fire-adapted ecosystems, fire suppression; Biogeography of ecosystems; Human impacts on ecosystem health.

**Unit 2: Conceptual Framework on Ecological Restoration** **15 hrs**

Ecological Restoration: Terminologies, history and importance; Ecological theory and restoration ecology; Hierarchical levels of consideration in Restoration Ecology; Restoration of populations and communities; Disturbance and impairment of ecosystems; Ecological attributes of restored ecosystems; Guidelines for restoration practices and steps; Reference sites; State and transition model; Functional group and ecosystem engineers; Thresholds in ecosystem degradation**.**

**Unit 3: Land Degradation and Restoration** **25 hrs**

Causes and processes of land degradation: Natural hazards (flood, wind, unmanaged fire, landslides, erosion), anthropogenic causes (land encroachment, poor farming practices, overgrazing and overdrafting, land use change and developmental structures, unmanaged transportation, quarrying, dumping wastes, soil contamination and acidification) and socio-economic and policy factors; Ecosystem stability, sensitivity and resilience in relation to land degradation processes; Quantitative evaluation of land degradation problems: (a) evaluation of degradational problems at national, regional and global scale (b) ecological, and economic indicators of ecosystem degradation - soil erosion, nutrient cycling, hydrological cycling, nutrient and water use efficiency, biodiversity, productivity, profitability (c) rapid appraisal techniques; Ecological basis of ecosystem restoration: Reproductive and growth strategies of plants, nutrient/water uptake and use strategies, environmental controls on soil formation and ecosystem productivity: vertical mulch, compost, tillage, topsoil salvage, soil biology and fertility processes, plants-animals-microbes linkages; Socio-economic considerations in ecosystem restoration: (a) Relationships between environmental, economic and social opportunities and constraints in restoration, (b) Ecosystem restoration imperatives in developing and developed countries, (c) Institutional requirements for ecosystem restoration, (d) Consideration of socio-cultural values in developing restoration strategies; Case studies on successful ecosystem projects.

**Unit 4: Habitat Restoration** **20 hrs**

Habitats and quantification; Wildlife habitat restoration: Introduction, desired conditions; Habitat disturbances: Natural and human accelerated; Passive and active restoration; Ecosystem-scale restoration of forests and wetlands; Methods to restore and monitor wildlife habitats (aquatic and terrestrial); Formulation and implementation of restoration plans; Introduced/Exotic species; Habitat restoration design concepts; Landscape restoration: Pattern and process; Connectivity: matrix restoration, corridors, stepping stones; Metapopulation: Metapopulation networks, metapopulation dynamics; Case studies on metapopulation approach to restoration.

**References**


1. Clewell, A. and Aronson, J. (2013). Ecological Restoration: Principles, Values, and Structure of an Emerging Profession, Society for Restoration Ecology International, Island Press: Washington D.C., 2nd ed. ISBN 13: 978-1-61091-168-9.
2. Falk, D. A., Palmer, M. A., and Zedler, J. B. editors. (2006). Foundations of restoration ecology, Society for Ecological Restoration International. Island Press, Washington, D.C., USA.
3. Ferris, et al., (1996). Handbook of Western Reclamation Techniques, Office of Surface Mining Reclamation and Enforcement, Denver, CO.
4. Morrison, M.L. (2009). Restoring wildlife: Ecological concepts and practical applications. Island Press, Washington, D.C., USA.
5. SER International. (2002). Wildlife Restoration, Island Press.

6. SER International. (2004). Primer on Ecological Restoration, Society of Ecological Restoration.

**Course Title: Solid Waste Management** **Lecture hours: 75**
**Course No: ENV. 304** **Full marks: 50**
**Nature of Course: Theory (Elective)** **Pass marks: 17.5**

**Unit 1: Introduction and Characteristics of Solid Waste 15 hrs**

Definition of waste, types of waste; Global scenario of waste, global and local issues on solid waste management; Waste management hierarchy; Integrated solid waste management; Holistic solid waste management; Waste management scenario in the context of Nepal.

Definition of municipal solid waste (MSW); Physical, Chemical and Biological properties of municipal solid waste; Sources of municipal waste; Types of municipal waste; Composition of municipal solid waste and its determination; Process of municipal solid waste management; Social , environmental and economic aspects of MSW management; Types of materials recovered from MSW.

**Unit 2: Generation, Collection and Processing of Solid Waste 20 hrs**

Assessment of solid waste generation and characteristics; Factors affecting solid waste generation rate; Source reduction: quantity and toxicity, effects of source reduction, strategies for source reduction.

The logistics of solid waste collection; Types of waste collection systems, equipment and personnel requirements; Collection routes; Management of collection systems; Collection system economics.

3R principle; Transfer station; Recycling and recovery of recyclable materials; Processing of municipal solid waste e.g. storage, conveying, compacting, shredding, pulping, granulating etc; Material recovery facilities (MRF); Recycling economics; Energy recovery from solid waste; Effects of combustion; Composting of municipal solid wastes - principles, technology and economics; case study.

**Unit 3: Disposal and Landfill Management 15 hrs**

Transfer station; Landfill: classification, planning and landfill processes; Landfill design considerations; Generation and composition of landfill gases; Formation, composition and management of leachate; Landfill operation; Environmental quality monitoring at landfills;

Landfill closure, post-closure care and remediation; case study.

**Unit 4: Hazardous and Special Wastes** **10 hrs**

Definition, identification and classification of hazardous solid waste; sources, impacts and characteristics of hazardous solid waste; Bio-medical waste, its sources, generation, storage, transportation, treatment and disposal; Hazardous waste management techniques; Special wastes and e-wastes and their management; Disaster waste and its management; case study.

**Unit 5: Institutions and Regulatory Framework** **10 hrs**

National level organization structure, human resource management, community mobilization, financial management on SWM; Types of private sector participation and its benefits.

Policy, law and regulations, strategy related to SWM in Nepal; International laws and treaties related to SWM; IEE/EIA related SWM projects; Solid Waste Management Act 2011 and Regulations 2013 in Nepal; UNEP guidelines and legal framework for solid waste management.

**References**


1. Tchobanoglous, G. and Kreith, F. (2002). Handbook of Solid Waste Management Second Edition; McGraw-Hill Publication, New York Chicago San Francisco.
2. ADB. (2013). Solid Waste Management in Nepal: Current Status and Policy Recommendations. Asian Development Bank, Philippines.
3. PAN and EU. (2008). Best Practices on Solid Waste Management in Nepalese Cities. Practical Action Nepal, Kathmandu.
4. UN-HABITAT. (2010). Solid Waste Management in the World's Cities. United Nations Human Settlements Programme. Earthscan Publications, London.

# B.Sc. III Year

# Geology (GEO.302a)

Subject:Geology of economic mineral deposits, Stratigraphy and Geology of Nepal, Geophysics & Geochemistry

Nature of course: Practical Course No.: GEO 302a

Full marks: 30 Total period: 160

Pass marks: 12

**Practical:**

**Geology of Economic Mineral Deposits**

Lab 1: Preparation of mineral maps of Nepal**.**
Lab 2: Study of ores and industrial minerals in hand specimen.
Lab 3: Study of polish sections of important ores in reflected light.

**Stratigraphy**

Lab 1: Study of standard stratigraphic scale.
Lab 2: Study of index fossils of each major standard stratigraphic units (systems).
Lab 3: Study of standard magneto-stratigraphic scale.

**Geology of Nepal**

Lab 1: Study of geological map of Nepal.
Lab 2: Study of Precambrian, Palaeozoic, Mesozoic and Cainozoic stratigraphy of Nepal Himalaya.

**Geochemistry and Geophysics**

Lab 1: Statistical treatment of geochemical data (mean, mode, variance, kurtosis, standard deviation).
Lab 2: Resistivity methods (profiling and sounding) and interpretation.
Lab 3: Seismic refraction method and interpretation.

# B.Sc. III Year

# Geology (GEO.302b)

Subject : Field Work

Nature of course: Field Work Course No.: GEO 302b

Full marks: 20

Pass marks: 8

**Course Load:** 7 hours per day per teacher

***Field Work Duration: 15 days***

Providing techniques of locating observation points in a topographical map, measuring attitude of beds and plotting them in a topographical map, observing different rock types, primary and sedimentary structures found in the field area, preparing route map taking geological traverses. Preparing geological map, geological cross-section, and stratigraphical column of the investigated area.

**Field work site**: The geology department will select appropriate field work site to meet the above objectives.

**Note: Each student shall compulsorily attend the field work and submit a report.**

# B.Sc. III Year

# Geology (Geo 303 Elective)

Subject: Geomorphology

Nature of course: Theory Course No.: GEO.303 (Elective)

Full marks: 50 Total period: 75

Pass marks: 17.5

| Main Topics | Contents | Period |
|---|---|---|
| Basic concept | Fundamental concepts of geomorphology, Degradation, aggradation, diastrophism, volcanism. | 3 |
| Processes and types of weathering | Processes of weathering, significance of weathering, rates of weathering, and processes of soil formation. | 6 |
| Igneous activity and landforms | Igneous activity in space and time, intrusive constructional forms, Extrusive constructional forms, igneous tectonism. | 8 |
| Structural landforms | Horizontal and domed structures, homoclinal structures, folded structures, faulted structures and joint structures. | 8 |
| Lithology and landforms | Arenaceous landforms, argillaceous landforms, calcareous landforms. | 8 |
| Mass movements | Significance, gravity, tectonics, classification, location of mass movement, causes of mass movement, mass movement and landform evolution. | 8 |
| Fluvial Geomorphology | River morphology, example of river metamorphosis, rivers and valley morphology, drainage basin evolution, *Fluvial depositional landforms*: Alluvial fans, valley fill, deltas. | 8 |
| Coastal and aeolian geomorphology | Shoreline processes and depositional forms, erosional coasts, sea-level variations, Organic coasts. Aeolian environments, Aeolian bedforms, coastal sand dunes, loess. | 8 |
| Glacial geomorphology | Glaciers, glacier flow, rock debris in glaciers, erosion by glaciers, deposition by glaciers, landforms of glacial deposition. | 6 |
| Climatic change and polygenetic landforms | Climatic change, the geomorphic effects of climatic change. | 6 |
| Applied geomorphology | Application of geomorphology to geo-hydrology, economic geology, engineering projects and other applied fields of geology. | 6 |

**Text and reference books:**

***Geomorphology***

Chorley, R. J. et al. (1984): *Geomorphology*. Methuen and Co. Ltd., London, 605p.

Thornbury, D. W. (2000): *Principles of Geomorphology*, New Age International (P) Limited, Publishers, India. 594 p

Bloom, A. L. (1992): *Geomorphology,* Prentice Hall of India, 532 p

# B.Sc. III Year

# Geology (GEO.304 Elective)

Subject: Geohazards and Climate Change

Nature of course: Theory

Course No.: GEO.304 (Elective)

Full marks: 50

Total period: 75

Pass marks: 17.5

| **Main Topics** | **Contents** | **Period** |
|---|---|---|
| Concept of hazard | Definition of hazard, types of geohazards, socio-economic impacts of geohazards. | 2 |
| Volcanic Hazards | Introduction, Volcanic hazard mapping. | 2 |
| Seismic hazards | Introduction, Earthquake vulnerability, Seismic hazard analysis: Seismic microzonation, Seismic risk assessment urbanization and seismic risk, Earthquake risk in the Himalayan region. | 6 |
| Landslide Hazards | Introduction to Landslide, Landslide hazard mapping. | 6 |
| Land subsidence | Types and causes of land subsidence, subsidence hazard mapping.<br>Land subsidence problems in Nepal. | 6 |
| Flood hazards | Introduction, Types of floods, Flood hazard mapping, Flood hazard in Nepal, Glacial Lake Outburst Flood (GLOF), The GLOF hazard, Landslide Dam Outburst Flood (LDOF). | 6 |

| | | |
|---|---|---|
| Risk reduction and mitigation methods | Vulnerability and risk assessment of geohazards, risk reduction and mitigation measures. | 6 |
| Policies and conventions | Policy in response to geohazards: lessons from developed and developing countries, Nature of responses to geohazards, Emergency responses, Planning for losses, Controlling the effects, Improving the understanding of hazard, The UN International Decade for Natural Disaster Reduction (IDNDR) and International Strategy for Disaster Reduction (ISDR), National Disaster Policy of Nepal | 6 |
| The Science of Climate Change | Climate, climate types and climate change, Observed changes in climate, Causes of climate changes, Climate parameter changes, Predicting future climates, Special features of climate changes in the Himalaya-<br>Tibetan region. | 6 |
| Recent climate change and its effects | Changes in air and sea surface temperature, Effects in Glaciers, Sea ice and Ice sheet, sea level, Effect of galactic variations. Evidences and misconception of climate change. | 6 |
| Conceptual and numerical climate model | The source of energy for our climate system, Energy loss and radiation system, The greenhouse effect, The carboncycle: Atmosphere–land-biosphere–ocean carbon exchange, Atmosphere–rock exchange, humans perturbing the carbon cycle, Climate sensitivity | 6 |
| The future of theearth's climate | The factors that control emissions, Population change and affluence effects, Emissionsscenarios, Volcanic eruptions, Projections of future climate. | 6 |
| Impacts of climate change | Impacts on health, food, water resources, vegetation, natural disaster, poverty and social security. | 6 |
| International climate change conventions, protocols and national perspectives | UNFCC, Kyoto protocol, Bali Action Plan, Copenhagen Accord,<br>Climate Change policies and related laws of Nepal. | 6 |

**Reference books:**


1. McCall G.J.H., Laming D.J.C., Scott S.C., 1992, Geohazards, natural and man-made, Chapman & Hall, 2-6 Boundary Row, London SEI SHN, 226p.
2. Waltham Tony, Bell Fred, Culshaw Martin, 2005, Sinkholes and Subsidence (Karst and cavernous Rocks in Engineering and Construction), Praxis Publishing Ltd, Chichester, UK, 382p.
3. Dahal, Ranjan Kumar, 2006, Geology for Technical Students, Bhrikuti Academic Publications, Exhibition Road, Kathmandu, Nepal, 756p.
4. Zeitoun David G., WakshalEliyahu,2013, Land subsidence analysis in urban areas, Springer Science and Business Media, Dordrecht, 307p.
5. Dessler, Andrew Emory, 2011, Introduction to modern climate change, Cambridge University Press, 32 Avenue of the Americas, New York, NY 10013-2473, USA, 238p.
6. Malik, Ashok, 2008, Causes of climate change, Rajat Publications New Delhi -110 002 (India), 296p.
7. Pelling, Mark, 2011, Adaptation to Climate Change: from resilience to transformation, Routledge, 2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN. 274p.
8. Letcher, Trevor M.(editor), 2009, Climate Change: Observed Impacts on Planet Earth, Elsevier Radarweg 29, PO Box 211, 1000 AE Amsterdam, The Netherlands, 494p.
9. Dragoni W. and Sukhija B. S., 2008, Climate Change and Groundwater, Geological Society Special Publication No. 288, The Geological Society London, 186p.
10. Henry j. Vaux (Chair), 2007, Himalayan Glaciers: Climate Change, Water Resources, and Water Security, The National Academies Press, Committee on Himalayan Glaciers, Hydrology, Climate Change, and Implications for Water Security Board on Atmospheric Studies and Climate, 206p.

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

**Course Title**: Computer Programming **Full Marks:** 75 (60 Theory + 15 Lab)

**Course No:** MAT 301 **Pass Marks:** 26.25 (21 Theory +5.25 Lab )

**Level**: B. Sc **Year:** III

**Nature of course:** Theory (6 Hrs.) + Lab (3 Hrs.). **Period Per Week:** 9 Lecture Hrs.

**Course Description:** This course is designed for third year of Four years B.Sc. program .The course covers the basics of computer systems and programming in the "C" programming language. The course aims at demonstrating the fundamental programming techniques of C. The course includes basics of C-programming, scalar data types and their operators. The course spans the details of flow control, complex data types such as arrays, structures, unions, and pointers, structuring the code using functions, and handling the files.

**Examination:** There will be a final examination of the theory part of 60 marks for the period of two hours. The examination for the practical (laboratory) part of 15 marks will be conducted by the concerned Department of Mathematics and the marks will be submitted to office of the controller of examination. The candidate must pass in theory and practical (laboratory) part separately.

For the Laboratory examination part, the examination for 10 Marks will be taken by the teacher of the concerned department by giving two programming problems for Laboratory work each carrying 5 Marks and for the rest 5 Marks there will be of a viva voce examination in the presence of the head of the department and the subject teacher.

**Course Contents**

**Unit 1: Introduction to Computer Systems:**

Introduction to computers, Architecture of digital computer, Central Processing Unit, Memory system, Primary memory, Secondary memory, Inputs devices, Output devices, Computer software, System Software, Application Software, Operating Systems, Generations of computers, Applications of computers. [11 Lectures]

**Unit 2: Introduction to Programming Languages**

Programming languages, Evolution of programming languages, Structured programming, The compilation process, Object code, Source code, Executable code, Interpreters, Linkers, Loaders, Fundamentals of algorithms, Flow charts. [7 Lectures]

**Unit 3: Fundamentals of C Programming**

Introduction to C, History of C, Structure of C program, Compilation and execution, The C-Character set, C-Tokens, Keywords and identifiers, Delimiters, Variables, Declaration of variable, Constants, Data types, Expressions, Statements, Comments, Symbolic constants. [11 Lectures]

**Unit 4: Input/ Output Statements**

Single character input/ output, Input data using scanf, Writing output data using printf, gets and puts functions. [5 Lectures]

**Unit 5: Operators and Expressions**

Arithmetic operators, Unary operators, Relational operator, Logical operators, Assignment operators, Increment or decrement operators, Conditional operator, Bitwise operator, Comma operator, Precedence of operators, Arithmetic expressions, Type conversion in expressions.
[10 Lectures]

**Unit 6: Control Statements**

Branching: if-else statement, Nested if-else, Looping: While statement, Do-while statement, For statement, Switch statement, Break statement, Goto statement. [8 Lectures]

**Unit 7: Functions**

Overview of functions, Library functions, User defined functions, Defining a function, Accessing a function, Function prototypes, Local and global variables, Passing arguments to a function, Call-by-value, Call-by-reference, Recursion. [12 Lectures]

**Unit 8: Arrays and Pointers**

Defining an array, Processing an array, One-dimensional array, Multi-dimensional array, Matrix operations, Arrays and strings, Introduction to pointers , The & and * operator, Pointer declarations, Passing pointers to a function, Pointers and one-dimensional arrays, Dynamic memory allocation, Operations on pointers, Pointers and multi-dimensional Arrays, Array of pointers. [18 Lectures]

**Unit 9: Structures and Unions:**

Defining a structure, Processing a structure, User defined data type (Typedef), Structures and Pointers, Passing structures to functions, Structure within structure (Nested/ self-referential Structure), Unions.

[10 Lectures]

**Unit 10: File Handling**

Concepts of file, Opening and closing of file, Modes, Input/ output function, Creating a file, Processing a file. [8 Lectures]

**Laboratory works** 50 Hrs.

This course requires a lot of programming practices. Each topic must be followed by a practical session. Practical sessions for each unit should be conducted and should include writing programs for mathematical problems as much as possible. The sample lab sessions could be as following descriptions;

- The lab sessions should include writing programs for basic mathematical operations like addition, subtraction, multiplication, division, average etc.

- The instructor should encourage the students to write the programs for finding factorials, computing GCD, primality testing, Fibonacci numbers, sum of natural numbers, generation of series of numbers, finding quadratic roots, generation of random numbers, computing area, volume etc.

- Students should write programs for matrix computation including addition of matrices, multiplication of matrices using the Arrays. The students should also be able to represent adjacency graphs using arrays.

- The students should write programs for creating user defined data types using Structures and Unions.

- The students should also practice handling files. They should write programs for reading and writing from/to the files.

**Text books**


1. Byron S. Gottefried, " *Theory and Problems of Programming with C*", Mc-Graw Hill.
2. Brian W. Kernighan & Dennis M. Ritchie, "*The C programming Language*", PHI.
3. E. Balagurusamy, "*Programming in ANSI C*", Tata Mc-Graw Hill.


**Reference books**


4. Yashavant Kanetkar: "*Let us C*", BPB Publications.
5. Stephen G. Kochan, "*Programming in C*", CBS Publishers & Distributors.
6. Efraim Turban, R. Kelly Rainer, Jr. Richard E. Potter, "*Introduction to Information Technology",* John Wiley & Sons (Asia) Pvt. Ltd.

Alexis Leon, Mathews Leon, "*Fundamentals of Information Technology*", Le

# Tribhuvan University

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

**Course Title:** Real Analysis **Full Marks:** 75
**Course No. :** MAT 302 **Pass Mark:** 26.25
**Level :** B.Sc. **Year:** III
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course description**

This course is designed for third year of Four years B.Sc. program. The main aim of this course is to provide elementary knowledge of real analysis.

**Course objectives**

The general objectives of this course is

a) To acquire basic knowledge and understanding of the language of mathematical terms, symbols, statements formulae, definitions, logic etc.
b) To develop basic knowledge and analytical skill in the emerging areas of Real Analysis.
c) To prepare a base for higher studies in Mathematical Analysis.

## Course Contents

### Unit 1. Basic Concepts

**Elementary logic:** Connectives, Quantifiers, Basic laws of logic, Techniques of proof.
**Sets and functions:** Sets and set operations, Relations and functions, One-to-one and onto functions, One-to-one correspondence, Images and inverse images, Composition, Inverse functions. [22 Lectures]

### Unit 2. Real Number System

Peano's axioms, Field axioms, Order axioms, Bounded and unbounded sets, Supremum and infimum, Completeness axioms, Archimedean property, Well ordering principle, Rational density, Countable and uncountable sets, Cardinality. [25 Lectures]

### Unit 3. Point-Set Topology of the Real Line

Neighbourhood, Interior points and limit points of a set, Open and closed sets and their properties, Bolzano-Weierstrass theorem, Closure of a set, Derived sets, Perfect sets. [15 Lectures]

### Unit 4. Sequences of Real Numbers

Sequences and subsequences, Convergent sequences, Bolzano-Weierstrass theorem for sequences, Cauchy sequences, Convergence criteria, Operations on convergent sequences, Monotonic sequence and convergence, Nested intervals theorem. [16 Lectures]

Unit 5 **Series of Real Numbers**

Series and sequences, Convergence and divergence, Cauchy's criteria for convergence, Different tests for convergence, Alternating series, Absolute and conditional convergence. [17 Lectures]

**Unit 6. Limits and Continuity**

Limits, Sequential criterion for limits, One-sided limits, Properties of limits, Continuity of functions, Sequential criterion for continuity, Discontinuities, Continuity and inverse images, Functions continuous on closed intervals, Sign preserving property, Intermediate value theorem, Bolzano's theorem, Uniform continuity, Lipschitz condition. [13 Lectures]

**Unit 7. Differentiation**

Derivative of a real-valued function of a single variable, Differentiability at a point and in an interval, Sequential criterion for derivatives, Differentiability and continuity, Monotonic functions, Rules of differentiation, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem and their geometric interpretations, Higher order derivatives, Taylor's theorem, Maclaurin's theorem and their infinite series form, Applications of Taylor's theorem in extreme values problems, Indeterminate forms, L'Hospital rule. [16 Lectures]

**Unit 8. Riemann Integration**

Partitions and refinement of partitions, upper and lower integrals, Riemann integrable functions and Riemann integrals, Condition of integrability, Properties of Riemann integrals, Alternative approach: Step function approach to Riemann integration. [14 Lectures]

**Unit 9. Fundamental Theorems of Calculus**

Primitives, Fundamental theorem of calculus, First mean value theorem, Generalized first mean value theorem, Integration by parts, Change of variable in an integral, Second mean value theorem (particular case). [12 Lectures]

**Text books**


1 Bartle, Robert G. & Sherbert, Donald R.: *Introduction to Real Analysis*, John Wiley and Sons Inc., Singapore.
2 Bajracharya, P.M.: *Real Analysis – An Introduction to Proof*, Buddha Academic Publishers & Distributors Pvt.Ltd., Kathmandu, Nepal
3 Shrestha, R.M. and Pahari,N.P.: *Fundamentals of Mathematical Analysis*, Sukunda Pustak Bhawan, Kathmandu, Nepal.

**Reference books**


4 Maskey, S.M.: *Principles of Real Analysis*, Bhundipuran Prakashan, Kathmandu, Nepal.

5 Malik, S.C.& Arora, Savita: *Mathematical Analysis*, Wiley Eastern Limited, New Delhi.


Tribhuvan University

Institute of Science and Technology

Course of Study for Four Years Mathematics

**Course Title:** Numerical Methods (Elective) **Full Marks:** 50
**Course No. :** MAT 303 **Pass Mark:** 17.5
**Level :** B.Sc. **Year:** III
**Nature of Course:** Theory (3 Theory + 2 Practical) **Period per week:** 5 Lecture Hrs.

**Course Description**

This course is designed for third year of Four years B.Sc. program as an elective subject. The main aim of this course is to provide the basic knowledge of Numerical Methods.

**Course Objectives**: The objective of this course is to acquaint students with the basic concepts of Numerical Methods. It aims at enabling students to build foundation of Numerical Methods.

**Examination:** Theory 35 + Practical 15 = 50 Marks. The practical examination will be conducted by the concerned department of the college and the marks must be sent to the controller of the examination. A student must pass separately in theory and practical exam. Pass Marks for Theory is 12.25 and for practical 5.25.

**Unit 1**: Introduction to MatLab, Process of Numerical Computing, Characteristics of Numerical Computing, Introduction to Approximations, Errors in Computation and Their Analysis, Significant Digits, Floating Point Representation, Accuracy and precision. [10 Lectures]

**Unit 2: Nonlinear Equations:** Bisection method, False position method, Newton- Raphson method, Secant method, Fixed Point Iteration Method: Derivation, Algorithm, Comparison between Them, Rate of convergence, Error Computation and Implementation. [15 Lectures]

**Unit 3: Discrete Solution of Linear Equations:** Basic Gauss Elimination Method, Gauss Elimination with pivoting, Triangular Factorization (Decomposition) Methods, Gauss Jordan Method, Matrix Inversion: Derivation of the Methods, Their Algorithms and Implementation. Jacobi and Gauss Seidel Iteration Methods: Derivation of the Methods, Algorithms, Rate of Convergence, Comparison between Them and Implementation. [15 Lectures]

**Unit 4: Interpolation and Curve Fitting:** Interpolation by Lagrange, Interpolation by Newton, Divided Differences, Forward and Backward Difference Operators, Chebyshev Polynomial: Derivation, Algorithm and Implementation. Least Squares Method: Fitting a Straight Line, Derivation, Algorithm, and Implementation. [15 Lectures]

**Unit 5: Numerical Differentiation and Integrations, Solutions of ODEs:** Difference approximation of first derivative, Difference Approximation for Second Order Derivative, Newton Cotes Methods, Trapezoidal Rule, Simpson's 1/3 and 3/8 rule, Romberg integration Method, Solutions of ODEs with Picard , Taylor, Euler, Modified Euler, Runge - Kutta Method of order four: Derivation, Algorithm, Error Computation, Comparison to Each other and Implementation. [ 20 Lectures]

**Text books**


1. Wan Young Yang, Wenwu Cao, Tae-Sang Chung and John Morris *Applied Numerical Analysis with Mat Lab*., John Wieley and Sons. INC., Publication.
2. B. S. Grewal, Khanna ; *Numerical Methods in Engineering and Science*, Publishers India, 2013.

3. Burden, R.L. and Faires, J.D., *Numerical Analysis, Theory and Techniques*, Cengage Learning, India Edition, 2010.

**Reference books**

4. Curtis F. Gerald, Patrick O; *Applied Numerical Analysis,*. Wheately, Pearson.
5. Bansal, R.K, Goel, A.K and Sharma, M.K., MATLAB Its Applications on Engineering. Delhi, Pearson Education Inc.
6. Interactive MatLab Course (Hand Out).
7. Ajay Wadhwa, Numerical Analysis with Algorithms and Computer Programs in C++; PHI Learning Pvt. Ltd. New Delhi, 2012.

## Tribhuvan University

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

**Course Title:** Discrete Mathematics (Elective) **Full Marks:** 50
**Course No. :** MAT 304 **Pass Mark:** 17.5
**Level :** B.Sc. **Year:** III
**Nature of Course:** Theory **Period per week:** 5 Lecture Hrs.

**Course Objectives:** This course is designed for third year of Four years B.Sc. program as an elective subject. The course aims to familiarize students with the knowledge of graph theory. The basic purpose of this course is to enable students to understand and apply basic discrete mathematics techniques based on graph theory.

**Course Description:** This course deals with discrete mathematics basically focused to graph theory for undergraduate students as an elective course.

**Course Contents**

**Unit 1. Fundamentals:** Sets, Set Operations, Functions, Sequences and Summations, Cardinality of Sets, Matrices, Algorithms, Complexity of Algorithms. [15 Lectures]

**Unit 2. Relations:** Relations and Their Properties, *n*-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations , Partial Orderings. [15 Lectures]

**Unit 3. Graphs:** Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graph. [15 Lectures]

**Unit 4. Trees:** Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees [15 Lectures]

**Unit 5. Network Flows:**
Graphs as models of flow, Folws, Maximal Flows and Minimum Cuts, Maximum Flow-Min Cut Theorem. [15 Lectures]

**Text/References books**

1. Kenneth H. Rosen, *Discrete Mathematics and its Applications*, Tata McGraw-Hill Publishing company Limited, 7th Edition
2. Joe L. Mott, Abraham Kandel and Theodore P. Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*, Prentice-Hall of India, 2nd Edition

# Third Year

## Synoptic and Aviation Meteorology

Course Title: Synoptic and Aviation Meteorology

Course Number: MET 301 Full Marks: 100

Nature of Course: Theory Pass Mark: 35

**Course objectives:**

Synoptic and Aviation Meteorology course is designed to provide the students with depth knowledge on various aspects of aviation weather, weather analysis and forecasting.

**Course content**:

**Definition and scope of synoptic meteorology**: Synoptic scale, synoptic hours, surface weather map analysis 2 hrs

**Air mass**: Introduction, Area of formation and classification, Cold and warm air masses, Continental and maritime air masses, Air mass modification 8 hrs

**Fronts**: Introduction, properties and classification of fronts (warm, cold and stationary), Locations of front in different seasons, Atlantic ocean area, Pacific area, Front models and weather associated with it, Quasi-stationary front, Warm front, Cold front (slow and fast moving) front, Occluded front, Warm front occlusion, Cold front occlusion, Frontogenesis and frontolysis (derivation). 10 hrs

**Wind**: Global wind, Trade wind, Geostrophic and Gradient wind, Local wind (land breeze, sea breeze), the earth's heat energy balance, single and three cells models. 7 hrs

**Synoptic climatology of extra-tropics**: Introduction to the zonal index, Synoptic situation during high index period and low index period 2 hrs

**Extra tropical cyclone and anti-cyclone**: Polar front theory (life cycle), Cyclone energetic, Cloud and precipitation associated with it, Vertical structure, Movement, Polar continental highs, Subtropical anticyclone, Highs within the cyclone, Polar out-break high, Cut-off cyclone and anticyclone 10 hrs

**Monsoon**: Introduction- southwest monsoon and northeast monsoon, Differential heating theory, Migration of ITCZ, Monsoon vagaries: Onset of monsoon and its importance associated with it, Onset criteria, Trough and weather associated with it, Depression and its movement,

Break/active monsoon and its synoptic situation, Withdrawal of monsoon

14 hrs

**Northeast monsoon**: Low pressure area during northeast monsoon, Depressions and tropical storms, Easterly waves 5 hrs

**Western disturbances (WD)**: Introduction and formation, Synoptic situation during the formation of WD, Movement of WD and weather associated with it. 3 hrs

**Tropical storms**: Introduction, classification of the storm, Life cycle of the tropical storm: Formative stage, Immature stage, Mature stage and Decaying stage, Areas and frequencies of formation of tropical storm, Atlantic ocean, Pacific ocean and Indian ocean, Characteristics of tropical storm, Surface pressure: Surface Temperature distribution, Surface wind, Upper wind, Rainfall distribution, Eye, State of sea, Cloud, Motion of the tropical storm, Internal force, External force, Re-curvature and Satellite tracking, Forecasting of tropical storm, Statistical method, Persistence method, Climatological method, Numerical Weather Prediction of tropical storm 14 hrs

**Jet stream**: Introduction, Types of Jet stream (westerly and easterly jet stream), Wind structure, Thermal structure, Geographical areas of formation and seasonal variation, Clear Air Turbulence (CAT) in relation to jet stream and its importance in aviation, Low level turbulence: convective currents, obstruction to wind flow, wind shear. 12 hrs

**Thunderstorm**: Introduction, Cell, super cells, etc, Life cycle of thunderstorm, Formative stage, Immature stage, Mature stage, Decaying stage, Hazards associated with thunderstorm

8 hrs

**Norwesters**: Introduction, Types of norwester (A, B, C and D type), Norwesters in association with winter disturbances and pre-monsoon depression, Mechanism of formation and its synoptic features. 6 hrs

**Wind, Pressure and temperature**: Wind near earth's surface and in free atmosphere, wind shear, mountain winds, drainage winds and their impacts in aviation, Atmospheric pressure ,(.cte .HNQ ,FFQ ,EFQ) thgilf htiw pihsnoitaler sti dnaHeat exchange processes

of atmosphere, Dew point, dry bulb and wet bulb temperatures, saturation of air and humidity. 12 hrs

**Cloud and Visibility**: rehtaew ni elor sti dna areneg duolC, dna ytilibisiVfactors affecting visibility, latnemurtsnI dna (CMV) snoitidnoc lacigoloroetem lausiV (sepyT) goF ,(CMI) snoitidnoc lacigoloroetem 14 srh

**Turbulence** ,**Icing and aviation hazards**: Low level and high level turbulence (CAT), t emarfria ,ti htiw detaicossa ecnelubrut dna mrotsrednuhicing .sdrazah noitaiva dna 10 srh

**Meteorological services and flight planning** 1 hrs

**Meteorological Watch Office and flight documentations** 1 hrs

**World Area Forecasting System**: wind and temperature chart, Sigmet chart, air-met chart 3 hrs

**Text Books**

- Petterssen, Sverre, 1941: Introduction to Meteorology, Mc-Graw Hill Book Company Inc., New York and London
- Petterssen, Sverre, 1956: Weather analysis and forecasting. Vol I and II, Mc-Graw Hill Book Company Inc., New York.
- Herbart Riehl: Tropical Meteorology, 1954, Mc Graw Hill, New York

**Reference Books**

- Ramage, C. S., 1971: Monsoon Meteorology, Academic Press, NewYork
- Critchfield, H. J., 1974: General Climatology, Prentice-Hall
- Manual of Aviation Meteorology, Australia, Bureau of Meteorology.

# Mountain Meteorology

Course Title: Mountain Meteorology

Course Number: MET 303 Full Marks: 50

Nature of Course: Theory Pass Mark: 17.5

**Course objectives:**

Mountain Meteorology course is designed to provide the students in depth knowledge on various aspects of weather and climate of mountainous region.

**Course content**:

**Mountain Climates:** Factors that determine climate (latitude, altitude, continentality, regional circulation) 4 hrs

**Atmosphere:** Atmospheric Scales of motions and atmospheric composition, Pressure and wind, Clouds and fogs, mountain thunderstorm 12 hrs

**Mountain winds:** Anabatic and Katabatic wind, Terrain-forced flows (three factors that Affect Terrain-Forced Flows, Flow over Mountains, Flow around Mountains, Flow through gaps ,channels, and passes, Blocking, cold Air Damming, and Obstruction of air masses, On the high plains: The low-Level Jet) 14 hrs

**Diurnal Mountain Winds:** The Daily Cycle of Slope and Along-Valley (Winds and Temperature Structure, Modification of Diurnal Mountain Winds by Variations in the surface Energy Budget, Disturbances of the daily cycle by Larger Scale Flows, The Four Components of the Mountain wind system, Diurnal Mountain Winds in basins, Diurnal Mountain winds over Plateaus, Other Local Thermally Driven Wind systems) 16 hrs

**Precipitation and Orography:** Lifting mechanisms (Terrain-forced mechanisms and convective mechanisms); Orographic Precipitation (Seeder-Feeder mechanism, Upslope Condensation, Orographic Convection). 7 hrs

**Mountain Waves**: Waves (Atmospheric Waves, Gravity Waves, Standing Waves, Mountain Waves); Features (Introduction, Cap Clouds, The Vertically-Propagating Waves, Breaking Waves, Downslope winds, Rotors, Rotor Clouds and Trapped Lee Waves), Climatology (Location, Tropical Mountaiin Waves, Areal Extent of Mountain Waves, Time of Year, and Time of Day) 8 hrs

**Hydro-meteorological Data and Forecasting:** Hydro-meteorological measurements, Hydro-meteorological data processing, Concept and types of weather forecasting, Weather forecasting methods, Satellite in weather forecasting, Weather forecasting for mountaineering expedition. 14 hrs

**Text Book**

- C. David Whiteman, 2000: Mountain Meteorology, Fundamentals and applications, Oxford University Press

**Reference Books**

- Roger G. Barry, 2008: Mountain Weather and Climate, Cambridge University Press.
- J. F. Griffiths, Handbook of Agricultural Meteorology, 1994: New Work, Oxford University Press. Academic Publication.

## Micrometeorology

Course Title: Micrometeorology

Course Number: MET 304 Full Marks: 50

Nature of Course: Theory Pass Mark: 17.5

**Course objectives:** Micro meteorology course is designed to provide the students with depth knowledge on different aspects of energy balance on the various surface of the earth.

**Course content**

**General Introduction:** Introduction micrometeorology, definition of surface boundary layer, relation between micrometeorology and microclimatology, scope of micrometeorology.

5 hrs

**Radiation process:** Definition of spectrum of radiation, effect of temperature on radiation, Introduction of short wave radiation and long wave radiation, black body radiation, definition of albedo, radiation energy at the outer boundary of atmosphere, depletion of solar radiation in the atmosphere, scattering and diffusion process of radiation, Rayleigh law of scattering.

15 hrs

**All wave net radiation:** Calculation and measurement of long wave radiation on the earth surface, definition of emissivity, introduction of greenhouse effect, measurement of short wave radiation from the atmosphere, definition of net radiation, measurement of all wave net radiation, total heat balance on the Earth's surface, conversion of mass flux into energy flux.

15 hrs

**Ground heat flux and temperature:** Surface air temperature, temperature variation on the earth's surface, soil temperature, temperature gradient and rate of temperature variation, derivation of ground heat flux at land surface, conduction of heat flux into the soil layer and determination of soil conductivity, soil moisture and its measurement, surface moisture and its measurement, soil moisture saturation process, relative humidity and specific humidity.

10 hrs

**Evaporation:** Evaporation from the earth surface, estimation of evaporation, measurement of temperature and relative humidity, relation between relative humidity and saturation vapor pressure, daily, monthly and seasonal variation of evaporation.

10 hrs

**Stability criteria of atmosphere:** Stable and unstable conditions in atmosphere, wind flow near the earth's surface, viscosity and shearing stress, surface shearing stress, wind shear and drag coefficient, difference between dynamic and kinematic viscocity, turbulent layer of atmosphere, introduction of friction velocity and roughness length, vertical wind profile in the absence of buoyancy. 10 hrs

**Turbulent transfer of heat fluxes from the land surface:** The Monin-Obukhov Length and Richardson Number, Relation to determine Richardson Number and its application, turbulence in atmosphere, sensible and latent heat fluxes, the ratio of diffusivity, night time turbulent heat fluxes, measurement of temperature and water vapor fluctuation.

10 hrs

**Text Book**

- Ronald B. Stull, 1988: An Introduction to Boundary Layer Meteorology, Kluwer

**Reference Books**

- J. F. Griffiths, Handbook of Agricultural Meteorology, 1994: New Work, Oxford University Press. Academic Publication.

- R. E. Munn, 1966: Descriptive Micrometeorology, Academic Press.

## Weather Analysis and Forecasting Practical

**Course Title:** Weather Analysis and Forecasting

**Course Number:** MET 302 Full Marks: 50

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

Practical 1: Surface coding and decoding

Practical 2: Surface map plotting and analysis

Practical 3: Upper air coding and decoding

Practical 4: METAR, SPECI, TAF, SIGMET

Practical 5: Preparation of Synoptic weather chart of different pressure level for specific cases

a) Just before the onset of monsoon
b) Severe thunderstorm case
c) During the peak of monsoon
d) During dry winter
e) During westerly disturbances

Practical 6: Collection of Satellite images (IR, visible and water vapor) for cloud pictures of same cases as of no 5.

# MICROBIOLOGY

## Molecular Cell Biology

### Description of the Course

**Course Title:** Molecular Cell Biology
**Course No:** MB 301 (Major)
**Nature of the Course**: Theory

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

### Course Objectives

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

a) understand how cell evolved and different organelles of the cell
b) understand role and importance of inter and intra cellular transport in cell
c) understand the concept of cell communication, its significance and importance
d) know the importance of cytoskeleton for the integrity of cell and its dynamic nature

### Course Contents

**An overview of cells** **5hrs**

Origin of life on Earth: import of life through meteorites, theory of chemical evolution, primitive earth conditions: anoxic reductive atmosphere, evolution of biomolecules to cell, evolution of prokaryotic cell, evolution of cellular organelles and eukaryotic cells

**Cell structure and function** **25hrs**

Introduction to cytoplasmic organelles and cytoskeleton: protoplasm, mitochondria, chloroplast, endoplasmic reticulum, golgi complex, lysosome, endosome, ribosome, centriole, microbodies: peroxisomes and glyoxisomes, flagella, cilia, cell wall, extracellular matrix

**Nucleus** **15 hrs**

Chromosomes, chromatin and nucleosome, chromosome structure in bacteria and eukaryotes, centromere, telomere, hetero and euchromatin, nucleosome model and radial-loop scaffold model

**Membrane structure and transport** **20hrs**

Models of membrane structure, membrane lipids, proteins and carbohydrates and their functions, fluidity of membrane, lipid raft, membrane electric potential, transport across cell membranes: diffusion of small molecules across phospholipid bilayers, uniporter catalyzed transport, cotransport by symporters and antiporters, active transport by ATP powered pumps

**Structure and organization of actin filaments** **12hrs**

Actin cytoskeleton, dynamics of actin assembly, myosin: the actin motor protein, actin and myosin in nonmuscle cells, cell locomotion

**The microtubule cytoskeleton** **18hrs**

Microtubule structures, components of microtubules and dynamics of microtubule assembly, associated proteins, kinesin, dynein, and intracellular transport, cilia and flagella movement, motor proteins during mitosis, microfilaments, intermediate filaments

**Intracellular transport** **15hrs**

Transport of molecules between nucleus, mitochondria, chloroplast and other cell organelles, vesicular transport: transport from ER to cell organelles; transport across plasma membrane: endocytosis (phagocytosis, pinocytosis, receptor mediated endocytosis) and exocytosis

**Cell signaling** **25hrs**

Signaling molecules and their receptors (extracellular and intercellular signaling molecules, ligands and receptors), local and long distance signaling, pathways of intracellular signal transduction, types of extracellular signaling processes, Intracellular second messengers with examples (cyclic nucleotides, phospholipids, calcium and protein kinases as elements of signal transduction), third messengers (DNA binding proteins) and role of signaling molecules in gene activation, interaction and regulation of signaling pathways as related to G-Protein coupled receptor signaling mechanisms, receptor tyrosine kinase based signaling mechanisms, receptor guanylyl cyclase based signaling mechanisms, Gated ion channel based signaling mechanisms, Adhesion receptor based signaling mechanisms

**The cell cycle** **15hrs**

Regulating eukaryotic cell cycle, cyclin dependant kinase regulation during mitosis, check points in cell cycle regulation, components of cell cycle control system: intracellular and extra-cellular control of cell division, mitosis and meiosis, programmed cell death (apoptosis), intrinsic and extrinsic pathways of cell death, apoptosis in relation with cancer and viral disease (AIDS), stem cells, embryonic stem cells and therapeutic cloning

## Recommended Readings

**Text books**


1. Lodish H, Berk A, Matsudaira P, Kaiser C, Krieger M, Scott M, Zipursky L and Darnell J (2003). Molecular Cell Biology, 5th Edition. W.H Freeman and Company.
2. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2002). Molecular Biology of the Cell, 4thEdition. New York: Garland Science.

# Molecular Cell Biology Practical

## Description of the Course

**Course Title:** Molecular Cell Biology Practical
**Course No:** MB 302 (Major)
**Nature of the Course**: Practical

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

## Course Objectives

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

a) develop skills in cell counting, be able to isolate cell organelles and analyze basic cellular activity

## Course Contents

**To perform differential centrifugation for separation of different cell organelles**

**To isolate mitochondria from different samples**

**To perform cell counting using haemocytometer**

**To perform lysis of cell using different techniques**

**Selective permeability of membrane (artificial membrane: cellophane)**

**Analysis of sub-cellular fraction:** Mitochondria by measuring succinate dehydrogenase activity, lysosomal fraction by protease activity

**Isolation of chloroplast from leafy vegetables (e.g. spinach, mustard, lettuce)**

**Extraction of brain lipid**

**Quantitative analysis of lipid classes by TLC**

**DNA extraction from eukaryotic and prokaryotic cells**

# Pharmaceutical Microbiology and Quality Management

## Description of the Course

**Course Title:** Pharmaceutical Microbiology and Quality Management
**Course No:** MB 303 (Elective I)
**Nature of the Course**: Theory

**Full Marks**: 50
**Pass Marks**: 17.5
**Year**: III
**Total Lecture Hours:** 75

## Course Objectives

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

a) understand applications of microbiology and quality control systems in pharmaceutical and food industries

## Course Contents

**Introduction of pharmaceutical microbiology** **5 hrs**

Definition, scope, objectives, application of microorganisms in pharmaceutical science

**Antimicrobial agents** **15 hrs**

Definition, sources, types, target and mode of action of antibiotics, antiviral, antiparasitic and antifungal drugs, drugs in combination

**Quality evaluation of pharmaceutical products** **15 hrs**

Bioassays, chemical assays, immunoassay of antibiotics, quality evaluation of disinfectants, antiseptics and preservatives

**Microbial spoilage and preservation of pharmaceutical products** **15 hrs**

Types of spoilage, factors affecting microbial spoilage, preservation of pharmaceutical products, physical, chemical and biological indicators of sterilization, principles and methods of sterility testing

**Quality assurance and quality management** **20 hrs**

Principles of quality risk management, quality risk management process, risk assessment, risk control and communication, risk management methodology and tools, hazard analysis and critical control points (HACCP), quality risk management for facilities, equipment and utilities, good hygiene practices (GHP), good manufacturing practices (GMP), good laboratory practices (GLP), quality management systems - ISO9001, ISO 22000, safety and quality auditing of the food and pharmaceutical products, quality assurance

**Food safety and consumer protection** **5 hrs**

Microbiological hazards, chemical hazards, food adulteration, genetically modified organisms and novel foods, sanitary and phytosanitary measures

## Recommended Readings

**Text books**


1. Denyer SP, Hodges NA and Gorman SP (Eds) (2004). Hugo and Russell's Pharmaceutical Microbiology, 7th Edition, Blackwell Science Ltd.
2. WHO (2007). Quality Assurance of Pharmaceuticals, Volume 2, 2nd Edition.


**Reference books**


1. Tripathi KD (2009). Essentials of Medical Pharmacology, 6th Edition, Jaypee Brothers, New-Delhi
2. Laurence DR, Bennette PN and Brown MJ (1997). Clinical Pharmacology, 8th Edition, Churchill Livingstone
3. US Pharmacopia
4. British Pharmacopia


# Bioinformatics

## Description of the Course

**Course Title:** Bioinformatics
**Course No:** MB 304 (Elective II)
**Nature of the Course**: Theory

**Full Marks**: 50
**Pass Marks**: 17.5
**Year**: III
**Total Lecture Hours:** 75

## Course Objectives

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

a) understand the principles and applications of bioinformatics in microbiological research

## Course Contents

**History, scope and importance of bioinformatics** **5 hrs**

Definition, contribution in bioinformatics, aims and tasks of bioinformatics, applications of bioinformatics, challenges and opportunities in bioinformatics

**Internet, World Wide Web and NCBI in bioinformatics** **5 hrs**

Computer programs and operating systems for bioinformatics, world wide web pages and websites, browsers, EMBnet and SRS, Sequence retrieval system, NCBI, Entrez, Data model, basic sites of bioinformatics

**DNA and protein sequencing and analysis** **15 hrs**

Genomics and proteomics, approaches to genome sequencing, genome mapping, DNA sequencing, ORF, CDS, determining sequence of a clone, expressed sequence tags, protein sequencing, determination of protein structure, gene and protein expression analysis, gene finding databases and accession sites, capturing expression profile, human genome project, benefits of genome research

**Databases, tools and their uses** **15 hrs**

Definition, importance of databases, types of databases, classification, database entries, sequence formats, database record, database management system, relational database management system, structured query language, data mining and knowledge discovery, nucleic acid sequence databases (EMBL, DDBJ, genebank, GSDB, Ensembl, specialized genomic resources, protein sequence databases, PIR databases, SWISS-PROT, TrEMBL, NRL-3D, Structure classification database (SCOP, CATH, DALI, CE, NDB, CSD, BMRB, 3Dee, FSSP, MMDB, CDD, Rasmol database), secondary databases (PROSITE, PRINTS, BLOCKS, HMMs, IDENTIFY, KEGG, MEDLINE databases), Specialized analysis packages (GCG package, EGCG package, staden package, lasergene package, sequencher package, vector NTI package, Macvector package), DALI program, uses of databases

**Sequence alignment** **15 hrs**

Algorithm, genetic algorithm, goals and types of alignment, study of similarities, high and low scoring matches, scoring mutations, deletions and substitutions, sequence alignment methods (dot matrix, dynamic programming, k-tuple, FASTA, BLAST, multiple sequence alignment, automatic alignment-CLUSTAL, CINEMA), algorithms for identifying domains within a protein structure, algorithms for structural comparisons, sequence search

**Predictive methods using DNA and protein sequences** **10 hrs**

Gene prediction strategies, prediction of RNA secondary structures, gene prediction programs, protein prediction strategies and methods, prediction of secondary structure of protein, comparative modeling, threading, protein function prediction, protein prediction programs, molecular visualization

**Homology, phylogeny, evolutionary trees and pharmainformatics** **10 hrs**

Definition of homology and similarity, orthologs, paralogs, xenologs, study of orthologous and paralogous proteins, modular proteins, phylogeny and relationships, evolutionary tree, approaches used in phylogenetic analysis, steps in phylogenetic analysis, phylogenetic trees, tree building methods, molecular approaches to phylogeny, phylogenetic analysis databases, definition of pharmainformatics, chemical libraries, search programs, docking algorithms, active site analysis, QSAR

## Recommended Readings

**Text books**

1. Ignacimuthu S. Basic Bioinformatics. Alpha Science International Ltd, UK.

2. Campbell AM and Heyer LJ (2007). Discovering Genomics, Proteomics and Bioinformatics (2nd Edition). Benjamin Cummings; CSH Press, Newyork.

**Reference books**

1. Pevsner J (2009). Bioinformatics and Functional Genomics (2nd Edition). Wiley Blackwell.
2. Mount DW (2004). Bioinformatics- Sequence and Genome Analysis (2nd Revised Edition). Cold Spring Harbor Laboratory Press, USA.

# B.Sc. THIRD YEAR

## Mathematical Physics and Classical Mechanics

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

**Course Title:** (**Mathematical Physics and Classical Mechanics**) **Year:** III
**Full Marks:** 100 **Pass Marks:** 35
**Course No.:** PHY301 **Nature of Course:** Theory

**Course Objectives:**

At the end of this course the student should be able to acquire sufficient knowledge in mathematical physics and classical mechanics and apply this knowledge for higher studies and research in physics.

## MATHEMATICAL PHYSICS (60%) [96 hours]

1. **Vector analysis: 1.1** Scalar and vector fields, 1.2 law of transformation of vectors, polar and axial vectors, solenoidal vectors, rotational and irrotational vectors, vortex lines, 1.3 Curvilinear coordinates: direction cosines, scale factors, curvature of co-ordinate lines, volume element, rotation of axes, contravarient and covariant vectors, 1.4 Gradient, divergence, curl and Laplacian in curvilinear co-ordinates, 1.5 Special orthogonal curvilinear coordinates: cylindrical, spherical, ellipsoidal, hyperbolic and parabolic co-ordinates [20 hours]
2. **Tensor analysis: 2.1** Contravariant, covariant and mixed tensors, 2.2 Kronecker delta, tensors of rank greater than two, scalars or invariants, 2.3 Tensor fields, symmetric and skew symmetric tensors, fundamental operations with tensors, stress tensor, 2.4 Line element and matric tensor, reciprocal tensors, associated tensors, length of a vector, angle between vectors, physical components, 2.5 Christoffel's symbols, transformation laws of Christoffel's symbols, geodesics, covariant derivatives, 2.6 Tensor form of gradient, divergence, curl and Laplacian [20 hours]
3. **Linear vector spaces: 3.1** Vectors in n-dimensions, linear independence, inner product, 3.2 Schwartz inequality, 3.3 Representation of vectors and linear operators with respect to a basis, change of basis, 3.4 Schmidt orthogonalization process, 3.5 Linear operators and their matrix representation: symmetric, Hermitian, orthogonal, unitary (normal) matrices, 3.5 Determination of eigen values and eigen vectors of the matrix, diagonalization [18 hours]

4. **Fourier series and transforms: 4.1** Fourier series representation, even and odd functions, 4.2 Fourier series expansion of square, triangular, saw-tooth waves and out put of full wave rectifier, 4.3 Complex representation of Fourier series, 4.4 Dirac delta function, 4.5 Parseval relation, 4.6 Fourier transform and convolution theorem, 4.7 Laplace transform, Laplace transform of derivatives and integrals, 4.8 Use of Fourier and Laplace transform in solving partial differential equations. [18 hours]
5. **Differential equations: 5.1** Series solutions of Bassels's, Legendre's, Hermite's, Laguerre's differential equations, 5.2 Rodrigue's formula, Recurrence relations, associated Legendre and Laguerre polynomials, orthogonality and generating functions [10 hours]
6. **Partial differential equations: 6.1** Wave equations, Laplace, Poisson and diffusion equations, boundary value problems, 6.2 Method of separation of variables [10 hours]

## CLASSICAL MECHANICS (40%) [64 hours]

7. **Motion in Central Field**: 7.1 Motion in central force field, motion in arbitrary potential field, equation of orbits, 7.2 Kepler's laws of planetary motion [6 hours]
8. **Elastic and Inelastic Collision**: 8.1 Collision of particles, collision in laboratory and center of mass systems, cross section, 8.2 Rutherford scattering [6 hours]
9. **Elementary Principles: 9.1** Constraints, 9.2 Generalized coordinates, generalized displacement, generalized velocity, generalized acceleration, generalized momentum, generalized force and generalized potential, 9.3 D'Alembert's principle and Lagrange's equations [10 hours]
10. **Variational Principles and Lagrange's Equations: 10.1** Calculus of variations: Geodesics, Minimum surface of revolution, The brachistochrone problem, 10.2 Hamilton's principle and derivation of Lagrange's equation, Extension of Hamilton's principle to nonholonomic systems (Method of Lagrange undetermined multipliers), 10.3 Conservation theorems and symmetry properties, 10.4 Energy function and the conservation of energy [12 hours]
11. **Inertial Frames**: 11.1 Moving co-ordinate system, translating and rotating co-ordinate systems, 11.2 Coriolis force, Foucault pendulum [6 hours]
12. **Motion of Rigid Bodies**: 12.1 Motion of rigid body, 12.2 Euler's theorem, angular momentum and kinetic energy, the inertia tensor, 12.3 Euler's equation of motion, torque free motion, Eulerian angle, symmetrical top [10 hours]
13. **Relativity: 13.1** Gallilean invariance, inertial frames of reference, 13.2 Gallilean transformations, non-inertial frames and fictitious forces, 13.3 Michelson-Morley experiment, 13.4 Lorentz transformation, length contraction, time dilation, transformation and addition of velocities, variation of mass with velocity, 13.5 Mass energy relation, 13.6 relation between momentum and energy, 13.7 transformation of energy and momentum. [10 hours]

**Text Books:**

1. *Mathew, J. & Walker, R*. - **Mathematical Methods in Physics**, Benjamin Menlo Park, Second Edition (1970)

2. *Spiegel, Murray R.* - **Vector Analysis (Schaum Series)**, McGraw Hill, London (1992)

3. *Harper C.* - **Introduction to Mathematical Physics**, Prentice Hall of India Pvt. Ltd. (1990)

4. *Goldstein Herbert, Poole Charles and Safko John* - **Classical Mechanics;** Addison-Wisley (2002)

5. *Mathur D. S.* - **Mechanics**; S. Chand & Company Ltd., New Delhi, (2008)

6. *Murugeshan R. and Sivaprasad K.* - **Modern Physics**, S. Chand & Co. Ltd. New Delhi, (2007)

**References:**

1. *Gupta B. D*.- **Mathematical Physics***,* Vikas Pub. House Pvt. Ltd., India (1994)

2. *Rajput B. S.*- **Elementary Mathematical Physics***,* Pragati Prakashan, India (1997)

3. *Arfken G.*- **Mathematical Methods for Physicists***,* Academic Press, New York (1970)

4. *Margenau H. and Murphy G. M.* - **The Mathematics of Physics and Chemistry***,* Krieger, New York, (1976)

5. *Pipes L. A.* - **Applied Mathematics for Engineers and Physicists**, McGraw-Hill (1970)

6. *Hinchey F. A***.**- **Vectors and Tensors for Engineers and Scientists***,* Wiley Eastern (1976)

7. *Joshi W.* - **Matrices and Tensors in Physics***,* Wiley Eastern (1995)

8. *Takwale R. G. and Puranik P. S.* - **Introduction to Classical Mechanics**, Tata McGraw-Hill (1979)

9. *Kibble T. W. B. and Berkshire F. H.* - **Classical Mechanics**, Prentice Hall (1996)

10. *Waghmare Y. R.* - **Classical Mechanics**; Prentice Hall of India Pvt. Ltd, New Delhi, (1990)

## Tribhuvan University
## Institute of Science and Technology
## Physics Subject Committee
## Central Department of Physics

| | |
|---|---|
| **Course Title:** Physics Laboratory | **Year: III** |
| **Course Code:** PHY302 | **Full Marks:** 50 |
| **Nature of Course:** Practical | **Pass Marks:** 20 |

**Course Description:**

Physics Laboratory (General) Practical course consists of three sections: (a) Modern Physics Experiments, (b) Optical Experiments, (c) Nuclear Experiments, and (d) Electronic 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 third 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.

## PHYSICS THIRD YEAR LAB WORKS [180 hours]

1. Calibrate the experimental set-up of photoelectric effect using yellow filter, standard value of planck's constant and work function of the given photocell. Find calibration factor.
2. Study photoelectric effect and estimate the value of Planck's constant using various color filters.
3. Study photoelectric effect and find the wavelength of the unknown color filters using calculated value of planck's constant *h*.

4. Use the measured dataset of photoelectric effect and calculate the standard deviation, standard error and probable error with significant figures. Generate theoretical data using photoelectric equation for given filters and photocell. Test how well the measured data agrees with the theoretical data in this experiment. Show the trend of measured and theoretical data in a graph and interpret it.
5. Study the activity of given $\gamma$-radioactive source using GM counter. Show that the gamma rays obey inverse square law.
6. Study the absorption of gamma rays by the given absorber and GM counter. Find the value of linear absorption coefficient.
7. Use measured dataset of the experiments 6, calculate the standard deviation for each absorber material, and then standard error and probable error with significant figures. Generate theoretical data using radioactive equation and study the differences in the measured and theoretical data.
8. Use the method of least square, draw the best straight line through a set of measured data in the experiment 6 with error bar and find the error in slope and intercept.
9. To study the level of natural background radiation at the laboratory in the given condition.
10. To study the level of natural background radiation in the outdoor field in all directions (east, west, north, south, up and down) in the given condition.
11. Use the dataset of experiment 10 and find the standard error in all directions separately. Compile this database in a single set and make a histogram showing Gaussian like distribution. Interpret the result.
12. To study the Michelson Interferometer to determine the wavelength of monochromatic light.
13. To use the microwave source for studying the phenomenon of (a) Refraction, (b) Interference, (c) Diffraction, and (d) Polarization.
14. To study the band gap of semiconductor using leakage current method.
15. Study the working of fine beam tube for the determination of the specific charge of an electron.

16. Study the functioning of Earth inductor and determine the dip using it.
17. Study the working of CRT for the determination of specific charge of electron.
18. To estimate the current gain (β) in a Common-Emitter Configuration.
19. Construct CE amplifier and determine the voltage gain of the amplifier with phase relation.
20. Construct CC amplifier and determine the voltage gain, input and output impedance with phase relation.
21. Construct CS amplifier and determine the voltage gain of the amplifier with phase relation.
22. Study the characteristic of inverting and non-inverting operational amplifier (Using IC).
23. To study operational amplifier for integrator (Using IC).
24. To study operational amplifier for differentiator (Using IC).
25. To study the working of half-adder and half-subtractor circuit.
26. Design and constructs the 1-bit digital comparator.
27. To study the astable multivibrator by using transistors and find its frequency and duty cycle.
28. To study the characteristics of phase shift oscillator.
29. To study the drain and transfer characteristics of junction field effect transistor (JFET).
30. To study the characteristics of uni-junction transistor.

**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 periods laboratory work twice a week to complete both PHY302 lab works.
2. PHY302 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% |

# ELECTIVE PAPERS

## Applied Mathematics

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

| | |
|---|---|
| **Course Title:** Applied Mathematics | **Year:** III |
| **Full Marks:** 50 | **Pass Marks:** 17.5 |
| **Nature of Course:** Theory(Elective) | **Course No.:** PHY304 |

**Course Objectives:**

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

## APPLIED MATHEMATICS [80 hours]

1. **Applications of differential equation:** 1.1 Differential equation of particle dynamics 1.2 Differential equation of electric circuit theory 1.3 Differential equation in nuclear physics 1.4 Differential equation in geometry 1.5 Elimination of arbitrary constant from a functional relation 1.6 Determination of arbitrary constants – initial and boundary value problems 1.7 Problems leading to first order equation with the variable separable 1.8 Problem leading to first order linear equations 1.9 Dynamical problem leading to ordinary linear differential equations 1.10 The damped harmonic oscillators: free vibrations 1.11 Systems of several masses 1.12 Geared systems [20 hours]
2. **Electric circuit theory:** 2.1 Electrical networks 2.2 Mechanical analogies 2.3 Steady state theory: Impedance 2.4 Filter circuits – variation of impedance with frequencies 2.5 Oscillator circuit: stability 2.6 Impulsive motion [10 hours]
3. **Particle dynamics:** 3.1 Function of position 3.2 Function of velocity 3.3 Non-linear problem in electric circuit theory 3.4 Oscillation of non-linear systems 3.5 Relaxation oscillation 3.6 Motion in two or more dimensions 3.7 Motion on a fixed plane curve 3.8 Central Forces 3.9 Motion of a particles whose mass varies [15 hours]

4. **Rigid dynamics:** 4.1 moments and products of inertia 4.2 Fundamental equations 4.3 Motion about a fixed axis 4.4 Motion in two-dimension 4.5 Problems of rolling and sliding 4.6 Impulsive motion 4.7 The gyrostat [15 hours]
5. **Applications of Fourier series:** 5.1 Fourier series in electric circuit theory 5.2 Fourier series in mechanical problems 5.3 Fourier series in boundary value problems 5.4 Double and multiple Fourier series 5.5 Fourier transforms: applications [10 hours]
6. **Applications of partial differential equations:** 6.1 The wave equation in one-dimension: simple solutions 6.2 The equations for the uniform transmission line 6.3 The Laplace equation in two dimensions 6.4 The use of Fourier series 6.5 The use of Laplace transformation 6.6 The use of conformal representation 6.7 Equation of continuity [10 hours]

**Text Book:**


1. *Jaeger J. C.* - **Introduction to Applied Mathematics**, Second Edition, Oxford University Press (1974)


**Reference Books:**


1. *Nearing J.* - **Mathematical tools for physics**, First Edition, University of Miami (2003)

2. *Mulholland H. & Phillips J. H. G***. - Applied Mathematics for Advanced level**, Butterworth & Co. Ltd (1969)

3. *Potter M. C. & Goldberg J*. - **Mathematical Methods**, Second Edition, Prentice Hall of India Pvt Ltd. (2000)

# ELECTIVE PAPERS

## Space Science

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

| | |
|---|---|
| **Course Title:** Space Science | **Year:** III |
| **Full Marks:** 50 | **Pass Marks:** 17.5 |
| **Nature of Course:** Theory / Elective | **Course No.:** PHY305 |

**Course Objectives**

At the end of this course the student should be able to acquire fundamental knowledge of space related science and technology and to apply it in the higher studies and research in physics

## SPACE SCIENCE [80 hours]

1. **Space Systems:** 1.1 Basic of orbital Mechanics 1.2 Concepts of orbits – propulsion 1.3 Aerodynamics, navigation, guidance and control systems 1.4 History and developments of Manned and Unmanned Space travel 1.5 Rocket launch technology [10 hours]
2. **Physics of Remote Sensing:** 2.1 Introduction – Electromagnetic Spectrum 2.2 Effects of Atmosphere – Fundamentals of Radiometry 2.3 Spectral Reflectance 2.4 Physical basis of signatures 2.5 Data Acquisition: Remote sensors 2.6 Optical-infrared sensors 2.7 Microwave 2.8 Geographical Information System: Components of GIS – Map Projections – Spatial and Non-Spatial data – Data model and input – data analysis and output 2.9 Remote Sensing Applications: Agriculture – forestry – land use / land cover mapping – water resources – snow and glacier – wetland management [15 hours]
3. **Earth System:** 3.1 Components of Earth System -- Atmosphere – Hydrosphere – Cryosphere – Lithosphere – Biosphere 3.2 Earth crust and Mantle. 3.3 Climate System – Feedback processes in Climate System – concept of feedback 3.4 Applications of feedback to the climate system. 3.5 Equations for the Atmosphere and Oceans 3.6 Equation of Continuity 3.7 Equations of Motion 3.8 Thermodynamic Energy Equation 3.8 Equation of state 3.9 Hydrological Cycle in the Earth System; 3.10 Carbon Cycle in the Earth System; 3.11 Oxygen in the Earth System [20 hours]
4. **Astronomy:** 4.1 Solar system 4.2 Comets and Asteroids 4.3 Exoplanets 4.4 Types and Population of stars 4.5 Magnitudes – apparent and absolute 4.6 Distance-magnitude relation 4.6 Extinction, 4.7 Hydrodynamic equilibrium 4.8 Linear Stellar

Model 4.9 Gaseous Nebulae 4.10 Dust clouds & Molecular Clouds 4.11 HR diagram 4.12 Stellar nucleosynthesis 4.12 Stellar spectra 4.13 Telescopes and Detectors at various wavelengths. [20 hours]

5. **Space Dynamics:** 5.1 Virial theorem and gravitational collapse 5.2 Thermodynamics: Heating and Cooling of gas 5.3 Ionization and Thermal equilibrium, 5.4 HII regions 5.5 Mechanical and Radiative Equilibrium 5.6 Evolution of the Universe: Hubble's law 5.7 Primordial nucleosynthesis 5.8 Cosmic background radiation 5.9 Galaxy rotation curve 5.10 Need for Dark Energy. [15 hours]

**Text Books:**


1. *Hale, F. J*.- **Introduction to Space Flight**, Prentice Hall (1994).

2. *Joseph G.* - **Fundamentals of Remote Sensing,** Second Edition, Universities Press (2005)

3. *Wallace J. M. and Hobbs P. V.* - **Atmospheric Science**, An Introductory Survey, International Geophysical Series (2006)

4. *Carroll B W & Ostlie D A* - **An Introduction to Modern Astrophysics**, Latest Edition, Addison-Wesley.


**Reference Books:**


1. *Wertz, J. R. and Larson, W. J.* (eds.) - **Space Mission Analysis and Design**, Microcosm Press (2006).

2. *Campbell J.B .*- **Introduction to Remote Sensing**, Fourth Edition, The Guilford Press (2008)

3. *Sparke and Gallaghar* - **Galaxies in the Universe: An Introduction**, Latest Edition, Cambridge University Press (2007)

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

Level: B.Sc.
Year: III
Course Title: Probability and Inference-II
Course Code: STA 301 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:** To impart theoretical and applied knowledge in probability distributions; convergence, inequalities and limit theorems; and statistical inference including decision theory and sequential analysis

## Group A

### 1. Continuous Distributions: [30]

- Logistic distribution: PDF, CDF, standard logistic distribution, MGF, properties and uses, distribution fitting
- Lognormal distribution: PDF, CDF, MGF (does not exist for whole range), properties and uses, distribution fitting
- Weibull distribution: PDF, CDF, MGF, CF, moments, properties and uses
- Inverse uniform, Inverse gamma, inverse chi-square distribution (concept and applications only)
- Problems and illustrative examples

### 2. Truncated Distributions: [20]

- Meaning of truncation, left, right and doubly truncations, truncated probability distributions: Binomial (with derivation), Poisson (with derivation), normal distributions (without derivation): their mass/density functions, moments, distribution fittings
- Problems and illustrative examples

### 3 Convergence, Inequalities and Limit Theorems [25]

- **Convergence:** Modes of convergence, convergence in probability, convergence in $r^{th}$ mean, convergence in distribution and almost sure convergence
- **Inequalities:** Chebyshev, Minkowisky, Holder, Cauchy-Schwartz, Markov and Kolmogorov

- **Limit Theorems:** Law of large numbers: weak law of large numbers and Khinchine's theorem, strong law of large numbers (statement only) and Kolmogorov's theorem, central limit theorem for independently and identically distributed random variables (Lindeberg-Levy)
- Problems and illustrative examples

**Group B**

**4. Testing of Hypothesis** **[20]**

- Uniformly most Powerful(UMP) test
- Uniformly Most Powerful(UMP) test via Neyman Pearson's Lemma
- Monotonic likelihood ratio properties
- Likelihood Ratio (LR) test, one sample problem, likelihood ratio test for mean in a normal population when variance is known and variance is unknown
- Likelihood ratio test for the variance of a normal population
- Properties of likelihood ratio test
- Problems and illustrative examples

## 5. Decision Theory [30]

- Basic idea on decision theory
- Essential elements of decision making environment
- Loss function, risk function, minimax, maximax and maximin decision rule
- Prior and posterior distributions, Bayes risk, simple problems based on Bayes estimation and testing of hypothesis
- Problems and illustrative examples

## 6. Sequential Analysis [25]

- Sequential Probability Ratio Test (SPRT): Definition, derivation of SPRT for testing parameters of binomial and normal distributions, properties of SPRT
- Fundamental identity of Wald's operating characteristic (OC) and average sample number (ASN) functions, or sequential estimation, graphical procedure in sequential tests
- Problems and illustrative examples

**References:**


1. Rohatgi V. K. and Ehsanes Saleh, A. K. MD (2005). *An Introduction to Probability and Statistics*, John Wiley & Sons
2. Shrestha H. B. (2006). *Statistics and Probability: Concepts and Techniques*, Second Edition, EKTA Books
3. Gupta S. C. and Kapoor V. K. (2007). *Fundamentals of Mathematical Statistics*, Sultan Chand and 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. Kale, B.K (1999). *A First course of Parametric Inference*, Narosa Publishing House
9. Wald, A.(1982). *Sequential Analysis*, John Wiley, New york
10. H.J Larson, *Introduction to Probability theory and Statistical Inference*, Wiley International Edition, N.Y.
11. Nitis Mukhopadhyay (2000). *Probability and Statistical Inference*, CRC Press Taylor & Francis Group

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

Level: B.Sc.
Year: III
Course Title: Probability and Inference-II
Course Code: STA 302 Full Marks: 50
Nature of the Course: Practical Pass Marks: 20
Total Number of Periods: 180

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**Pre-requisites:** Sound knowledge in the topics of Probability and Inference-II

**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 | Continuous probability distributions (Logistic, lognormal and weibul ) | 4 |
| 2 | Truncated distributions (left and right truncation, Poisson and normal) | 4 |
| 3 | Convergence and Limit Theorems (Law of large numbers, inequalities and central limit theorem) | 5 |
| 4 | Problems in testing of hypothesis | 4 |
| 5 | Loss function, risk function and decision criteria | 2 |
| 6 | Prior and posterior distributions, Bayesian estimation and testing of hypothesis | 2 |
| 7 | Sequential probability ratio test | 2 |
| 8 | Operating characteristic curve and average sample number | 2 |
| | **Total number of practical problems** | **25** |

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

Level: B.Sc.
Year: III
Course Title: Economic Statistics (Elective Course)
Course Code: STA 303 Full Marks: 50
Nature of the Course: Theory Pass Marks:17.5
Total Number of Periods: 75

**Course objectives:**
After the completion of this course students will be able to i) to understand the knowledge about the economic indicators and their computation and ii) to have the knowledge of Index number and Time Series Analysis and their applications.

**A. Development Economics and Economic Measures [50]**

- **Concept of Statistics in Economics.** Definition of some useful economic terms: micro & macroeconomics, demand & supply, consumption, value added, trade, labor force, output, shadow price, opportunity cost.
- **Development Indices& their components**: Human Development Index (HDI), Gender Development Index GDI, Human Poverty Index HPI. Millennium Development Goal.
- **System of National Account**: accounting systems(current, accumulation & Balance Sheet), Gross Development Production(GDP), GDP deflator & calculation of growth rate, ISIC classification. Primary, secondary & tertiary sector. Gross National Income(GNI). Gross National Expenditure, Capital stock and National wealth, nominal and real values.
- **Estimation of National Income**: Product Approach, Income Approach, Expenditure Approach.
- **Consumption**: consumption quintiles& percapita consumption, consumption basket and approaches, calculation of CPI and use.
- **Income Inequality & Poverty measures**: concept, calculation of Ginni Coefficient, Poverty Line, Poverty Gap, Intensity of Poverty, Combined Measures. Concept of social welfare-Kakwani's,Theil's & Sen's index.
- Numerical exercises

**B. Index Numbers [10]**

- Introduction, definition and meaning
- Points to be considered in construction of index numbers.

- Simple and weighted index numbers.
- Laspeyre's, Passche's and Fisher's index numbers.
- Time reversal test and factor reversal test
- Cost of living index number
- Base shifting, inflation and deflation
- Description of the Nepalese Economics Data produced by Nepal Rastra Bank, Central Bureau of Statistics (CBS), Finance Ministry.
- Numerical exercises

**C. Time Series Analysis [15]**

- Introduction, definition and meaning
- Importance of time series analysis in economics data
- Components of time series: (i) secular trend (ii) short term fluctuations seasonal variation and cyclic variation (iii) random or irregular movement
- Mathematical models for time series: Additive and multiplicative models, methods of measuring trend: (i) graphic method, (ii) semi average method (iii) moving average method, (iv) least square method; prediction using least square method using linear trend
- Measurement of seasonal variation: (i) method of simple average (ii) ratio to trend method (iii) ratio to moving average method (iv) link relative method
- Deseasonalizing the time series data (description and computation), measurement of cyclic fluctuation
- Numerical exercises

**References:**


1. Enrico Giovanini (2008). *Understanding Economic Statistics*, OECD press (http://www.oecd.org/statistics/understandingeconomicstatistics)
2. *Economic Survey*, Ministry of Finance, Nepal
3. केन्द्रीयतथ्यांक विभाग(२०६६): नेपालमा आधिकारिक तथ्यांक प्रणाली तथा विधि (System and Methods of Official Statistics in Nepal).
4. UNDP, *Human Development Report (HDR).*
5. UNDP, *Nepal Human Development Report ( NHDR).*
6. Joseph E. Stiglitz and Carl E. Walsh(2007), *Economics*, W.W. Norton & Company, Inc., NewYork, International Student Edition, 4th edition
7. Aman ULLAH, & David E A. GILES (1998*), Applied Economic Statistics*, Eastern Hemisphere Distributions
8. Ray, Devraj (1998). *Development Economics*, Oxford University Press
9. Sen, Amartya (1997). *Poverty and Inequality*, Oxford University Press
10. Foster, James E. and Sen, A. (1973). *On Economic Inequality*, Oxford University Press.

11. Gupta, S. C. and Kapoor V. K. (Latest Ed.). *Fundamentals of Applied Statistics*, Sultan Chand and Sons.

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

Level: B.Sc.
Year: III
Course Title: Operations Research (Elective Course for Statistics)
Course Code: STA 304 Full Marks: 50
Nature of the Course: Theory Pass Marks: 17.5
Total Number of Periods: 75

**Course objectives:**
To acquaint students with skills of operations research in the analysis of market and financial problems

**1. Introduction [5]**

History, development, objectives, scope, nature and definition, characteristics, scientific method, limitations of operations research, types of mathematical models.

**2. Linear Programming Problem(LPP) [20]**

Concept of LPP, application of LPP using Simplex method, including Duality; Transportation and Assignment Problems

**3. Network Analysis [15]**

Introduction of network analysis, terminologies, construction network, Network analysis Method PERT, CPM networks, time estimates, determination of critical path, determination of float, resource analysis and allocation, probability estimates, time chart, shortest route technique
Examples and problems

**4. Inventory Management [25]**

Types of inventories: Movement inventories, buffer inventories, anticipation inventories, decoupling inventories, cycle inventories
Inventory decisions

Inventory costs: Purchase cost, ordering/set-up cost, carrying cost, stockout cost
Inventory management systems: Fixed order quantity system, periodic review system
Classical economic order quantity (EOQ) model, assumptions and robustness of the EOQ model, EOQ with price breaks, EOQ model for production runs, inventory models with planned shortages, determination of safety stock
Different Methods (Approaches) to inventory control: Always Better Analysis (ABC), Vital Essential Desirable (VED), High Medium Low (HML), S for Scarce, D for Difficult and E for Easy to obtain (SDE), Seasonal items and off season items (S-OS), Fast moving, Slow moving and Non moving items (FSN) and X for high valued, Y for moderate value and Z for low valued items (XYZ) analysis
Examples and problems

**5. Sequencing Models and Related Problems [10]**

Sequencing problems, Assumption in sequencing problems, processing *n* jobs through one machine, processing *n* jobs through two machines, processing *n* jobs through three machines, processing two jobs through *m* machines, processing *n* jobs through *m* machines.
Examples and problems

**References:**


1. Berger J.O. *(1993). Statistical Decision Theory and Bayesian Analysis*, Springer Series
2. Wald A. *Statistical Decision Functions*, John Wiley and Sons, New York, Latest Edition
3. Koch Karl-Rudolf (2007). *Introduction to Bayesian Statistics*, 2nd edition, Springer Publication.
4. Taylor Bernard W., (2007). *Introduction to Management Science,* Prentice Hall, Pearson Education
5. Vohra N.D.(2006). *Quantitative Techniques in Management*, TATA McGraw Hill
6. Sthapit Azaya, Rashindra P. Yadav, Govinda Tamang (2015). *Operations Research* Asmita Publication, Kathmandu.
7. Gupta Prem Kumar, Hira D. S (2007). *Operations Research*, 4th edition, S. Chand & Company Ltd.
8. J. K. Sharma (2001). *Operations Research Theory and Application*, Macmillan India
9. Goel B. S. , *Mittal S. K.* (1991). *Operation Research*, Reprint, Pragati Prakashan India.

# Zoology : NO Revision

**Tribhuvan University**
**Institute of Science and Technology**
**4 Years Bachelor of Science (B.Sc.) Programme**
**B.Sc. third year Zoology Course of Study**
**2071**

**Course Title: Physiology, Genetics and Molecular biology** **Full Marks: 100**
**Course No. : Zool.301** **Pass Marks: 35**
**Nature of Course: Theory** **Year: III**
**Instruction Lectures: 150**
**Objectives of the Course:**
At the end of course students will be able to understand:

- Physiological processes in animals.
- Details of endocrine glands and their roles.
- Various biochemical phenomena in animals.
- Embryonic development in animals.
- Structure and function of animal cell organelles
- Basic concept of genetics and molecular biology.
- Some molecular techniques necessary for carrying out molecular analysis

## Group A: Physiology (75 lec.)

**Nutritive substances, Enzymes and Energetics:** Biological role of nutritive substances. Metabolism and metabolic pathways. Bioenergetics. General properties and mechanism of action of enzymes. Cofactors and Coenzymes. Factors influencing enzyme activity. (**15 lec.)**
**Digestion**: Digestion and absorption of nutrient. Gastrointestinal secretions and its regulation. **(4 lec.)**
**Respiration:** Respiratory mechanism. Respiratory pigments. Respiratory gases. Regulation of respiration. (**8 lec.**)
**Circulation:** Blood groups. Haemostasis and blood coagulation. Conduction system of the heart. Cardiac output and its control. **(8 lec.)**
**Excretion:** Excretion and excretory products in animals. Mechanism of urine formation. Role of kidney in the maintenance of electrolyte balance & pH**.** **(5 lec.)**
**Nervous System:** Nerve cells and electrical signaling. Synaptic transmission and neuronal integration. **(6 lec.)**
**Endocrine System:** Primary endocrine glands, respective hormones and their functions. (**12 lec.)**

**Sensory System:** General principles of sensory physiology:- vision, hearing and balance, taste, smell and touch. **(6 lec.)**

**Reproduction and Development:** Female reproductive cycle (ovarian and uterine cycles in human). Gametogenesis. Types of eggs. Mechanism of fertilization. Embryonic development. **(11 lec.)**

## Group B: Cell Biology, Genetics and Molecular biology (75 lec.)

### B1-Cell Biology (22 lec.)

**Cell:** General organization of Prokaryotic and Eukaryotic cells. **(2 lec.)**

**Cell membrane**: Molecular organization. Membrane transport principles. **(2 lec.)**

**Cytoskeleton and Cell Motility**: Microtubules, microfilaments, intermediate filament, Cilia and flagella. **(2 lec.)**

**Structure and functions:** Endoplasmic Reticulum, Golgi Complex, Lysosome, Peroxisome, Mitochondria and Ribosomes. **(10 lec.)**

**Nucleus**: Structure of nuclear envelope, nucleoplasm, chromatin fibres and nucleolus. Nucleo-cytoplasmic inter-relationship. **(2 lec.)**

**Chromosomes and Chromatin**: Nomenclature, karyotype and giant chromosomes. Heterochromatin and euchromatin. **(2 lec.)**

**Cell cycle and Cell division**: Cell cycle, mitosis and meiosis. **(2 lec.)**

### B2-Genetics (19 lec.)

Mendelian and Non-Mendelian Inheritance. **(2 lec.)**

**Genetic Interaction:** Gene, Alleles, Dominant and Recessive. **(2 lec.)**

**Multiple Alleles**: Blood groups in human (ABO and Rh). **(2 lec.)**

**Linkage and Crossing over**: Theories, types and significance. **(2 lec.)**

**Sex-Linked Inheritance**: Characteristics, X, Y and X-Y linked genes inheritance, Non–disjunction as proof of chromosomal basis of heredity. **(3 lec.)**

**Sex determination** in animals. **( 1 lec.)**

**Chromosomal Variations**: Chromosomal aberration. Euploidy, monoploidy, polyploidy nullisomy, trisomy, double trisomy and tetrasomy, mutations and their types. **(2 lec.)**

**Human Genetics**: Pedigree analysis, human traits, sex-linked diseases, disorders due to mutant genes, Eugenics, and Euphenics. **(4 lec.)**

**Genetic Engineering and Gene Therapy**: Introduction and their applications. **(1 lec.)**

**B3-Molecular Biology (34 lec.)**

**Nucleic acids:** Structure and composition of DNA, DNA Replication**:** DNA polymerase-properties and mechanism of action. Semi-discontinuous, uni-directional and bi-directional DNA replication. DNA replication mechanisms in prokaryotes and eukaryotes. Structure and composition of RNA, RNA Processing: Processing of messenger RNA (mRNA), ribosomal RNA (rRNA), and transfer RNA (tRNA). **(10 lec.)**

**Genetic Code and Central Dogma:** Characteristics and Wobble hypothesis. Concept of Central Dogma. **(3 lec.)**

**Transcription, Translation and Protein Synthesis:** Differences between replication and transcription. RNA polymerase in prokaryotes- properties and organization of promoters. Mechanism of prokaryotic and eukaryotic transcription. Mechanisms of translation (initiation, elongation and termination), Translation process in prokaryotes and eukaryotes. Post-modification of released protein. **(9 lec.)**

**Gene Regulation:** Gene expression, regulation and control in prokaryotes and Eukaryotes. Transcriptional, translational and posttranslational modification system. Control at hormonal level. **(7 lec.)**

**Techniques of Molecular Biology**: Polymerase chain reaction (PCR), DNA fingerprinting, gene cloning, DNA sequencing, Blotting and Enzyme linked immunoserbent assay (ELISA).

***** **(5 lec.)**

**Text Books**


Balinsky, B.I. 1970. An Introduction to Embryology. W.B. Saunders, London.

Dhami, P.S. and Dhami, J.K. A Textbook of Zoology, vol. II & III. latest ed., Pradeep Pub., New Delhi.

Jordan, E.L. and Verma, P.S. Chordate Zoology & Animal Physiology. latest ed., S. Chand, New Delhi.

Kotpal, R.L. Modern Textbook of Zoology: Vertebrates. latest ed., Rostogi Pub., Meerut India.

Rastogi, S. C. 2001. Cell and Molecular biology. New Age International (P) Limited, Publishsers: New Delhi, Banglore, Calcutta, Chennai,Lucknow, Mumbai, India.

Rastogi, S.C. Text Book of Physiology.Willey Eastern Ltd.

Singh, B.D. 2006. Fundamentals of Genetics. Kalyani Publishers, Ludhiana, New Delhi, Noida (UP), India.

Verma, P.S. and Agarwal, V.K. 2012. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. Published by S.Chand & Company LTD,New Delhi India.


**References:**


Bijlani, R.L.(Ed.) Understanding Medical Physiology, Jaypee Brothers, Medical Publishers (P.) LTD. India.

Eckert, R. and Randall, D. Animal Physiology, CBS Publishers and Distributers, India.

Goel, K.A. and Sastri, K.V. 1998. A Text Book of Animal Physiology. Rastogi Pub., Meerut.

Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, Elsevier.

Hoar, William S. General and Comparative Physiology. Prentice Hall.
Jeremy, M. Berg and John L. Lubert Stryer. Biochemistry. 5th ed. W.H. Freeman & Company, New York.
Knut Schmidt- Nielson. Animal Physiology. Cambridge Univ. Press.
Knut Schmidt-Nielsen. 1973. Animal Physiology. Foundations of Modern Biology Series. Prentice Hall.
Nelson, David L. and Cox, Michael M. 1982. Lehninger Principles of Biochemistry. 4th ed. Pub. Prentice- Hall of India Private Limited New Delhi.
Powar, C.B. and Chatwal, G.R. Biochemistry. Himalaya Pub.House, Mumbai, latest ed.
Randall, D.,Burggern, W. and French, K. Eckert Animal Physiology. WH Freeman & Co.
Satyanarayan, U. Biochemistry. Books and Allied (P) Ltd., Kolkata, India.
Stanfield, C.L. and Germann, W.J. Principles of Human physiology, Third edition, Pearson International Edition.
Turner, P.C., McLennan, A.G., Bates, A.D. and White, M.R.H .1998. Instant Notes in Molecuar Biology. Viva Books Pvt.Limited, New Delhi, Mumbai and Chennai, India.
Vander, Sherman and Luciano. Human Physiology. McGraw- Hill.
Winter, P.C., Hickey, G.I. and Fletcher, H.L (2000): Instant Notes in Genetics. Bios Scientific Publishers Ltd, 9 Newtec Place, Magdalen Road, Oxford 0X4 IRE, UK.
Yapp, W.B. 1970. An Introduction to Animal Physiology. Oxford at the Clarenden Press.

**Course Title: Physiology, Genetics and Molecular Biology** **Full Marks: 50**
**Course No. : Zool. 302** **Pass Marks: 20**
**Nature of Course: Practical** **Year: III**
**Objective of the Course:** For better understanding of the topics of Zool.301.

## Physiology Practical

1. Detection of carbohydrates, proteins and lipids.
2. Effect of temperature and pH on enzymatic action of amylase on starch.
3. Estimation of Haemoglobin.
4. Blood grouping.
5. RBC and WBC counting.
6. Detection of sugar, urea and protein in urine.
7. Study of the models and embryological slides of different stages of Chick.

## Molecular Biology Practical

1. Study of the cytological slides: Cell division (Mitosis and Meiosis).
2. Study of Lampbrush chromosome of any animal.
3. Study of the human genetic traits (ear lobe, colour of eye, etc.).
4. Extraction and quantification of DNA.
5. Separation of DNA by Agarose gel electrophoresis.

6. Preparation of short community/family based survey report on human genetic traits.

**Practical note book preparation as regular study.**

**Books (Latest Eds.)**

Arora, M.P. Genetic Engineering. Himalaya Publishing House, India.

Sambrook, J. and Russel, D.W. Molecular Cloning , A labortory manual. Cold Spring Harbor Laboratory Press, New-York

Swarup, H., Pathak, C.S. and Arora, S. Laboratory Techniques in Modern Biology. Himalayan Publishers.

Verma, P.S. and Agrawal, V.K. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Co., New Delhi.

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**Tribhuvan University**
**Institute of Science and Technology**
**4 Years Bachelor of Science (B.Sc.) Programme**
**B.Sc. third year Zoology Course of Study**
**2071**

**Course Title: Natural Resource Management** **Full Marks: 50**
**Course No. : Zool.303** **Pass Marks: 17.5**
**Nature of Course: Theory (Elective)** **Year: III**
**Lecture Hrs: 75**

**Objectives of the Course:**

At the end of course students will be able to:

- Understand an overview of the various natural resources
- Know the resource degradation problem
- Be familiar with issues and conservation of natural resources.

**Introduction to Natural Resources and Management:** Concept, values and types. Consumption trends and factors affecting resource use. Depletion and management of natural resource. Sustainable development. Policy and governance. (**10 lec.)**

**Water Resource:** Introduction. Hydrological cycles. Major sources of water. Use and depletion of water resources. State of water resources of Nepal. Water resource management.

**(10lec.)**

**Land resource**: Concept of land resource. Land use. Land resource degradation. Land resource management (Policy, planning and practice). **(9 lec.)**

**Mineral resource:** Introduction, types and importance of mineral resource. Consequence of mineral extraction, Status of major minerals in Nepal. Conservation of mineral resources. **(7 lec.)**

**Mountain Resource:** Mountain natural resource and their conservation. **(4 lec.)**

**Biodiversity Resource:** Introduction, types and importance of biological resources. Concept of biodiversity. State and threats of biodiversity of Nepal. Management of biodiversity (ex-situ and in-situ). **(11 lec.)**

**Forest resources:** Importance. Forest types of Nepal. Forest products and their uses in Nepal. Forest degradation. Forest Management and Community forestry program of Nepal.**(8 lec.)**

**Energy resources:** Introduction. Consumption trends of energy. Sources of energy: renewable and non renewable sources. Consequence of rapid consumption of non renewable energy. Status of energy resources in Nepal. Energy policy. **(10 lec.)**

**Natural Resource Management in the Context of Climate Change:** Climate change. Climate change impacts and vulnerability. Climate change mitigation and Adaptation. **(6 lec.)**

**Suggested Readings**


Agarwal, K.M., Sikdar, P.K., Deb., S.C. 2005. A Text Book of Environment. Macmillan India Limited

Asthana, D. R. and Asthana, M. 2012. Environment: Problems and Solutions. S Chand and Company PVT LTD.

Khadka, N. B. 2008. Natural Resource and Conservation.

Klee, G.A. 1991. Conservation of Natural Resources. New Jersey: Prentice Hall Publ. Co.

Miller, G. T. (Jr.) and Spoolman, S. T. 2010. Living in the Environment. Brooks/Cole. Belmont, California, USA: Wardsworth Publishing Company.

Nalini, K.S. 1993. Environmental Resources and Management. Anmol Publishers.

NPC, 2011: Climate-Resilient Planning. [Working Document], Government of Nepal, National Planning Commission, Kathmandu, Nepal.

Owen. O.S, Chiras. D.D, Reganold. J.P, 1998. Natural Resource Conservation Management for a Sustainable Future (7th Edition). Prentice Hall.

Peter, M. Dixit, A. and Athukorala, K. (edited). 2007. Integrated Water Resources Management: Global Theory, Emerging Practice and Local need. Sage Publication

Primack, R.B., Poudel, P.K. & Bhattarai, B.P. 2013. Conservation Biology: A Primer for Nepal. Dreamland Publication, Kathmandu

Ramade, F. 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
Ristinin, R.A. and Kraushaar, J.J. 2006. Energy and Environment. New York: John Wiley and Sons, Inc.
Sharma, V.K. 1985. Water Resources Planning and Management. Himalaya Pub. House
Stainton, JDA. 1972. Forests of Nepal. John Murray, London.
WECS. 1995. Alternative Energy Technology – Overview and Assessment. Kathmandu: WECS, GoN.
WECS. 2011. Water Resources of Nepal in the Context of Climate Change. Water and Energy Commission Secretariat. GoN
William M. B., Shrestha, A., Subedi, B. Dulal, HB. and Baumback, R.. 2013. Nepal Forest Sector Survey: Policy priorities and recommendations. Washington, DC: Program on Forests (PROFOR).

**Tribhuvan University**

**Institute of Science and Technology**

**4 Years Bachelor of Science (B.Sc.) Programme**

**B.Sc. third year Zoology Course of Study**

**2071**

**Course Title: Bioinformatics** **Full Marks: 50**
**Course No. : Zool.304** **Pass Marks: 17.5**
**Nature of Course: Theory ( Elective)** **Year: III**
**Instruction Lectures: 75**
**Objectives of the Course:**
At the end of the course the students will be able to:

- Understand what is bioinformatics
- Understand bioinformatics as the meeting point of computational science and biology
- Understand algorithms & statistics for biological data analysis with the use of biological software
- Align single and multiple biological data
- Develop creativity of using biological data to solve problems related to computational science.

**Introduction to Bioinformatics:** Introduction, application, dawn of sequencing, human genome, homology and analogy. **(15 lec.)**

**Information networks:** Introduction, www, web Browsers, EMBnet and NCBI. (**7 lec.)**

**Protein Information Resources:** Introduction. Biological databases. Structure Classification databases. **(5lec.)**

**Genome Information Resources:** Introduction. Human genome. DNA sequence databases. **(3lec.)**

**DNA sequence analysis** : Introduction. Features of DNA sequence analysis. EST, cDNA library and EST analysis. **(10lec.)**

**Pairwise alignment techniques:** Introduction. Database searching. Algorithms and programs. Identity and similarity. Global and local alignment. **(10 lec.)**

**Multiple alignment techniques:** Introduction. Manual, simultaneous and progressive methods. Databases of multiple alignment **(10 lec.)**

**Phylogenetic trees:** Introduction and methods. **(4 lec.)**

**Secondary database searching:** Introduction. **(1 lec.)**

**Building a sequence search protocol:** Introduction, a practical approach, structural and functional interpretation. **(3 lec.)**

**Analysis packages:** Introduction. Commercial database and software. comprehensive packages. **(5 lec.)**

**Ethics, and workflow management system in Bioinformatics** **(2 lec.)**

**Text Books:**

**Pangeni, R.P. 2007.** Concept on Bioinformatics. Sukunda Pustak Bhawan, Bhotahity, Kathmandu, Nepal.

**Attwood, T.K. & Parry-Smith, D.J. 1999 and 2014**. Introduction to Bioinformatics (Cell and Molecular Biology in Action Series) Published by Prentice Hall, edited by DR. Ed Wood, Department of Biochemistry and Molecular Biology, Univ. of Leeds, UK.

**Lesk, A.M. 2003**. Introduction to Bioinformatics. Oxford University Press, UK, printed in India by Gopsons, Noida 201301, Published by Manzar Khan, Oxford University Press, YMCA Library Building, Jai Singh Road, New Delhi 110001.

**References**

Andrew, J., Cammon, Mc, Harvey S. 1988. Dynamics of Proteins and Nucleic acids.

Cambridge University Press.

Campbell, A. M. and Heyer, L. J. 2004. Discovering Genomics, Proteomics & …….

Leach, A. R. 2001. Molecular Modeling. Prentice Hall.

Pevsner, J. 2003. Bioinformatics & Functional Genomics. John Wiley and Sons.

Pevzner, P. A. 2004. Computational Molecular Biology. An Algorithmic Approach PHI.

Rastogi, S.C., Mendiratta, N., Rastogi, P. 2004. Bioinformatics, Methods and Applications. PHI Publication.

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

Level: B.Sc.
Year: III
Course Title: Research Methodology (Compulsory Paper)
Course Code: RM 305 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:**
After completion of this course, students will be (i) familiar with the principles behind research work (ii) acquainted with practical knowledge of research work and (iii) able to perform a research work in their field independently or in collaboration

**Unit 1: Introduction to Research [15]**

1.1 *Scientific Methods and Research:* Concept, Definitions of research; Purpose, importance, steps levels and rigor of research, Different paradigms of research
1.2 *Basic Types of Researches:* Fundamental/Applied research, Descriptive/Analytical research, Quantitative /Qualitative research, Conceptual/Empirical research, Diagnostic/Hypothesis testing research, Conclusion oriented/Decision oriented research, Theoretical / Action research, Longitudinal /Cross sectional research
1.3 *Research Question:* Introduction, types and identification; *Research Problem:* Definition, identification of problem, ways of understanding problem, criteria of a good problem, guidelines for selecting meaningful problem; *Research Objective:* Definition, broad and specific objectives, goals; *Research Hypothesis:* Meaning of research hypothesis, sources of hypothesis, qualities of workable hypothesis, utilities of hypothesis;
1.4 *Designing of Research work:* Introduction, Purposes, Characteristics of a research design, Principles of designing a research, conceptual framework and its operationalization, Sectors of research design, Similarities and differences between research design and research method, Research methods as research designing,

**Unit 2: Some Research Methods [20]**

2.1 *Conventional Research Method:*, Principles and Importance of conventional method (Scientific methods as conventional methods), Characteristic of a scientific method; Aspects of scientific Method, Evolution of scientific Studies Steps in scientific methods,
2.2 *Historical Research Method:* Nature and Steps in Historical method, Importance and fundamentals of Historical method, Sources of Historical data, Limitations.
2.3 *Experimental Research Method:* Introduction, Types of experiments, steps in experimental research, Problems in experimentation; Ex-post facto research: definition and technique.

2.4 *Survey Research Method:* Introduction, and Importance of survey method, Comparison of survey method with other methods; Objectives of social and survey and technical survey, types of social and technical survey, Steps in social and technical surveys, Pilot survey

2.5 *Case study:* Introduction, Types of case studies: Exploratory and Hypothesis testing; Steps in case studies, Sources of case data, limitations.

**Unit 3: Data, Methods of Data Collection [20]**

3.1 *Needs and Nature of data:* Necessity of data in Natural (Physical and biological) and Social sciences, Nature of data in natural and social sciences. Different forms of information: Primary and secondary data, Cross section and categorical Data, Time series, spatial and ordered data.

*3.2 Types of data according to scales of measurement:* Qualitative and quantitative data, nominal ordinal, interval and ratio scale data

3.3 *Data collection in Social Sciences:*

- *Schedule*: Purpose of schedule, Kinds of schedule, Content of schedule, Limitations
- *Questionnaire:* Types, Requisites of a good questionnaire, Importance of questionnaire method, Limitations of questionnaire method, Difference in schedule and questionnaire, Format of a questionnaire, Problems in questionnaire method
- *Interviews:* Direct & indirect interviews, ways of obtaining an interview, focus group discussion.
- Survey and Census: Introduction, Similarity and differences, Methods of sampling of human population.
- Observation Methods: *Participatory and non participatory observation Method*: PRA / RRA, Controls used in social survey, Observational documents and their types

3.4 *Data collection in Lab-oriented sciences and Technologies*:

- Introduction, Methods of data collection in natural sciences, Data measurement, Observation method.
- Observation schedule, observation plan, check sheet, rating scale, Likert scale
- Controlled and Non- controlled observation
- Sample and specimen, Sampling of objects or beings, Ethical issues in research: Anonymity, confidentiality, informed consent
- Observational method vs experimental method

3.5 *Non-responses:* Causes of non response in information collection, Estimation of non response rate, Technique of getting response, Random response technique.

3.6 *Questions*: Types of question used, Question to be avoided, Sequences of questions in schedule or questionnaire or interview.

**Unit 4: Sampling** **[10]**

4.1 Introduction and review of Sampling: Definition, needs, steps; Definitions of population, sample, sampling unit, sampling frame, sampling error and non sampling error; Steps in sampling; Fundamentals, characteristics, advantages and disadvantages of sampling.

4.2 Types of sampling: Probability (simple, stratified, systematic , cluster and multistage –in brief), Process of selecting random sample; non probability sampling ( convenience, purposive, quota, snowball, self selecting); Advantages and disadvantages (brief discuss only)

4.3 Size of sample: Factor affecting size of sample, Testing the reliability of sample, Methods of estimating sample size, Process of selecting random sample

**Unit 5: Data Analysis and Synthesis** **[20]**

5.1 Ways of data organization and summarization: data editing, coding, classification, entering into spread sheets, management of missing and inconsistent information

5.2 Principal Methods of Analysis and Interpretation,

- Uses of descriptive statistical Measures: concentration, spread, comparison of spread
- Ways of identifying nature of curves and distributions.
- Estimation of population parameters, Standard error, Testing hypothesis and Variance analysis (all in brief, as the revision of Applied statistics of B. Sc. II year)

5.3 Synthesis: Meaning and Introduction, Logical Generalization and Statistical generalization

**Unit 6: Measurement and Scaling** **[20]**

6.1 Review of concepts of measurement and scales, their types, Sources of error in measurement, Needs of scaling, Characteristics of scale.

6.2 *Reliability*: Definition, Methods of Estimating Reliability, Length of the test and the Reliability, Reliability theory, Estimation of true score

6.3 *Validity:* Introduction to validity of scale, Types of validity, Factors influencing Validity, validity theory, measures of validity, Validity and the length of the test, General Criteria of Validity of a scale

6.4 *Scaling:* Scores and scales, scaling of the scores, difficulties in scaling, scales used in physical social sciences (introduction only), standard scores and standard scales: Z scale, σ scale, t scale, percentile scale and ranking scales

**Unit 7: Task of Writing in Research** **[20]**

7.1 *Research Proposal:* meaning and purpose of research proposal, Academic/ Project/ Case study proposals, Steps for the preparing proposal, Framework and arrangement of sub heading in research proposal; Writing research proposal for academic programme; Common mistakes in proposal writing

7.2 *Reviewing of literature and Note Taking:* Methods selecting relevant literature, ways of note taking and recording; from different sources;

7.3 *Research Report*: Introduction, purpose and different forms of report; Qualities of research reports; Presentation of preliminary, general and technical reports; Format of research report, Necessary elements of research report, Precautions for report preparation.

7.4 *Thesis/ Dissertation:* Introduction, Features of thesis, Structure of Thesis, Steps in thesis writing, Documentation of a Thesis/Dissertation.

7.5 *Citation and Referencing:* Different ways of work citation, arranging reference material; bibliography quoting from different sources; Different system of citation and referencing: APA, MLA, and ISO690 (numerical reference)

7.6 *Publication in Research journals:* Introduction and its importance, Arrangement of the article; Difference between general and research article.

**Assignment Works / Exercises [25]**

- Preparation of a research/project proposal
- Questionnaire designing
- Preparation of observation schedule for field / lab work
- Case analysis / situation analysis
- Survey report preparation / Field or lab work report preparation
- Presentation on related topic (class seminar)
- Analysis of references and citation (books, journals, reports, theses etc)

**References:**


1. M. L. Singh (1998). *Understanding Research Methodology*, J. M. Singh
2. C. R. Kothari (1990). *Research Methodology*, Vishwa Prakashan, India
3. Robert E. Slavin (1994). *Research Methodology in Education*, A practical guide, prentice Hall,
4. Robert A Day (1994). *How to write and publish a scientific paper*, Cambridge University press
5. F. N. Kerlinger (2000). *Foundations of Behavioral Research*, Surjeet Publication, New Delhi
6. S.R. Bajpai (1990). *Methods of Social Survey and Research*, Kitabghar, Kanpur
7. Khatiwada, R. P., Pradhan, B. L. & Poudel, N. (2016). *Research methodology* (2nd ed). Kathmandu: KEC publications .

# Fourth Year

## Subjects : IV$^{th}$ year

1. Botany
2. Chemistry
3. Environmental Science
4. Geology
5. Mathematics
6. Meteorology
7. Microbiology
8. Physics
9. Statistics
10. Zoology
11. Computational Course (Compulsory Course)

# Environment and Biodiversity

## B. Sc. IVyr (4 yrs course)

**Course title**: Environment and Biodiversity **Full Marks**: 100

**Course No**: Bot401 **Pass Marks**: 35

**Nature of the Course**: Theory **Instruction Hours**: 150

**Objectives (Bot 401& Bot 402)**

To understand:

- Different aspects of environment
- Concept of nature conservation
- Different aspects of biodiversity
- Value of economic plants and livelihood development

**Course Contents**:

## I. Environment 75 hr

1. Introduction: Basic components of environment (the atmosphere: structure, importance, meteorological conditions and air circulation; hydrosphere: importance, physico-chemical properties, global distribution; lithosphere: rocks, disintegration of rocks and soil formation, soil profile, importance of soil to the biosphere**3+3+3** = **9hr**
2. Biosphere and Biomes: (i) Structure and composition of biosphere: ecosystem, energy flow and biogeochemical cycles, system homeostasis(ii) Major biomes of the world: major terrestrial biomes (tropical rain forests, tropical seasonal forests, tropical woodlands and thornlands, tropical grassland and savannas, temperate rainforests, temperate deciduous forests, temperate woodland and shrublands, temperate grassland, hot deserts and cool deserts, alpine shrubland and grasslands); freshwater aquatic biomes: lentic (lakes and ponds), lotic ( rivers), wetlands (swamps and marshes)**3+5=8hr**
3. Ecosystem Services: (i) Concept and categories (ii) Carbon sequestration and carbon trade, concept of REDD+ (iii) Watershed services (upstream-downstream linkages)**1+4+2=7hr**
4. Environmental Issues: (i) Human population (ii) Deforestation and land use(iii) Urbanization (iv) Pesticide use and abuse (v) Chemical fertilizers (vi) Global environmental change – weather and climate, invasive species, human health (heat stress and migration of disease vectors), food security, water security (vii) Environmental toxicants – toxins of biological and non-biological origin**2+3+1+1+1+9+3 =20hr**
5. Energy Issues: (i) Renewable energy resources (wind, solar and biofuel) (ii) Non-renewable energy resources (hydropower, coal, gas)**3+3 =6hr**
6. Natural Resource Management: (i) Concept, Participatory Technology Development (PTD) approach for NRM in context of Nepal with some case studies as examples (ii)

Environmental indicators – role of plants in environmental monitoring (iii) Bioengineering**4+2+2 = 8hr**

7. Environmental Impact Assessment (EIA):(i) Origin and development(ii) IEE and EIA process (iii)A case study of any developmental project in Nepal. **3+4+1 =8hr**
8. Environmental Affairs: (i) Environmental organizations (ii) Environmental legislations (iii) International conventions with special reference to various treaties and environmental laws in the context of Nepal (iv) Environmental education **2+2+3+2 =9hr**

## II. Biodiversity 75hr

1. Introduction: (i) Concept and levels (ecosystem, species, genetic level) (ii) Biodiversity and systematics (ii) Important institutions/centers of biodiversity study (herbarium, museum, botanical gardens) (iv) Important literatures (Flora)

**1+1+3+1 =6 hr**

2. Biodiversity Overview: (i) Global distribution of plant biodiversity richness (ii) Biodiversity hotspots (iii) Status of biodiversity in Nepal (iv) Agrobiodiversity (v) Centre of origin of crop plants (vi) Plant gene pools (v) Forest types of Nepal **1+2+2+2+1+1+5 =14 hr**
3. Uses of Biodiversity: (i) Plant use (timber, firewood, food and oil yielding plants, fiber plants in context to Nepal) (ii) Medicinal and aromatic plants – status and distribution in different ecological zones of Nepal**7+5=10 hr**
4. Loss of Biodiversity: (i) Drivers of biodiversity loss (ii) Species extinction (iii) Threatened species (the IUCN Red List categories) **5+1+2 =8hr**
5. Conservation and Management of Biodiversity: (i) Fundamentals of wild life management (ii) Current practices in conservation (in situ, ex situ, sacred groves and cryopreservation) (iii) Protected areas network and connectivity (iv) Park-people conflict and case studies from protected areas of Nepal (v) Participatory community approach of biodiversity conservation **1+5+3+2+4 =15 hr**
6. Biodiversity and climate change: (i) The nature of climate change (ii) Biological consequences of climate change (phenological changes in plants, species range shift, ecosystem process changes) **1+3 = 4 hr**
7. Ethnobotany: (i) Introduction, history, Scope and future perspectives (ii) Methods of ethnobotanical study (iii) Data collection and hypothesis testing (iv) Bioprospecting and biopiracy of traditional knowledge, (v) Integrating ethnobotany in conservation and community development **1+1+2+2+2 =8 hr**
8. Biodiversity Policy, Legislation and Strategies: (i) Important policy and legislations (ii) Conservation ethics (iii) Major strategies of biodiversity conservation and salient features of CBD, CITES, Ramsar Convention (iv) Intellectual Property Rights (IPRs)**3+1+5+1 = 10 hr**

**Suggested books**


1. Asthana DK and Asthana M. 2005. *Environment: Problems and Solutions*. S. Chand & Co. Ltd. New Delhi
2. Chaudhary RP. 1998. *Biodiversity in Nepal – Status and Conservation*. S. Devi Saharanpur, India
3. Rana SVS. 2010. *Essentials of Ecology and Environmental Science*. PHI Learning Pvt. Ltd. New Delhi
4. Lekhak HD and Lekhak B. 2009. Natural Resource Conservation and Sustainable Development in Nepal. Kshitiz Publication, Kathmandu
5. Groombridge B (ed.). 1992. *Global Biodiversity – Status of Earth's Living Resources*. Chapman and Hall
6. Jha PK et al. 2008. *Medicinal Plants in Nepal*. Ecological Society (ECOS), Kathmandu, Nepal
7. Jha, P.K., F.P. Neupane, M.L. Shrestha and I.P. Khanal. 2013. *Environment and Natural Resources* (Nepalpedia series No 1). Publ. Nepal Academy of Science and Technology (NAST) Kathmandu.
8. Jha PK, Neupane FP, Shrestha ML and Khanal IP (eds.). 2013. *Biological Diversity and Conservation.*Nepalpedia Series No. 2. Publ. Nepal Academy of Science and Technology (NAST) Kathmandu.
9. Uprety B. 2003. *Environmental Impact Assessment: Process and Pactice*.Mrs. UttaraUprety, Koteshwor, Kathmandu.
10. Martin G. 1995. *Ethnobotany* – a Methods Manual. Chapman and Hall
11. Miller GT and Spoolman S. 2007. *Environmental Science: Problems, Connections and Solutions*. Thomson Brooks/Cole
12. Rajbhandary S. and Ranjitkar S. 2006. *Herbal Drugs and Pharmacognosy: Monographs on Commercially Important Medicinal Plants of Nepal*. Ethnobotanical Society of Nepal (ESON). Kathmandu.
13. Shrama PD. 2007. *Ecology and Environment*. BPR Publishers
14. Station JDA. 1972. *Forests of Nepal*. John Murray, London.
15. Stocking M, Helleman H and White R (eds.). 2005. Renewable Natural Resources Management for Mountain Communities. ICIMOD. Nepal
16. Primack Richard B. 2002. *Essentials of Conservation Biology*. Sinauer Associates Inc.

# Environment and Biodiversity
# PracticalB. Sc. IV yr

**Course title**: Environment and Biodiversity
**Course No**: Bot 402
**Nature of the Course**: Practical

**Full Marks**: 50
**Pass Marks**: 20
**Instruction Hours**: xx

## I. Environment

1. To analyze abiotic and biotic components of an aquatic ecosystem.
2. To analyze vegetation quantitatively (density,relative density, frequency, relative frequency, coverage, relative coverage, importance value index).
3. To study soil profile of the given area.
4. To analyze soil samples (textures, water holding capacity, soil pH, porosity).
5. To analyze water samples and compare results with water quality standard ofWHO.
6. To study pollution effected plants and compare it with plants growing in undisturbed area.
7. To record climatic information (temperature, rainfall, relative humidity) and summarize it in graphs.
8. To determine carbon stock of major tree species in the area.
9. To assess environmental impact of a development project or industrial belt.

## II. Biodiversity

1. To familiarize students with use of herbaria, slides, transparency, etc.
2. To study medicinal plants.
3. To study leaf anatomy to see oil glands in available plants (e.g. tea, lemon, camphor etc.).
4. To study food plants (staple food, beverages, spices and condiments etc.).
5. To study structure of oil storing tissues in sectioned seeds of mustard, groundnut and soybean, using microchemical tests.
6. To study timber andornamental plants.
7. To study wood anatomy (TS, TLS, RLS) of available timber yielding species.
8. To study rattan and fiber plants.
9. To study stem and leaf of fibre yielding plants to identify fibre tissues.
10. To explore plant diversity of a specified area (measurement of species richness, Shannon diversity index, similarity index etc.).
11. To perform practical assignment onEthnobotany.

12. To visit the nearest national park/protected areasto study biodiversity management practice and prepare a report.
13. To study the phenological changes in vegetation of local area.
14. To prepare a report on International Conventions related to biodiversity.

Note: A **three day** field visit should be arranged by the department/campus for both Environment and Biodiversity (combined) to study management measures and biodiversity of a national park/protected area. The students will be required to prepare a report for each to be submitted at practical examination for final evaluation.

**Suggested books**


1. Zobel DB, Jha PK, Behan MJ, and Yadav UKR. 1987. *A practical manual for Ecology*. Kathmandu. Ratna Book Distributors.
2. Pandey BP. 1985.*Modern Practical Botany*. Vol. I. S. Chand and Co. Ltd. New Delhi.
3. Sharma OP. 2012. *A Manual of Practical Botany*. Vol. I. Gyan Books Pvt. Ltd.
4. Shrama PD. 2007. *Ecology and Environment*. BPR Publishers


## Plant Pathology and Protection

### B. Sc. IV yr (4 yrs course)

**Course title**: Plant Pathology and Protection
**Course No**: Bot.403
**Nature of the Course**: Theory

**Full Marks**: 100
**Pass Marks**: 35
**Instruction Hours**: 150

**Objectives**:

- Concept of different aspects of plant diseases,
- To understand disease occurrence in different crop plants,
- To understand the different aspects of plant protection,
- To familiarize with the rules and regulation of plant protection,

**Course Contents**

**Plant Pathology**

(i) Concept of diseases in plants, history of plant pathology, classification and symptoms of plants diseases. **8**

(ii) Method of studying plant diseases (Field, laboratory: media, isolation, culture and purification, Kotch's Postulate), factor affecting plant disease development (physical, biological, economical and environmental) **12**

(iii) Principal of infection; concept of epidemiology and plant disease forecasting, severity and losses cause by plant diseases, Plant disease and food security, climate

change and plant disease occurrence. **20**

(iv) Symptoms, Etiology and Control of Crop Diseases: (a) **Cereals:** Rice: Blast of rice, Bacteria leaf blight of rice; **Wheat:** Black rust or stem of wheat, Loose smut of wheat; **Maize:** Loose smut of maize, Brown spot of maize (b) **Vegetables:** Leaf curl of tomato, Wilt of tomato, Late blight of potato, Powdery mildew of cucurbits (c) **Cash Crops:** Sugarcane: red rot of sugar cane (d) **Fruits:** Citrus: Citrus canker, Anthracnose of Mango, Apple scab (e) **Pulses:** Mosaic bean virus, Wilt of Arhar (Pigeon Pea), Rust of Peas. **38**

(v) Seed Pathology: Introduction and importance of seed pathology, detection of seed born fungi, control of seed born pathogen, seed certification, seed regulation of Nepal **12**

(vi) Forest Pathology: Introduction and significance; Pathogenic and non pathogenic disease. Host, causal agents, symptoms, and control of major forest diseases: Nursery Disease: Steam Diseases: Die back and Root Diseases: (iv) Major diseases at forests of Nepal. **15**

**Plant Protection**

(vii) Concept and significance of plant disease control; Principle of plant disease control, Defense mechanism in Plants, **Disease control methods:** Culture method; Chemical method; Biological method; Physical and Mechanical methods; Sanitation; Resistance varieties; Fungal antagonists; Plant disease management, Post harvest management; Concept and significance of IPM and its policies and practices in Nepal. **30**

(viii) Concept and significance of plant quarantine, regulation of plant quarantine in Nepal. 5

(ix) Crop certification, Plant disease clinic, Pesticides use and its impacts on health and environment, Status of plant protection activities in Nepal, Regulation of pesticide in Nepal. **10**

**Text Books:**

1. Vashista, B. R. and Sinha, A. K. (latest edition). Botany for Degree students Fungi. S. H hand Higher Academy.
2. Mahadevan, A and Rangaswami, G. 2008. Disease of crop plant in India. Prentice-Hall of India P. Ltd.
3. Pandey, B. P. 1992. Plant pathology: pathogen and Plant diseases. S. Chand and company Limited
4. Negi, S. S. 1996. *An Introduction to Forest Pathology*. International Books Distributers, Dehradun.

**Reference Book:**

Mehrotra, R. S. 2003. Plant Pathology. The MC-Graw-Hill Publishing Company Limited.

# Plant Pathology and Protection

## Practical

**Course title**: **Plant pathology and Plant Protection** **Full Marks**: 50
**Course No**: Bot 404 **Pass Marks**: 20
**Nature of the Course**: Practical **Class Hours**:
**Year**: Fourth Year

1. Study of basic functions of (Autoclave, Laminar flow, Incubator and Hot air oven, Growth chamber).
2. Preparation of basic solid media: Agar and PDA; both in Petridish and slant.
3. Preparation of liquid media (broth).
4. Method of isolation, pure-cultures of preservation of microorganisms.
5. Use of lacto phenol and cotton blue in the mounting of fungi.
6. Study of Plant disease symptoms of Cereals, Vegetables, Pulses, Cash crops and Fruits: (i) Collection and identification of infected plant specimens (ii) Isolation of plant diseases and culture, inoculation, incubation and identification by using identification key.
7. Herbarium preparation of plant diseases.
8. Isolation of soil and air bacteria and fungi (microorganism).
9. Study of different techniques of seed sterilization (Heat, radiation, chemicals and filtration)
10. Preparation of the slides of different fungi by cellophane tape technique (temporary and permanent slides).
11. Estimation of the number of fungal spores by using the counting chamber.
12. Study of seed-borne fungi by standard blotter method.
13. Control of pathogens by fungicides (thread methods and poison food technique).
14. Demonstration of biological control of plant pathogens by dual culture method.
15. Demonstration of compost making process with and without using EMO.
16. To list the quarantine posts in Nepal and review the existing regulation of plant quarantine in Nepal.

To list the band pesticides and review the pesticides regulat

# Applied Botany

**Course title**: **Applied Botany** **Full Marks**: 100
**Course No**: Bot 405 **Pass Marks**: 35
**Nature of the Course**: Theory **Instruction Hours**: 150
**Year**: B.Sc. IV year

**Objectives**

1. To understand the concepts and technologies of Floriculture and mushroom cultivation
2. To learn the simple techniques for floriculture and mushroom cultivation.

**Floriculture (Teaching periods 75)**

1. **Introduction: Definition, scope, significance and classification of floriculture crops/plants** (Bedding and garden plants ; Cut foliage or greens; Cut flowers; Floriculture crops; Foliage plants; Greenhouse crops; Nursery crops). **Floriculture production, exports and imports in Nepal** (information to get from Floriculture Association of Nepal). **Establishment and management of floriculture enterprises** (nurseries, green houses, tissue culture). **Role botanical garden in plant conservation and development** (What is botanical garden?; Objectives of the Botanical Gardens; History of Botanical garden; Major Botanical Gardens of the world; Functions of Botanical garden). **Concept of garden landscaping/ designs** (Definition; Planning; Elements of Design (Line- straight line, curved lines, Vertical lines, Horizontal lines; Form - circular form, square form; Plant forms - tree forms, shrub forms, groundcover forms; Texture of plants - coarse texture, fine texture, medium texture; Principles of Design: Order - symmetrical balance, asymmetrical balance). **National policy and institutions for floriculture promotion** (Download available). 22

2. **Ornamental plants in garden and nature: Introduction of different types cultivated and natural ornamental plants** (examples of Lawn plant, pot plants, cut flower crops, bulbous plants, annuals and other bedding plants, rock garden plants, Bonsai, and aquatic plants). **Distribution of wild ornamental plants in different physiographical zones of Nepal** (need to develop by yourself). 15

3. **Plant propagation:** Asexual propagations - stem, leaves, roots, bulbils, and sexual propagations – seeds; and artificial vegetative propagation: cutting, layering, grafting, budding, micro-propagation, etc 8

4. **Garden implements and operations**: **Pinching, training and pruning practices**; **Soil** (Basic soil types: Stony soils, Clayey soils, Sandy soils, Limy soils, Peaty soils, Loamy soils); **Climate (**Definition, Types - general climate, local climate, and microclimate around growing plants, Important Weather Conditions: Temperature, Frost, Sunshine, Rain and wind) ; land preparation and planting, manuring, irrigation and other

intercultural operations, role of growth regulators, times and methods of propagation, management of weeds, diseases and pests. 15

5. **Production technology of commercial Flowers**: Rose, Carnations, Gladiolus, Gerbera, Orchids, Chrysanthemum, Jasmine, Dahlia, Bird of Paradise, Marigold and Gomphrena (Local name, English name, Botanical name, Family, Native of, Description, Species record, Distribution, Propagation & Cultivation for each flower) 10

6. **Post-harvest technology of ornamental plants:** Collection, storing, transportation and marketing of cut flowers, seeds, bulbs. 5

**Mushroom Cultivation (Lecture Hr 75)**

1. **Introduction:** General Introduction of Mushroom, Mushroom taxonomy, Collection, Preservation and Identification of mushroom. Biology of mushrooms, Bioconversion of Agro-waste using mushroom cultivation technology. Identification of poisonous and non-poisonous mushrooms, natural habitat of mushrooms, economic, edible and medicinal value of mushrooms. **18**

2. **Influence of Climatic factors:** Temperature, Relative Humidity, Rainfall, light, Wind, Carbon Dioxide. **4**

3. **Production technology:** Equipment required for mushroom cultivation, The principles of mushroom cultivation technology, Major phase in mushroom cultivation (selection of an acceptable mushroom, Requirement and selection of a fruiting culture, development of spawn, Preparation of compost, mycelia running and mushroom development) preparation of mushroom culture media, isolation of mushroom strains, and preparation of mushroom spawn, mushroom substrates (compost and non-compost), preservation and maintenance of mushroom cultures. **20**

4. **Cultivation Techniques:** Cultivation and harvesting of some valuable mushrooms such as Oyster mushroom (*Pleurotus* spp.), white button mushroom (*Agaricus* spp.), Shittake mushroom ( *Lentinula edodes*, ), paddy straw mushroom (*Volvariella volvacea*), *Grifola frondosa* (Maitake), *Flammulina velutipes* (golden pin mushroom), *Ganoderma lucidum*, fungal disease, bacterial disease, viral disease , (Management of pest and weed fungal attack) and their control measures. **25**

5. **Post-harvest management of mushrooms**: Short-term preservation: Washing, packaging, Conventional packaging, Storage of Fresh mushrooms, Transport of fresh mushrooms, Steeping preservation, Long term Preservation: Canning, Drying, Pickle Preparation, and marketing. **8**

**References**

Biswas, Subrata, M. Datta and S.V. Nagachan (2012). Mushrooms: A Manual for Cultivation. PHI Learning Private Limited, New Delhi, India.

Chanda, K.L. &Prateek, D.P. 1996. .*Advances in Horticulture,* vol. 3.Malhotra Pub.House,India.

Des Raj (2002). *Floriculture and Landscaping*.1st Edition, KalyaniPublishers, Ludhiana, India.

Hartmann, H. T., D. E. Kester, F. T. Davies Jr. and R. L. Geneve (2002) *Plant Propagation: Principles and Practices, 7th Edition.* Pearson Education, Inc. (Prentice-Hall), Upper Saddle River, New Jersey.

Ram, R.C. 2007.*Mushrooms and their cultivation Techniques.* Aviskar Prakashan. Jaipur, India.

Shrestha, G.K., Shakya, S.M. and Baral, D.R. and Gautam, D.M. 2001 .*Fundamentals of Agriculture.* IAAS, Rampur, Chitwan.

**Tribhuvan University**
**Institute of Science and Technology**
**Four Years B. Sc. Zoology Course of Study**

**Course Title: Project Work** **Full Marks : 100**
**Course No. : BOT 406** **Pass Marks: 40**
**Nature of Course: Research Work / Presentation** **Year: IV**

**Objective of the Course:**

This course offers students to strengthen the knowledge in research based academic activities related with Botany.

**Botany-Interdisciplinary**

**Plants and Society**

**B. Sc. IVyr (4 yrs course)**

**Course title**: Plants and Society **Full Marks**: 50
**Course No**: Bot 407 **Pass Marks**: 17.5
**Nature of the Course**: Theory **Lectures**: 75

**Objectives:**

To understand:

- Different aspects of plant biodiversity

- Value of plants and livelihood development
- Overall plant and people relationship

**Course Contents**:

1. ***Plant diversity and its importance*** ***25 Lect. Hrs***

   Introduction of plant diversity (global and national context) **3 hr**

   Plants in traditional uses (baskets, cushion, mat, bags, agricultural tools, …..) **5 hr**

   Plants for medicine, food, fodder, ornaments (Orchid, Rose, Carnation, Ferns), timber, fiber (*Girardinia diversifolia*, *Cannabis sativa,Daphne bholua, Agave americana* )and religious use **10 hr**

   Plants and biofuel (biodiesel: *Aesandrabutyracea*, *Jatrophacurcas*, *Ricinuscommunis*), bioethanol, biofertilizers and biopesticides **5 hr**

   Concepts of sustainable use of biodiversity **2 hr**

2. ***Plants in Industry*** ***20 Hrs***

   Dye plants (*Juglansregia*, *Rubiamanjith*, *Mahonianapaulensis*, Lichens): availability, opportunities and livelihood promotion and challenges**4 hr**

   Algae in industry (nutrition, fertilizer, pollution control, energy sources): availability, opportunities and livelihood promotion and challenges **5 hr**

   Bamboo (decorations, building materials, fabrics and clothing, cooking, agriculture instruments, weapons, Briquett(ex. *Lantana camara, Ageratum conyzoides*): availability, opportunities and livelihood promotion and challenges **6 hr**

   Essential oils(ex.Tulsi, Cinnamomum, Eucalyptus, Jasmine): use and value; Waste water treatment: plants in waste water treatment; soil reclamation and bioremediation: plants in soil reclamation and bioremediation **5 hr**

3. ***Society and Plant Resources*** ***30 Hrs***

   Vegetation and society interactions: Trees and forest products, ecosystem services, fire **5 hr**

   Traditional ecological knowledgeand management system: forest and forest products, agriculture and agriculture products) **5 hr**

   Social institutions: Eco-clubs, Aamasamuha, CBOs, CFUGs **5 hr**

   Sacred groves and biodiversity conservation: concept, role in biodiversity conservation **2 hr**

   Transhumance practice and biodiversity conservation: concept, role in biodiversity conservation **2 hr**

Traditional farming system (conventional, conservational agriculture), climate change and agricultural production, genetically modified crops and their effects (ecosystem and human health) **10 hr**

Ethics in plant use **1hr**

**Text Books**


1. Cunningham, A.B. 2001. Applied Ethnobotany. Earthscam, London, UK.
2. GoN/MoFSC. 2014. Nepal Biodiversity Strategy and Action Plan 2014-2020. Government of Nepal, Ministry of Forests and Soil Conservation, Nepal.
3. Jha PK, Neupane FP, Shrestha ML, Khanal IP. 2013. Biological diversity and conservation (Nepal Pedia Series 2). NAST, Kathmandu.
4. Jha PK, Neupane FP, Shrestha ML, Khanal IP. 2013. Environment and Natural Resources (Nepal Pedia Series 1). NAST, Kathmandu.
5. Lekhak HD, Lekhak B. 2009. Natural resource conservation and sustainable development in Nepal. Kshitiz Publication, Kathmandu.
6. Primack, R.B. 2006. Essentials of conservation Biology. Fourth Edition, Sinauer Associates Inc. Publishers, Sunderland, MA, USA.
7. Rajbhandary S. and Ranjitkar S. 2006. *Herbal Drugs and Pharmacognosy: Monographs on Commercially Important Medicinal Plants of Nepal*. Ethnobotanical Society of Nepal (ESON). Kathmandu.
8. Singh, V., Pande, PC and Jain, DK. 2005.Economi Botany. Rastogi Publications, Meerut, India.


**References Books**


9. Jha PK, Karmacharya SB, Balla MK, Chetrri MK, Shrestha BB. 2010. Sustainable use of biological resources of Nepal. ECOS Nepal.
10. Chaudhary RP, Subedi BP, Veetas OR, Aase TH. 2002. Vegetation and Society-Their interaction in the Himalayas. TU, Nepal. UiB, Norway.
11. Joshi KK, Joshi SD. 2001. Genetic heritage and medicinal and aromatic plants of Nepal Himalaya. Budha Academics. Kathmandu.

**Tribhuvan University**

**Institute of Science and Technology**

**4 Years B.Sc. 4th Year Chemistry Course**

**(Revised-2073)**

**Course Title**: General Chemistry-II **Full Marks**: 100

**Course No**.: CHE 401 (major) **Pass Marks**: 35

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

**Course Objectives:**

- To develop student's ability to communicate in appropriate ways.
- To encourage student's to apply their chemical knowledge and understanding to familiar and unfamiliar higher studies in chemistry.
- To pursue higher studies in chemistry.
- To explain the social, economic, environmental and technological implications of chemistry.
- To explain the fundamentals organic synthesis.
- To explain the mechanism, stereochemistry and scope of widely used organic reactions.
- To introduce phase equilibrium & surface chemistry.
- To explain solid structures & its defects.
- To introduce the basic concepts of quantum & statistical mechanics.
- To provide mechanistic approaches of organic reactions.

## Group A: Inorganic Chemistry

**Reactions in Nonaqueous Solvents:** Protic and non protic solvents, criteria of selection of non aqueous solvents, reactions of $NH_3$, reactions of $SO_2$. **6 hrs**

**Inorganic Polymers:** Introduction, review, types of polymerization, homopolymers and heteropolymers, organosilicon compounds and silicones, phosphonitrilic compounds, polythiazyles $(SN)_x$, geopolymer, Silicon nitrides. **10 hrs**

**Organometallic Compounds:** Non transition metals: general survey of types, synthetic methods, metal alkyls of group I, II and III elements, transition metals: transition metal to carbon σ bonds, alkene complexes, haptonomenclature, alkyne complexes, allyl complexes, metallocenes (preparation, properties, structure and elementary approach of bonding with reference to ferrocene), Homogeneous catalysis, Heterogeneous catalysis, Selection of criteria of catalyst.

**10 hrs**

**Bioinorganic Chemistry:** Introduction, Roles of metals in biological system, Essential and trace elements in biological system, Metals and its complex as therapeutic agents, Iron and copper as oxygen carriers in biological system, The chemistry of elements in medicine, Chelation therapy and anticancer drugs, Introduction to anticancer drugs and its mechanism with reference to cis-platin. **13 hrs**

**Lanthanides and actinides:** Lanthanides: Comparative study of lanthanide elements, with respect to electronic configuration, atomic radii, oxidation state and complex formation, colour and spectra, magnetic properties, lanthanide contraction, occurrence and principles of separation of lanthanides, General features and chemistry of actinides, principles of separation of Np, Pu, Am from U. Trans-uranium elements: Introduction, synthesis of transuranium elements from $_{93}$Np to $_{103}$Lr). **11 hrs**

## Group B: Organic Chemistry

**Name Reactions**: Introductory study of glossary of at least 30 name reactions, their simple mechanism, applications and the utilities of the synthetic reagents involved therein under the following heading of reaction types– oxidation, reduction, condensation, rearrangement, addition and elimination (name reactions are given in the Appendix I) **16 hrs**

**Introduction of Green Chemistry**: Introduction, definition of green chemistry, price of achievements of green chemistry, foundation pillars of green chemistry, future status of green chemistry, green catalyst (phase transfer catalyst). **2 hrs**

**Organic Synthesis: Retrosynthetic Analysis by Disconnection Approach–** Gradual development of organic synthesis, Retrosynthesis, Monofunctional disconnection (Examples of alcohol, alkene, ketone, carboxylic acid and their derivative, alkane, amine disconnections), Bifuntional disconnection, Microwave assisted organic synthesis, Protection of functional groups, Introduction, Protection of C-H bond, C=C bond, alcoholic-OH, amino group, aldehydes and ketones, carboxylic group, solid support synthesis, combinatorial synthesis, common solid supports, peptide synthesis on solid support. 1**2 hrs**

**Introduction to Supramolecular Chemistry: Host-Guest Chemistry–** Introduction, cation binding host molecules, selectivity of host molecules, a few synthetic cation binding host molecules, some uses of cation binding host compounds, anion binding host compounds, neutral molecule trapping host compounds. **6 hrs**

**Drugs: Chemotherapeutic and Pharmacodynamic Agents:** Introduction, classification of drugs, chemotherapeutic agents, antibacterial drugs, antibiotics, synthetic antibacterial agents, antiprotozoal drugs, antifungal agents, antiviral drugs, action of chemotherapeutic agents against microorganisms, pharmacodynamic agents, analgesic and anti-inflammatory agents, psycotropic drugs, antihistamines, antidiabetic drugs, drugs for cardiovascular diseases, antineoplastic drug, drug resistance, new development in drug research, drug designing, computer aided drug designing. synthetic dyes, classification and uses of dyes, brightening agents. **14 hrs**

## Group C: Physical Chemistry

**Phase Equilibrium:**

Introduction, definition and meaning of the terms–phase, component and degree of freedom, Gibbs phase rule, phase diagram, phase equilibrium of one component system: water.

***Phase equilibrium of two component system (solid-liquid system)–*** Introduction and cooling curves, simple eutectic Pb–Ag system, desilverization of lead, system involving compound formation with congruent melting point (phase diagram of Mg–Zn) and system involving compound formation with incongruent melting point (phase diagram of NaCl-water).

***Binary liquid systems–*** Completely miscible liquid pairs, ideal and non-ideal liquid mixture, distillation of binary liquids, ratio of distillate to residue, fractional distillation, azeotropes.

***Partial miscible liquid pairs–*** Phenol–water system, tri–ethylamine water system, nicotine water system, lower and upper consolute temperatures, Henry's law, Nernst distribution law and applications, distribution of solute between two phases, solvent extraction.

***Completely immiscible liquid pairs–*** Benzene water system, steam distillation. **14 hrs**

**Solid State Chemistry:**

Interplanar distance in cubic system, Braggs law and its application, crystal structure of NaCl and KCl, defects in crystals: point defects (Frenkel, Schottky and self-interstitial defects), line defects (edge and screw dislocations) and plane defects (grain boundary and stacking faults), color centers and formation of F-centre, classification of solids based on the formation of band: conductor, semiconductor, insulator and superconductor. **14 hrs**

**Surface Chemistry:**

Adsorption: absorption and sorption, physical and chemical adsorptions, types of physical adsorption isotherms, Gibbs adsorption equation, Freundlich adsorption isotherm & Langmuir adsorption isotherm: postulates, derivation, interpretation and limitation; Brunauer-Emett-Teller (BET) adsorption: postulates, equation, interpretation and limitations, determination of surface area of solid adsorbents **10 hrs**

**Quantum & Statistical Mechanics:**

*Quantum Mechanics*– Introduction, history of quantum mechanics (Max Planck to Schrödinger), ultraviolet catastrophe, wave-particle duality, time independent Schrödinger wave equation, wave function and probability, concept of orthogonal and normalized wave functions, postulates of quantum mechanics, quantum mechanical operators, particle in a box (one dimensional and three dimensional).

*Statistical Mechanics*– Introduction, history of statistical mechanics, concept of phase space, ensemble, entropy and thermodynamic probability, distribution of identical but distinguishable particles, Boltzmann distribution law **12 hrs**

**Course Title**: General Practical Chemistry-II **Full Marks**: 50

**Course No.**: CHE 402 (major) **Pass Marks**: 20

**Nature of the Course**: Practical **Year**: IV

**Course Objectives:**

- To follow instructions for practical work.
- To make students aware of the importance to scientific method of accurate observation and measurements being aware of possible sources of error.
- To record and interpret accurately and clearly the results of experiments.
- To explain practical techniques, procedures and safe laboratory working practices.

**Experiments in Inorganic Chemistry**

**Quantitative Estimation**

- Precipitation titration of silver nitrate in acidic media (Volhard Method ).
- Redox titration involving potassium dichromate (Determination of iron in Mohr's salt and haematite). **12 hrs**

**Gravimetric Analysis**

- Nickel as complex with dimethyl glyoxime; Copper as cuprous thiocyanate; Aluminum as oxinate; Lead as lead chromate; Magnesium as magnesium ammonium phosphate and as pyrophosphate. **27 hrs**

**Paper Chromatography**

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

**Ion–Exchange chromatography**

- Separation of metal ions from mixture.

**Preparation of complex**

- Preparation of potassium trioxalatoferrate(III) trihydrate and measurements of its conductivity. Estimate the amount of iron present in the above complex. **6 hrs**

**Experiments in Organic Chemistry**

1. Spectral analysis (spectra of simple organic compounds including aliphatic and aromatic hydrocarbons, alcohols, aldehydes, ketones, carboxylic acid, amines, etc will be provided and students are required to interpret the given spectra and find out the structures of organic compounds).

2. Two-three sets of two steps synthesis.
3. Purification and separation of organic mixtures by paper, thin layer and column chromatographic techniques.
4. Determination of the amount of aspirin present in the given 150 mg aspirin tablet by indirect titration against the standard HCl.
5. Estimation of ascorbic acid in vitamin C tablet iodometrically.
6. Benzoin condensation (a green synthesis using thiamine hydrochloride replacing KCN).
7. Introduction to micro scale organic experiments. **51 hrs**

**Experiments in Physical Chemistry**

1. To carry out conductometric titration between the mixture of hydrochloric and acetic acids against standard sodium hydroxide solution.
2. To study the kinetics of acid catalyzed iodination of propanone.
3. To study the kinetics of oxidation of ethyl alcohol with potassium dichromate in acidic media.
4. To determine the partition coefficient of iodine between organic liquid and water.
5. To determine the freezing point curve of the mixture of naphthalene and biphenyl and also to construct the phase diagram.
6. To verify the Beer-Lambert's law and to determine the concentration of a color solution of unknown strength using filters colorimeter/spectrophotometer.
7. To determine the critical solution temperature of phenol-water system and the composition of the solution at CST.
8. To study the adsorption of acetic acid from aqueous solution by activated charcoal and to examine the validity of Freundlich and Langmuir's adsorption.

**51 hrs**

**Course Title**: General Chemistry-III **Full Marks**: 100

**Course No.**: CHE 403 (major) **Pass Marks**: 35

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

**Course Objectives:**

- To understand the fundamentals of coordination compounds.
- To know the chemistry of lanthanides and actinides.
- To understand the chemistry of bio-organic molecules.
- To discuss different types of chemical and photochemical reactions, and their kinetics.

- To provide knowledge on modern electrochemistry and its uses.
- To introduce the basic concepts of corrosion sciences.

## Group A: Inorganic Chemistry

**Coordination Compounds:** Isomerism in coordination complexes: (a) polymerization isomerism, (b) ionization isomerism, (c) hydrate isomerism (d) linkage isomerism, (e) coordination isomerism, (f) coordination position isomerism (g) geometric isomerism, (h) optical isomerism, IUPAC nomenclature of coordination compounds, **8 hrs**

**Bonding and Application of Coordination Compounds:** Valence bond theory, inner and outer orbital complexes, crystal field theory, Jahn Teller distortion in octahedral and tetrahedral complexes, characterization of complexes by spectroscopic, Optical and magnetic methods, chelates and polynuclear complexes, high spin and low spin complexes, stereochemistry of complexes with coordination number 4 and 6, substitution reactions and trans effect, application of complexes in analytical and biological fields.

Stability constant or formation constant: Kinetic stability (Labile and inert complexes), thermodynamic stability, (stable and unstable complexes), stepwise stability constant and overall stability constant of complexes, factors influencing the formation of complexes (thermodynamic and kinetic stability). **22 hrs**

**Inorganic Reaction Mechanism:**

Fundamentals of ligand substitution reaction: Activated complex, Labile and inert complexes, mechanism of substitution reaction: 1. dissociative (d) mechanism, 2. Associative (a) mechanism, basic idea of redox reaction in coordination complexes: atom transfer mechanism and electron transfer mechanism.

**10 hrs**

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

**10 hrs**

## Group B: Organic Chemistry

**Bio-organic Chemistry:** Biological oxidation and reduction, (ethanol and acetaldehyde), biological oxidation and reduction (deuterium labeling experiments), stereochemistry of biological oxidation and reduction, organic chemistry of vision, biosynthesis of fatty acids, mechanism of enzyme action (chymotrypsin). **10 hrs**

**Carbohydrates:** Introduction, definition and classification, (+)–glucose as an aldohexose, (-)-fructose as a 2-keto hexose, stereo isomers of (+) –glucose, oxidation (effect of alkali, osazone formation (epimers), lengthening and shortening the carbon chain of aldoses, conversion of an aldose into its epimer, conversion of aldose into ketose and vice versa, configuration of (+)–glucose (the Fischer proof), configuration of aldoses, optical families D and L, tartaric acid,

families of aldoses (absolute configuration), open and cyclic structure of glucose, configuration about C-1, methylation, determining ring size, conformation. **18 hrs**

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

**Proteins & Nucleic Acid:** Protein, structure of amino acids, amino acids as dipolar ions, isoelectric point, configuration of natural amino acids, preparation of amino acids, reactions of amino acids, Dopa mine and its uses in medicine peptides (geometry of peptide linkage), determination of structure of peptides, synthesis of peptides, proteins (classification and functions), structure of protein, peptide chain, side chain (isoelectric point, electrophoresis), conjugated proteins, secondary structure of protein, nucleoproteins and nucleic acids, the genetic code. **16 hrs**

## Group C: Physical Chemistry

**Chemical Kinetics:**

Consecutive reaction, parallel reaction, opposing reaction, theories of reaction rates: collision theory of a bimolecular and unimolecular reactions, transition state theory, chain reaction, kinetics of some gas phase photochemical reactions: (a) decomposition of ozone, (b) hydrogen and chlorine (c) hydrogen and bromine, kinetics of condensation polymerization **15 hrs**

**Modern Electrochemistry:**

*Ion-solvent and ion-ion interactions*: Ion-solvent interaction, solvation (thermodynamic and spectroscopic approaches) and dielectric effects, quantitative treatment of the Debye-Hückel (ion cloud) theory of ion-ion interactions, Debye-Hückel theory of activity coefficient and its limitations **15 hrs**

**Polarization & Commercial Cell:**

Polarization of electrochemical cell, types of polarization (activation, concentration & overvoltage), determination of hydrogen overvoltage, application of overvoltage (deposition of metal), commercial cells; principles, applications and limitations of primary cell (Leclanche cell) and secondary cells (lead-acid and nickel-cadmium cells), fuel cells (introduction & types) **8 hrs**

**Corrosion of Metallic Materials:**

Introduction, cost & importance of corrosion study, types of corrosion: based on corroded surfaces & environments (aqueous, atmospheric, soil & concrete), fundamentals of corrosion cells, brief discussion of corrosion control methods (including inhibitors and cathodic protection techniques) **12 hrs**

**Full Marks**: 50

**Course Title**: General Practical Chemistry-III

**Course No.**: CHE 404 (major) **Pass Marks**: 20

**Nature of the Course**: Practical **Year**: IV

**Course Objectives:**

- To follow instructions for practical work.
- To make students aware of the importance to scientific method of accurate observation and measurements being aware of possible sources of error.
- To know the principles of qualitative and quantitative analysis of chemical substances.
- To record and interpret accurately and clearly the results of experiments.
- To explain practical techniques, procedures and safe laboratory working practices.

## Experiments in Inorganic Chemistry

**Qualitative analysis of salt mixture containing 6 radicals (including interfering radicals)**

**30 hrs**

**Iodometric Titration** **6 hrs**

1. Estimation of available chlorine in bleaching powder iodometrically.
2. Determination of dissolved oxygen in water sample by Winkler's iodometric method.

**Complexometric Titration** **6 hrs**

1. Determination of amount of Magnesium and Manganese in a given mixture solution by EDTA.
2. Determination of amount of Copper and Iron in a given mixture solution by $K_2Cr_2O_7$ solution.

**Colorimetric Analysis** **9 hrs**

1. Determination of Pb as dithizone complex colorimetrically.
2. Colorimetric determination of $PO_4^{-3}$ by molybdenium blue method.

## Experiments in Organic Chemistry

1. Quantitative analysis of any two: (OH-group, nitrogen, sulphur, glucose, carbonyl group),
2. Isolation of the following natural products (any two): lactose, caffeine, camphor, essential oil.
3. Perform the characteristic reactions of carbohydrates, fats and protein.
4. Determination of acid value of fats or oil.

5. Determination saponification value of fats or oil.
6. Determination of iodine number of fat or oil.

**51 hrs**

**Experiments in Physical Chemistry**

1. To determine the size of a molecule of the given compound by viscosity measurement.
2. To determine concentration of $Cl^-$ in KCl or $I^-$ in KI solution titrating with standard silver nitrate solution potentiometrically.
3. To determine rate constant for the saponification of ethyl acetate by sodium hydroxide by conductivity method.
4. To determine the concentration of phosphoric acid in cola beverage using pH meter.
5. To study the effect of concentration of catalysts on the reaction rate for acid catalyzed hydrolysis of methyl acetate.
6. To determine the activation energy for the reaction between potassium persulfate and potassium iodide by iodine clock method.
7. To determine the $\lambda_{max}$ and molar absorbtivity coefficient ($\varepsilon$) for ferric-thiocynate complex and also to determine the concentration of iron in a given sample of water.
8. To carry out potentiometric titration of acetic acid with sodium hydroxide using quinhydrone electrode and to determine the dissociation constant.

**51 hrs**

**Text Books: for theory courses CHE 401 & CHE 403:**


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. R. Pokhrel & B. R. Poudel, *A Textbook of Inorganic Chemistry*, 2nd Edition, National Book Centre, Kathmandu, 2011.
4. D. F. Shriver & P. W. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press.
5. J. E. Huheey, E. A. Keiter & R. L. Keiter, *Inorganic Chemistry, Principles of structure and Reactivity*- Addison Wesley Publishing House, 1990.
6. S. Pimplapure, R. Jain, A. Sahai & U. Soni, *Inorganic Polymer Chemistry*, Pragati Prakashan, Meerut, 2012.
7. W. U. Malik, G. D. Tuli & R. D. Madan, *Selected Topics in inorganic chemistry*, .S. Chand & Company, New Delhi, 1995.
8. B. Doglas, D. MacDaniel & J. Alexander, *Concepts and Models of Inorganic Chemistry*, Recent edition

9. F. Basolo & R. G. Pearson, *Inorganic Reaction Mechanism*, 2nd edition, Wiley, New York, 1967.
10. R. B. Jordan, *Reaction Mechanism of Inorganic and Organometallic Systems*, 3rd edition, oxford University Press, 2007.
11. R. T. Morrison, R. N. Boyd & S. K. Bhattacharjee, *Organic Chemistry*, 7th Edition, Prentice- Hall of Pearson, 2012.
12. J. March, *Advanced Organic Chemistry*, 4th Edition, Wiley Eastern Ltd., India, 2005.
13. Jonathan Clayden, *Organic Chemistry*, 2nd Edition, Oxford University Press, India.
14. F. Carey, R, Giuliano, *Organic Chemistry*, McGraw-Hill 8th Edition, 2010.
15. S. H. Maron & C. Prutton, *Principles of Physical Chemistry*, 4th Edition, Oxford & IBH Pub. Co., 1992.
16. J. O'M Bockris & A. Reddy, *Modern Electrochemistry*, **Vol. I**, 2nd Edition, Plemum Pub. Corp., New York, 1998.
17. 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.
18. R. W. Revie & H. H. Uhlig, *Corrosion and Corrosion Control; an Introduction to Corrosion Science and Engineering*, 4th Edition, John Wiley & Sons, Inc., New York, 2008.
19. S. O. Pillai, *Solid State Chemistry*, Wiley Eastern Ltd., 1994.
20. A. K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw-Hill, New Delhi, India, 1994.

**Reference Books: for theory courses CHE 401 & CHE 403:**

1. R. D. Madan & Satya Prakash, *Modern Inorganic Chemistry*, S. Chand & Company Ltd., 1994.
2. A. K. Bhagi & G. R. Chatwal, *Bioinorganic and Supramolecular Chemistry*, Himalaya Publishing House, Mumbai.
3. A. Sharpe, *Inorganic Chemistry*, 2nd Edition, ELBS & Longman, Singapore, 1986, (Recent edition).
4. M. L. Sharma & P. N. Chaudhary, *A Textbook of B. Sc. Chemistry* (Volume I and II), Second Edition, Ekta Books Nepal, 2007.
5. K. N. Upadhyaya, *A Textbook of Inorganic Chemistry*, 2nd Edition, Vikash Publishing House Pvt., Ltd., 1995
6. C. Agrawal, *Modern Inorganic Chemistry*, Wiley Eastern, New Delhi, 1981, (Latest edition).
7. I. L. Finar, *Organic Chemistry*, Vol. I and Vol. II, Prentice Hall, London, (Latest edition).

8. Streitweiser & Heathcock, *Introductory Organic Chemistry*, Wiley and Sons, New York, 1981.
9. B. S. Bahl & A. Bahl, *A Textbook of Organic Chemistry*, S. Chand Publication, New Delhi, India, 2012.
10. T. W. Graham Solomons, *Organic Chemistry*, (latest edition), John Wiley and Sons, New York.
11. G. M. Loudon, *Organic Chemistry*, Fourth Edition, Oxford University Press, India.
12. R. A. Bansal, *A Textbook of Organic Chemistry*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1993 (Available recent edition).
13. C. Norman, *Principles of Organic Synthesis*, 2nd Edition, Chapman and Hill. London, 1978, (recent edition)
14. Warren, *Organic Synthesis, The Disconnection Approach*, Wiley, New York, 1982. (available recent edition)
15. H. House, *Modern Synthetic Reactions*, 2nd Edition, W. A. Benjamin. New York, 1972.
16. S. Glasstone & D. Lewis, *Elements of Physical Chemistry*, Mcmillan & Co., Ltd.
17. P. Atkins & J. D. Paula, *Atkin's Physical Chemistry*, 10th Edition, Oxford University Press, 2014 (reprinted).
18. J. O'M Bockris, A. Reddy & M. Gamboa-Aldeco, *Modern Electrochemistry* Vol. 2A, 2nd Edition, Kluwer/Plemum Publishers, New York/London/Moscow, 2000.
19. S. Negi & S. C. Anand, *A Textbook of Physical Chemistry*, New Age International (P) Ltd., New Delhi, 1999.
20. A. Bahl, B. S. Bahl & G. D. Tuli, *Essential of Physical Chemistry*, Revised Multicolor Edition, S. Chand & Co. Ltd., New Delhi, 2009.
21. D. Alberty, *Physical Chemistry*, 6th Edition, Wiley Eastern Ltd., New Delhi, 1992.
22. J. Bhattarai, *Frontiers of Corrosion Science*, 1st Edition, Kshitiz Publication, Kathmandu, 2010.
23. J. Bhattarai & D. B. Khadka, *Surface Characterization and Solid State Chemistry*, Sunlight Publication, Kathmandu, 2010.
24. K. L. Kapoor, *Text Book of Physical Chemistry*, Macmillan India Ltd., Vol. I to Vol.V, 3rd Edition, 2001.
25. D. N. Bajpai, *Advanced Physical Chemistry*, S. Chand & Co., New Delhi.
26. J. N. Gurtu & A. Gurtu, *Advanced Physical Chemistry*, 8th Edition, Pragati Publication, Meerut, India, 2006.
27. H. V. Keer, *Principles of the Solid State*, New Age International (P) Ltd., New Delhi, 2002.
28. V. K. Jha, *Introductory Quantum Mechanics*, Balkhu, Kathmandu, Nepal, 2012.

29. S. K. Gautam, S. K. Kalauni, K. R. Sharma, B. R. Poudel, D. Wagle, *Text Book of Chemistry*, vols 1 & 2, National Book Centre, 2016.

**Text Books: for practical courses CHE 402 & CHE 404:**

1. A. I. Vogel, *A Text Book of Quantitative Inorganic Analysis, Including Elementary Instrumental Analysis*, ELBS & Longman, 1969, (Preferably available recent edition).
2. 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).
3. N. K. Vishnoi, *Advanced Practical Organic Chemistry* (2nd Revised Ed), Vikas Publishing Pvt. Ltd. India.
4. Moti Kaji Sthapit & R. R. Pradhananga, *Experimental Physical Chemistry*, Taleju Prakasan, Kathmandu, 1998.
5. N. M. Khadka, S. D. Gautam & P. N. Yadav, *A Core Experimental Chemistry for B.Sc.* Heritage Publication, Kathmandu, 2016.

**Reference Books: for practical courses CHE 402 & CHE 404:**

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, (Latest Edition).
3. F. G. Mann & B. C. Saunders, *Practical Organic Chemistry*, Orient Longman, 1986, (recent edition).
4. M. R. Pokhrel, P.N. Yadav & S. Shrestha, *Advanced Practical Inorganic Chemistry for M. Sc.*, Kshitiz Publication, 2009.
5. A. K. De, *Environmental Chemistry*, New age International Ltd Publishers, New Delhi.
6. J. N. Gurtu & A. Gurtu, *Advanced Physical Chemistry Experiments*, 4th Edition, Pragati Prakashan, 2008.
7. J. N. Gurtu & R. Kapoor, *Advanced Experimental Chemistry* (Vol I-III), S. Chand & Co. New Delhi, 1984.
8. J. B. Yadav, *Advanced Practical Physical Chemistry*, 33rd Edition, Goal Publ. House, Meerut, 2014.
9. A. Rajbhandari (Nyachhyon) and S. Pradhananga (Shrestha), *Inorganic Salt Analysis*, 1st Edition, Rajbhandari-Pradhananga Publication, Kathmandu, 2013.

**Course Title:** Applied Chemistry **Full Marks:** 100

**Course No.:** CHE 405 **Pass Marks:** 35

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

**Course Objectives:**

The outcome of this course will be:

- To encourage students to apply chemical knowledge in understanding the chemical process involved in the industrial processes.
- To understand the natural wealth of Nepal and develop ideas to apply these resources for the industrial growth of Nepal.
- To develop student's ability in the applied field of chemistry.

**Introduction of Applied Chemistry: 5 hrs**

Introduction, chemical industries-facts and figures.

Unit operation and unit process (outlines of unit operations, general principle applied in studying industry, process and design with focus on block diagrams.

Economics (profitability analysis-capital investment, total production costs, economic analysis (return on investment), principle of economic balance-choice between alternative processes.

**Inorganic Chemical Industries: 35 hrs**

Introduction on inorganic chemical industries.

*Fertilizer industries*: introduction, NPK fertilizers, consumption and scopes.

*Nitrogen industries*: introduction, consumption and major products.
Urea: properties, consumption pattern, methods of production (from ammonium carbamate decomposition), raw materials, process description, flow sheet, major engineering problems, economics.

*Phosphorus industries*: introduction, consumption pattern, major products

Calcium phosphate: superphosphate vs triple phosphate, production of superphosphate and triple phosphate, raw materials, process description, flow sheet, major engineering problem, economics

*Cement and lime*: Introduction, properties (constituents of cement-Portland and its type, high alumina, hydraulic hydrated lime), compressive strength, Cement industries in Nepal, methods of production (Portland cement), raw materials with emphasis on Nepalese context, process description, flow sheet, major engineering problems, economics, overall factors to be considered in cement industries
Lime: properties, consumption patter, methods of production, process description, flow sheet, major engineering problem, economics

*Ceramics*: Introduction, manufacturing process, raw materials (clay minerals, kaolin, ball clay, fire clay), methods of production: firing, stages of firing, types of kilns, properties, consumption pattern, ceramics industries in Nepal, economics

*Water industries*: Introduction, sources of water, consumption pattern, water storage and related problems, methods of treating fresh water, process description, flow sheet, major engineering problem, economic considerations, waste water treatment and disposal.

**Natural Products Industries: 25 hrs**

*Oils*: Introduction, raw materials of oils, methods of extractions (mechanical, solvent extraction, purification), hydrogenation of oils (with flow sheet diagram).

*Soaps and detergents*: Introduction, classification of cleansing compounds, use of soap and detergents, methods of soap production: continuous process for fatty acids, soap, and glycerine, methods of detergent manufacture, consumption pattern.

*Paints and varnishes*: Introduction, pigments and extenders, functions of oils in paints, uses of driers in paints, uses of resins, diluents in paints and varnishes, economics of paints and varnishes industries.

*Fermentation industries*: Introduction, characteristics and economics of fermentation industries, kinetics and scale-up of submerged and aerobic fermentation process, air and media sterilization, continuous and batch fermentation, consumption pattern of ethyl alcohol, methods of ethyl alcohol production with flow sheet diagram, economics of ethyl alcohol industry.

*Pulp and paper industries*: *Pulp:* Introduction, methods of production, sulfate (Kraft) pulp process, comparison of chemical pulping process for cellulose fibers, major engineering problems. *Paper:* introduction, types of paper, raw materials, methods of production (including Nepali paper- Lokta) and economics of paper industries.

**Polymerization Industries: 15 hrs**

*Polymerization technology*: Introduction, classification of polymer applications (adhesive, coatings, fibers, solid shapes).

*Polymer manufacturing process*: Process description with flow sheet and economics involved in plastic (polyethylene, PVC, epoxide), butadiene-styrene rubber and fibers (nylon).

**Metallurgical Industries: 30 hrs**

*Iron and Steel:* Introduction

*Iron:* Raw materials, sources of ores with reference to Nepal, production of Pig iron (process description with flow sheet), major engineering problems.

*Steel:* Raw materials, production of steel, process description with flow sheet-Open Hearth process, major engineering problems and economics.

*Aluminum:* Raw materials, method of production, process description, major engineering problems and economics.

*Copper:* Raw materials, method of production with flow sheet diagram.

*Lead:* Raw materials and production.

*Zinc:* Raw materials and production.

**Electrochemical Industries: 15 hrs**

Introduction

Some practical problems in using electrochemical theory (voltage efficiency (polarization), current efficiency, energy efficiency, decomposition efficiency

Example of electrochemical industries: 1. electroplating of Nickel and chrome on steel; 2. Fuel cells-efficiency, $H_2$-$O_2$ fuel cell, development of commercial fuel cell and battery-lead–acid battery; 3. Electro-organic chemical processes: production of adiponitrile and tetraethyl lead-raw materials, flow sheet with process description and major engineering problems; 4. Corrosion and its prevention: selection of materials, proper design, altering environments, inhibitors, coatings

**Safety Considerations in Chemical Process Industries: 25 hrs**

Introduction

*Chemical storage-safety issues:* past experience, layout, safety standards, safety features, operational hazards, packaged chemical storage, safety measures, fire protection and loss prevention

*Observations related to safety aspects:* management's concern for safety, plant design, hazard identification and safety audit, system and procedures, maintenance, technical services, safety organization, firefighting facilities, emergency preparedness, human inhabitation in the vicinity of chemical plants, factory act and statuary bodies

*Specific recommendations for hazard control and improved plant safety*: Nepalese Guidelines/acts, Guidelines from developed countries, environment protection act, hazards and safety of chemical plants.

*Packaging of chemical and dangerous goods:* basic requirements, types of container, sacks, glass carboys, plastic containers, intermediate-bulk containers.

*Chemical plant safety-from concept to decommissioning:* Technology-selection and development, process design, instrument design, equipment design, plant layout, plant erection, training, plant start-up and commissioning, regular plan operation and maintenance, plant decommissioning or demolition.

**Text Book: for theoretical course CHE 405**


1. Charles E. Dryden, *Outlines of Chemical Technology*, edited and revised by M. Gopala Rao and Marshall Sittig, affiliated East-West Press Pvt. Ltd. New Delhi, 2010.


**Refernce Books: for theoretical course CHE 405**


1. K. H. Davi & F.S. Berner, *Handbook of Industrial Chemistry*, Vol. 1 and 2( Edited by S. C. Bhattia, CBS Publishers and Distributors, New Delhi, 2000.
2. Philip Matthews, *Advanced Chemistry*, Cambridge University Press, 1997.
3. Thankamma Jacob, *A Textbook of Applied Chemistry*, Macmillan India Limited, 1997.

4. P. K. Gangopadhyay, *Application Orientated Chemistry*, Book Syndicate Pvt. Ltd., Kolkata, 2009.
5. B. R. Pandey, *An Easy Approach to Applied Chemistry*, Heritage Publishers & Distributors Pvt. Ltd., Kathmandu, 2016.
6. *ISO-Laboratory Safety*-Accreditation by Nepal Bureau of Standards & Metrology, Kathmandu, Nepal.
7. L. P. Poudel, *Mineral Resources of Nepal*: An Analytical Study (**in Nepali**), Devi Dhakal, Kathmandu, 2011 (2068).
8. www.doind.gov.np

**Course Title:** Basics of Nanoscience and Technology **Full Marks:** 50

**Course No.:** CHE 407 **Pass Marks:** 17.5

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

**Course Objectives:**

- To provide fundamentals of nanoscience and nanotechnology to the undergraduate student.
- To make the students acquainted with basic techniques of nano-meterials fabrication and characterization.
- To provide the knowledge of nanotechnology and its applications.

**Introduction to Nanotechnology:** History of nanotechnology, definitions, nanotechnology as interdisciplinary field, nanotechnology in nature, classification of nonstructural materials. **5 hrs**

**Preparation Methods of Nano-materials:** Bottom up approaches: physical vapor deposition (inert gas condensation, laser ablation) & chemical vapor deposition (thermally activated CVD, plasma-enhanced CVD, spry conversion processing, sol-gel process, wet chemical synthesis, self assembly), top down approaches: mechanical alloying, nanolithography, consolidation of nanopowders: shockwave consolidation, hot isostatic processing & cold isotatic processing, spark plasma sintering. **20 hrs**

**Characterization Techniques for Nano-materials:** Characterization of nano-materials using X-ray diffraction (Scherrer's equation) and imaging microscopic techniques (scanning electron microscopy, scanning probe microscopy: scanning tunneling microscopy & atomic force microscopy, and transmission electron microscopy), nano-indention. **20 hrs**

**Applications of Nano-materials:** Nano-electronic, nanotube-based sensors, nano-catalysis, cosmetics and consumers goods, Food and agriculture, nano-medical applications, water

treatment and environment, energy, textile, paints, defense, health risks, applications in structural engineering. **20 hrs**

**Nonostructural Materials with High Application Potential:** Quantum dots, carbon nanotubes, nanocrystalline ZnO & $TiO_2$, multilayer films. **10 hrs**

**Text Book: for theoretical course CHE 407:**

1. B. S. Murthy, P. Shankar, Balvev Rj, B. B. Rath & James Murday. *Textbook of Nanoscience and Nanotechnology*, Series in Metallurgy and Materials Science, Baldev Raj (Ed.), Universities Press Private Hyderabad, India, 2012.

**Reference Books: for theoretical course CHE 407**

1. K. K. Chattopadadhyay & A. N. Banerjee. *Introduction to Nanoscience and Nanotechnology*, PHI Learning Private Limited, New Delhi, 2012.
2. C. P. Poole & F. J. Owens. *Introduction to Nanotechnology*, Wiley India Limited, 2012.
3. C. N. R. Rao, *Nanoworld: An Introduction to Nanoscience and Nanotechnology,* JNCASR, Bangalore, 2010.
4. J. Bhattarai, *Frontiers of Surface Science*, 1st Edition, Kathmandu, 2012.

**Appendix I**

**List of name reactions:-**

**Condensation reactions**

1. Dieckmann condensation
2. Darzen's reaction
3. Intramolecular Claisen Condensation
4. Knoevenagel condensation
5. Benzoin condensation

**Rearrangement reactions**

1. Beckmann rearrangement
2. Claisen rearrangement
3. Cope rearrangement
4. Favorskii rearrangement
5. Curtius rearrangement
6. Pinacol-pinacolone rearrangement
7. Wagner–Meerwein rearrangement
8. Wittig rearrangement

9. Benzelic acid rearrangement

**Reduction reactions**

1. Birch reduction
2. Catalytic hydrogenation reduction
3. Meerwein Ponndorf-Verley reduction

**Oxidation reactions**

1. Baeyer–Villiger oxidation
2. Oppenauer oxidation
3. Lead tetraacetate oxidation
4. Chromic acid oxidation
5. Permanganate oxidation
6. Peracid oxidation

**Elimination reactions**

1. Hofmann degradation
2. Pyrolytic elimination

**Addition to Carbon Carbon multiple bond andCarbon –Hetero multiple bond**

1. Michael reaction
2. Diel's Alder reaction
3. Mannich Reaction
4. Reformatsky Reaction
5. Halogenation of dienes

# Environmental Science

## FOURTH YEAR

**Course Title: Env. Resources and Biodiversity Conservation** **Lecture hours: 150**
**Course No: ENV. 401** **Full marks: 100**
**Nature of Course: Theory (Compulsory - I)** **Pass marks: 35**

### Objectives

The broad objective of the course is to provide basic theoretical knowledge on environmental resources and biodiversity conservation. The specific objectives of the course are as follows:

- To give an overview of a concept and issues of natural resource: water resource, land and mineral resource, biological resource, energy resource and food resource
- To familiarize the students with the human resources, indigenous knowledge and their importance on sustainable natural resources management
- To acquaint students with the current state of global and national biodiversity
- To provide extensive knowledge on major threats to biodiversity and threatening processes
- To familiarize students with the practices and approaches to biodiversity conservation
- To familiarize students with conservation policies leading to sustainable development

### A. Environmental Resources

**Unit 1: Water, Land and Mineral Resources** **20 hrs**

**1.1 Water Resource** 10 hrs

Introduction; Major sources of water; Types of storage structure: aquifers, cisterns, ponds, reservoirs; Existing water use; Water scarcity; Sustainable management of water resources; Rain water harvesting techniques; Watershed management; Planning for water resources development; Hydrology of urban area and agricultural lands; Water quality control.

**1.2 Land and Mineral Resources** 10 hrs

Land resource: Land resource and land use; Land type: Land capability, land suitability; Land reform; Mineral resource: Introduction; Type: Metallic, non-metallic and energy minerals; Mineral resource potential in Nepal; Mining practices; Adverse effect of mining practice in environment (exploration, transportation and uses); Mine field reclamation, Mineral based industries in Nepal.

**Unit 2: Food and Energy Resources** **20 hrs**

**2.1 Energy Resources** 10 hrs

Concept of energy and energy units; Production and consumption of energy: Global, regional and national scenario; Energy efficiency: industry, transportation, commercial and residential buildings; Non-renewable energy resources: Coal, oil and natural gas; Renewable energy resources: Solar, wind power, hydropower, biomass, geothermal, tidal, wave, oceanic, nuclear and energy from wastes; Status and issues of energy resources in Nepalese context.

**2.2 Food Resources** 10 hrs

Major food resource and production; World food problems; New trends in food resource; Human nutrition and health problem associated with food; Food sufficiency; Food aid; Organic food product and environmental benefit.

**Unit 3: Indigenous Practices in Resource Management** **15 hrs**

Human population growth trends in global, regional and national level; Human population distribution, regulation; Development of human society and use of environmental resources; Environmental crisis on planet earth; Natural resources and community values; Concept of indigenous knowledge, Indigenous knowledge practices in Nepal; Case study.

**B. Biodiversity Conservation**

**Unit 1: Introduction and Status of Biodiversity** **25 hrs**

Biodiversity: concepts, levels (gene, species, ecosystem); Scope and importance of biodiversity; Patterns in distribution of biodiversity; Factors affecting distribution of biodiversity; Gradients of biodiversity: Major hypotheses in biodiversity gradients; Biodiversity crisis (ecocrisis); Conservation history: Antiquity (eastern versus western practices and philosophies), the middle ages, the industrial ages, the post industrial age (*Silent Spring, The Quiet Crisis*); Conservation movement: Pinchotism, Chipko movement; The Land Ethics; The death of environmentalism; Conservation science as a mission driven discipline: Challenging the global challenge.

Current state of biodiversity: Global, regional and national; Biodiversity and ecosystem services, biodiversity and ecosystem functioning; Value of biodiversity: Instrumental value and intrinsic value; Monetizing value of biodiversity; Payment for ecosystem services (PES).

State of biodiversity in Nepal: Forests (types and distribution, importance, degradation and its causes, consequences of forest degradation), wetlands (types, distribution, Ramsar Sites, importance), rangelands (coverage and distribution, importance: grazing, medicinal plants), agro-biodiversity; Rare, endangered, endemic and protected species of Nepal (flora and fauna);

Protected species of Nepal - flora and fauna.

**Unit 2: Threats to Biodiversity** **20 hrs**

Biodiversity crisis: Prehistoric extinctions, recent extinctions and endangerment; Extinction forces, impacts of extinctions; Major threats and threatening processes: Current patterns and processes of global endangerment, vulnerability of species to extinctions, economic and social contexts of endangerment.

Major threats to biodiversity: (a) Habitat degradation and loss: Patterns of habitat transformation, human activities that cause habitat degradation, pollution as a form of habitat degradation; (b) Habitat fragmentation: Fragmentation and heterogeneity, fragmentation processes, biological consequences of fragmentation; (c) Overexploitation – impacts of exploitation on target and non-target species and on ecosystems, wildlife trade; (d) Species invasion: Invasive species and invasion process, conservation implications of invasions, biological impacts of invasions (case studies on *Mikania micrantha, Eichhornia crassipes, Lantana camara, Parthenium hysterophorus*); (e) Climate change: biological impacts of climate change, conservation implications of climate change; Impacts of loss of biodiversity; Nature of biodiversity problems between developed and developing worlds; Development versus conservation: Dams and roads in the Himalayas; Challenges to biodiversity in urban areas.

**Unit 3: Conservation and Management of Biodiversity** **25 hrs**

Responses to the biodiversity crisis: Approaches to global habitat conservation (hotspots, Global 200 eco-regions, crisis eco-regions, wilderness protection), sustainable resource use: Biological theory of sustainable exploitation, methods of calculating sustainable yields; Management of invasive species: Invasion control, invasion protection;

Methods and aspects of biodiversity conservation: *in-situ* and *ex-situ* conservation; Conservation genetics (use and importance of genetic information in biodiversity conservation), species and landscape approaches to conservation, ecosystem approaches to conservation; Protected areas (goals, limitation and designs, IUCN categories of protected areas); Restoration of damaged ecosystems and endangered species (ecological restoration, animal reintroduction); Community-based conservation: Community participation, community mobilization in biodiversity conservation; Indigenous knowledge and practices in biodiversity conservation: Recoupling culture and environment, culture and holistic management.

Biodiversity conservation in Nepal: Shifting paradigm in biodiversity conservation in Nepal; Protected areas of Nepal; Conservation management in buffer zone; Conservation outside protected areas: Challenges and opportunities; Conservation of agro-biodiversity; Community forestry: contribution in biodiversity conservation.

**Unit 4: Conservation and Sustainable Development** **20 hrs**

Nexus between development and biodiversity conservation; Ecological economics and

biodiversity conservation; Sustainable development: Goals, principles, pillars and indicators; Sustainable conservation: Integrated conservation and development projects (ICDPs); Ecotourism: principles and sustainability; Ecotourism as source of conservation finance; Wildlife tourism; Green economy and sustainable development.

**Unit 5: Conservation Policies** **15 hrs**

Conservation challenges in 21st century: Problems of commons; Integration of conservation science and policy; Use of scientific knowledge in conservation; International policy for management of global commons: Convention on Biological Diversity (CBD), Convention on International Trade in Endangered Species (CITES) – pitfalls of CITES implementation in Nepal, Ramsar Convention; Aichi Target; Intellectual Property Rights (IPR) and Patent Rights (PR); Advanced Informed Agreement (AIA).

National policy for conservation of biological diversity in Nepal; Institutional arrangements for biodiversity conservation in Nepal; Effectiveness of conservation policies on biodiversity conservation.

**References:**

**Environmental Resources**


1. Brady, N.C. and Well, R.R. (2007). The Nature and Properties of Soils. Pearson Prentice Hall, New Delhi.
2. Klee. G.A, (1991). Conservation of natural resources. Prentice Hall Publ. Co., New Jersey.
3. Landon, M. (2006). Environment, Health and Sustainable Development. Tata McGraw-Hill.
4. Miller, Jr. G.T. and Spoolman, S.E. (2009). Living in the Environment: Concepts, Connections, and Solutions, 16th Edition. Brooks/Cole, Cengage Learning.
5. Nalini K.S. (1993). Environmental Resources and Management. Anmol Publishers.
6. Ristinin, R.A. and Kraushaar, J.J. (2006). Energy and Environment. John Wiley and Sons, Inc., New York.
7. Sharma, V.K. (1985). Water Resources Planning and Management. Himalaya Publishing House.


**Biodiversity Conservation**


1. Bhuju, U.R., Shakya, P.R., Basnet, T.B., and Shrestha, S. (2007). Nepal Biodiversity Resource Book: Protected Areas, Ramsar Sites and World Heritage Sites. International Centre for Integrated Mountain Development (ICIMOD) and Ministry of Science, Technology and Environment (MoSTE), Government of Nepal (GoN), Kathmandu.

2. Carson, R. (2012). Silent Spring, Anniversary Edition with an introduction by Linda Lear and an afterword by E.O. Wilson. Houghton Mifflin, Boston, MA.
3. Chaudhary, R.P. (1998). Biodiversity in Nepal: Status and Conservation. S. Devi, Shanpur (UP), India and Tecpress Books, Bangkok.
4. Chhetry, D.K. (2013). Biodiversity and Protected Areas of Nepal. Neupane Publication, Buddhanagar, Kathmandu
5. Groom, M.J., Meffe, G.K., and Carroll, C.R. (2006). Principles of Conservation Biology. Sinauer Associates Publication, Sunderland.
6. Jordan, C.F. (1995). Conservation: Replacing Quantity with Quality with a Goal for Global Management. John Wiley and Sons, Inc., New York.
7. Leopold, A. (1949). A Sand County Almanac and Sketches Here and There. Oxford University Press, New York, NY.
8. MoFSC. (2014). Nepal Fifth National Report to Convention on Biological Diversity. Ministry of Forests and Soil Conservation, Kathmandu, Nepal.
9. Primack, R.B., Paudel, P.K., and Bhattarai, B.K. (2013). Conservation Biology: A Primer for Nepal, 1st Edition. Dreamland Publications, Kathmandu.
10. Sodhi, N.S., and Ehrlich, E.R. (2010). Conservation Biology for All. Oxford University Press, Oxford.
11. Wilson, E.O., and Peter, F.M. eds. (1988). Biodiversity. National Academy Press, Washington, DC.

**Course Title: Env. Resources and Biodiversity Conservation** **Lecture hours: 150**
**Course No: ENV. 402** **Full marks: 50**
**Nature of Course: Practical (Compulsory-I)** **Pass marks: 20**

This practical paper of 50 marks shall be evaluated under two heads: lad based exam of 30 marks and field based studies of 20 marks. It is compulsory for a student to pass in the above-mentioned examination separately.

**Environmental Resources**

1. Estimation of water resources potential by different methods.
2. Analysis of human population composition, population growth trend and population distribution by using population census data of Nepal.
3. Analysis of the major food resources in different regions of Nepal.
4. Calculate the calorific value of fuel (solid, liquid based).
5. Study energy consumption in different sectors with D-P-S-I-R framework in Nepal.

**Biodiversity Conservation**

1. Estimation of ecosystem services value of an ecosystem:
    a. Wetlands
    b. Forests

2. Study on distribution of plants/animals along an environmental gradient:
   - Altitude,
   - Disturbance
3. Estimation of ecotourism potential of a protected area.
4. Study on carrying capacity (ecotourism) of a protected area.
5. Study on effectiveness of *ex-situ* conservation (a) zoological garden, (b) botanical garden, (c) animal breeding centers.
6. Determination of basal area, wood volume and standing biomass of trees in forest ecosystem.
7. Study of carbon sequestration (carbon stock and rate) of forest ecosystem.
8. Structural attributes and canopy mapping of forest.

**Field Work**

It is mandatory that all the students participate in the 10 days field visit (any protected area or protected forest or community forest designated by the Government of Nepal) program managed by the Department. Based on this field visit, each student has to prepare a report which is to be submitted during the practical examinations. Some suggested themes for the field visit in the protected area/forest are:

1. Growth pattern of trees in forest ecosystem.
2. Carbon inventory of community forest or protected area/forest.
3. Preparation of inventory of flora and fauna and their environmental values.

**Course Title: Pollution Monitoring and Control** **Lecture hours: 150**
**Course No: ENV. 403** **Full marks: 100**
**Nature of Course: Theory (Compulsory-II)** **Pass marks: 35**

**Objectives**

The broad objective of this subject is to acquaint students on the environmental pollution monitoring and control techniques. The specific objectives of the course are as follows:

- To familiarize students with air, water, noise and land pollution monitoring and control techniques
- To acquaint students with municipal and hazardous solid wastes
- To make students familiar on different discipline of toxicology and fate of toxicants in ecosystem

**Unit 1: Air Pollution Monitoring and Control** **25 hrs**

Combustion: Pre combustion Control, Combustion modification, post combustion control, new industrial processes, energy conservation (combustion control and energy saving), Air pollution

control: Atmospheric cleansing processes, Equipment selection, Best Available Technology (BAT), Better Fuel Counter measures, Preventive and control technology, Guiding principles (long-term & short-term); Industrial air pollution control: Specific control devices for particulates and gaseous pollutants; Transportation pollution controls: Air to fuel ratio, Fuel additive, Road infrastructure, Traffic management, Alternative/blended fuel, Specific control devices and Aircraft emission (regulatory, technical, operational & economic measures): Indoor Air pollution: Improve Cooking Stove (ICS), Indoor air emission control, Building design, Building code; Legal and regulatory tools for air pollution control in Nepal; Specific case assessment: general and advance air pollution control technologies for cement and brick kiln industries.

**Unit 2: Water Pollution Monitoring and Control 25 hrs**

Water Pollution Consequences: Nutrient enrichment, sedimentation, aquatic toxicity, groundwater contamination; Ecological impacts of water pollutants: Heavy metals (Cadmium, Chromium, Lead and Zinc), Manmade Organics; Bioaccumulation & bio magnification (specific case with mercury), storm water runoff pollution (Diversification, Sedimentation & Nutrient Enrichment); Sampling: Ingredients of sampling protocol, Sampling type (Grab, Composite, Depth and area representative); Monitoring frequency for surface & ground water, and industrial effluent; Sampling equipment, General sampling techniques for microbiological and physical/ chemical water quality; Guidelines, Standards and Water quality Legacy: Water quality criteria & guidelines; Fundamentals of criteria selection for health based drinking water contaminants (microbial, inorganic and organic substances, treatment/construction chemicals & design), lake trophic criteria; Glimpses in water legislative tools in Nepal

Drinking water production & treatment: Drinking water treatment steps, RWH, HH drinking water treatment methods; Wastewater treatment: General approach on screening, grit removal, flow equalization; settling; Design parameters, sludge processing - storage and disposal; Principles of biological treatment (Bio-oxidation, nitrification and denitrification mechanisms); Glimpses on advance WW treatment; Disinfection, constructive wetland approach – examples of wastewater treatment system in municipalities & urban centers.

**Unit 3: Noise Pollution Monitoring and Control 25 hrs**

CB analysis of noise pollution control (approach on direct and indirect cost, CB ratio for standards and control) - problems in performing CB analysis, cost effectiveness, risk analysis, key components of cost and benefits; Aspects of noise pollution control; Concept; Anechoic chamber, dampening and vibration control methods; Examples of noise barriers and absorbers; Design modification; Receiver control - ear plugs and ear muffs; Traffic noise abatements - noise barriers, alternatives to noise barriers; Noise control strategies: standards and guidelines; Endorsement of standards (National) and guidelines (WHO); Approach on noise abatement measures - ISO, ILO, American Conference of Government Industrial Hygienists (ACGIH), OSHA, etc.; Provision of national labor and industrial enterprises acts – Nepal.

**Unit 4: Land Pollution Monitoring and Control** **25 hrs**

Importance of soil; Role of soil in natural (environmental) purification; Changes in soil chemical characteristics: Hazardous waste dumping, Chemicals contamination; Soil health indictors & functions: biological, chemical, physical, and interpretation framework for soil health indicators; Concept of soil quality index and soil health: Introduction of SQI, soil quality index values and associated soil property threshold values and interpretation; Remediation and reclamation strategies: site assessment and mapping, excavation and dredging, pump and treat, solidification and stabilization, oxidation, tillage practices, soil vapor extraction, bioremediation, phyto - remediation and land farming, policy and legislative framework: policies, legislation (Act), regulatory framework.

**Unit 5: Solid Waste Management** **25 hrs**

Definitions and concepts; Sources, types and composition solid waste; Principles of solid waste management; Integrated solid waste management; Solid waste management techniques: Reuse, reduce, recycling, composting, vermi-composting and disposal; Landfill site: site considerations; Sanitary land filling, treatment of leachate; Environmental quality monitoring at landfill sites; Hazardous SWM: Secure land filling, radioactive waste management; Hazardous waste management techniques; Energy recovery from solid wastes; Special wastes and e-wastes and their management; Solid waste management issues in Nepalese context; Municipal wastes in Nepalese cities and management practices; Municipal SWM problems and opportunities; Legal provisions on solid waste management in Nepal: SWM Act 2011 and SWMR 2013; UNEP guidelines and national level institutional set up and legal framework for solid waste management.

**Unit 6: Eco-toxicology** **25 hrs**

Disciplines of toxicology: Environmental, economic, forensic and Industrial toxicology; Scope and importance of eco-toxicology; Toxicants and toxicity: sources and types of toxicants, types of toxic effect; Routes of toxic agents in biological system; Movement, distribution, behavior and fate of toxicants in ecosystem; Toxicity of heavy metals and bioremediation; Bioaccumulation, bio-concentration, bio-magnifications and biotransformation; Dose-response relationship: Dose-response curve, effect and response of dose, indices of toxicity; Biological and chemical factors influencing toxicity; Mechanism to minimize toxic effects; Laboratory determination of toxicity-bioassays.

**References:**


1. Agrawal, K.M., Sikdar, P.K., and Deb., S.C. (2005). A Text Book of Environment. Macmillan India Limited.
2. Amacher, Michael C.; O'Neil, Katherine P.; Perry, Charles H. (2007). Soil vital signs: A new Soil Quality Index (SQI) for assessing forest soil health. Res. Pap. RMRS-RP-65WWW. Fort Collins, CO: U.S. Department of Agriculture
3. APHA. (1998). Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington.
4. Bradley M.J. & Associates. (2005). Best Available Technology for Air Pollution Control: Analysis Guidance and Case Studies for North America, Manchester, US
5. Chhetry, D.K. (2012). Environmental Toxicology. Uma Silwal Karki, Kathmandu.
6. Conrad, J. and Hemond Jr., (1983). Engineering Acoustics and Noise Control. Prentice-Hall International Inc., London.
7. De, A.K. (2010). Environmental Chemistry, 17th edition. New age international publishers.
8. Masters, G.M. and Ela, W.P. (2013). Introduction to Environmental Engineering and Science, 3rd Edition. PHI Learning Pvt. Ltd, Delhi.
9. Metcalf & Eddy. (2004). Wastewater Engineering Treatment & Reuse, Fourth Edition, McGraw-Hill Education (India) Pvt. Ltd.
10. Miller, Jr. G.T. and Spoolman, S.E. (2009). Living in the Environment: Concepts, Connections, and Solutions, 16th Edition. Brooks/Cole, Cengage Learning.
11. Santra, S.C. (2005). Environmental Science, 2nd Edition. New Central Book Agency (P) Ltd, Kolkata.
12. Sapkota, B. (2004). Fundamental of Noise Pollution, Department of Physics, Pulchowk Campus, Lalitpur, Nepal
13. Tchobanoglous, G. and Kreith, F. (2002). Handbook of Solid Waste Management Second Edition; McGraw-Hill Publication, New York Chicago San Francisco.
14. UNEP (2009). Converting Waste Plastics into Resource – Assessment Guidelines, Revised version
15. Vesilind, P.A., Perirce, J.J., and Weiner, R.F. (1990). Environmental Pollution and Control. Butterworth- Heinemann, USA.
16. World Bank (1998). Airborne Particulate Matter: Pollution Prevention Control; Pollution Prevention & Abatement Handbook

**Course Title: Pollution Monitoring and Control** **Working hours: 150**
**Course No: ENV. 404** **Full marks: 50**
**Nature of Course: Practical (Compulsory)** **Pass marks: 20**

This practical paper of 50 marks shall be evaluated under two heads: lad based exam of 30 marks and field based studies of 20 marks. It is compulsory for a student to pass in the above-mentioned examination separately.

1. Study on quality monitoring techniques for air, water, soil environment.
2. Emission inventory base on fuel use.
3. Determination of Phosphate and Nitrate from a sample of water.
4. Preparation and interpretation of noise hazard map.
5. Study on techniques for Hazard Identification (FETI, Past Accident Analysis, HAZOP and Consequence Analysis).
6. Monitoring of sound pressure level in different micro-environmental settings and to calculate equivalent sound pressure level.
7. Calculation of percentile level ($L_{min}$, $L_{95}$, $L_{90}$, $L_{50}$, $L_{10}$, $L_5$, $L_{max}$).
8. Study on solid waste sampling technique, proximate analysis and solid waste management equipment.
9. Study about vermi-composting techniques.
10. Physio-chemical analysis of leachate.
11. Water quality analysis of water and waste water treatment plant.
12. Collection of soil samples from contaminated sites (industrial, land field etc.) and analyze the contaminants.
13. Impacts of contaminants on growth of plants (control and treatment experiments).
14. Plant potential for removal of contaminants.

**Field Visit**

The students have to be mandatorily involved in the 7 days field visit program managed by the Department, based on this field visit, each student in a group has to prepare a report which is to be submitted during the practical examination.

1. Air quality monitoring stations; Vehicular emission monitoring – Nepal Police/Transportation Office.
2. Study of municipal drinking water supply plant, and wastewater treatment plant.
3. Noise level assessment of different places (e.g. airport, industries, movie theatre etc.).
4. Visit to observe different types of incinerators in Hospitals etc.
5. Visit to industrial sites to observe waste disposal and management practices.
6. Field visit to transfer stations, sanitary landfill, leachate treatment plant.

**Course title: Urbanization and Sustainable Development** **Lecture hours: 150**
**Course Code: ENV. 405** **Full marks: 100**
**Nature of Course: Theory** **Pass marks: 35**
**(Optional, Applied Science leading to core subject)**

**Objectives**

The broad objective of the course is to enhance knowledge on urbanization and sustainable development in prospect of national and international issues. The specific objectives of the course are as follows:

- To provide an overview of urbanization, urban growth and pattern
- To understand the socio-cultural and environmental issues of urbanization
- To highlight the concept of sustainable cities, strategies for sustainable urbanization, and urban management initiatives
- To explain briefly the concept, scope, challenges and approaches of sustainable development
- To acquaint with the status of sustainable development in Nepalese context
- To understand national and international initiatives of environmental sustainability

**Unit 1: Introduction to Urbanization** **15 hrs**

Concept and characteristics of urban, trend, process and pattern of urbanization; Historical analysis of urbanization and development; Urban growth and urbanization in developed and developing countries; Influencing factors and patterns of urban growth and urbanization in Nepal.

**Unit 2: Urban Environmental Concerns** **30 hrs**

Introduction to urban environment and environmental concerns; Concept of urban ecology; Economic and ecological components of urbanization; Socio-cultural and environment impacts; Urban infrastructures, water supply and solid waste, sanitation and drainage, traffic congestion, air and noise pollution, urban land use change and patterns; Urban poverty, slum and socio-economic crimes and urbanization; Environmental sustainability and urban health; Socio-economic challenges; Environmental Good Practices – a case study of any one municipality of Nepal.

**Unit 3: Sustainable Cities and Urban Management Initiatives** **30 hrs**

Concept on sustainable cities; Sustainable urbanization; concept of inclusive urban development; Strategies for sustainable urbanization; Green infrastructure, zoning and land pooling, carrying capacity, bioregionalism, Initiatives: Eco- cities, energy and water efficient cities; National: Nepal initiatives and urban governance; Urban planning, policies and institutions; Laws and

policies related to urban issues including ; Urban perspective plan; Global: Global initiatives of urban planning and policy; Development control of zoning regulations; Global urban plan preparations; Integrated urban management; SDG 11: Sustainable Cities and Communities.

**Unit 4: Introduction to Sustainable Development 30 hrs**

Introduction to development; Theories of development; Socio-economic dimensions of development; Concept of sustainable development; Evolution of sustainable development; Importance, scope and key indicators of sustainable development.

Issues and approaches of sustainable development**:** Environmental issues and sustainable development; An overview of local, regional and global environmental issues; Natural resources and sustainable livelihoods; Application of sustainability principles for solving environmental problems.

Economics of Sustainable Development: Concept of resource economics; economic growth and development; resources in classical and neoclassical economics; Ecology and economy nexus in reference to environmental sustainability; Environmental limits of economic growth; Communal properties and tragedy of commons; Cost benefit analysis; Green growth: origin and development of green economy; Green business; Green design and design for environment; Human Development Approaches: Pillars of human development; Vulnerability dimensions of human development: Equity, social justice and empowerment; Resource and knowledge based human development; Ecological footprints; Equally weighted indices (living planet index and environmental sustainability index); Integrated sustainable development index; Unequally weighted indices: Environmental pressure indices, well-being of nations; Eco-efficiency; Tools for sustainable management of resources.

**Unit 5: Sustainable Development in Nepal 20 hrs**

Practices and sustainable development planning in Nepal; Prospects and problems for sustainable development; Sustainable development in rural and urban areas; Planned development and developmental activities in Nepal; Emerging priorities for sustainable development; Eco-villages; eco-city development; Environmental design and sustainable community; Integrated ecosystem management and livelihood; Integrated urban management; Institutional and capacity building; Media and sustainable development; Education for sustainable development (ESD); Leading change for sustainability.

**Unit 6: Policy Framework on Environmental Sustainability and Development Goals 25 hrs**

Concept of development paradigms and shift to sustainable development and policy regulations; Resource policy and ladder of sustainable development; Global Initiatives towards environmental sustainability: Evolution; international environmental policies, plans, strategies

and commitments; National Initiatives towards environmental sustainability: environmental policies, plans and strategies and their effectiveness in Nepalese context; International and national environmental institutions, their role and responsibilities; Millennium Development Goals; Sustainable Development Goals.

**References:**


1. Brundtland, G.H. (1987). Our Common Future. World Commission on Environment and Development. Oxford University Press, Delhi India.
2. Dahal, M. K. & Dahal, D. R. (1998). Environment and Sustainable Development. Issues in Nepalese Perspective. Nepal Foundation for Advanced Studies (NEFAS), Kathmandu.
3. Elliott, J.A. (1994). An Introduction to Sustainable Development: The Developing World. Routlege, London.
4. Field B. C. (2001). An Introduction of Natural Resources Economics. McGraw Hill, Boston.
5. Furtado, D.R and T. Belt (2000). Economic Development and Sustainability. The Word Bank, Washington, DC.
6. Joshi, A. R., Shrestha, S.L & Joshi, K. (2003). Environmental Management and Sustainable Development at the Cross Road. Ankus, Kathmandu Nepal.
7. Joshi, Jibgar (2009). Regional Strategies for Sustainable Development in Nepal, Lajmina Joshi, Kathmandu.
8. Mitlin, Diana and Satterthwaite D. (1994). "Cities and Sustainable Development", background paper, Global Forum '94, Manchester.
9. MoUD. (2015). National Urban Development Strategy (NUDS), 2015 (Final Draft). Ministry of Urban Development, Government of Nepal, Kathmandu.
10. National Planning Commission, 2015: Sustainable Development Goals, 2016-2030, National (Preliminary) Report. Government of Nepal, National Planning Commission, Kathmandu, Nepal
11. Price, Charles and Tsouros A., eds. (1996). Our Cities, Our Future: Policies and Action Plans for Health and Sustainable Development. Healthy Cities Project Office, Copenhagen.
12. Rodney R. (1994). White Urban Environmental Management: Environmental Change and Urban Design. John Wiley &Sons, Chichester.

**Course Title: Project Work** **Working hours: 300**
**Course Code: ENV. 406** **Full marks: 100**
**Nature of Course: Field and/or Lab Work (Optional)** **Pass marks: 40**

## Objectives

To develop the basic research skills in laboratory and field based research areas.

## Specific Objectives

- To develop basic scientific observation on natural and built environment
- To develop the basic field research and laboratory skills
- To develop confidence on seminar presentation and defend of the project work

This research project is designed as an elective paper for the interested students in order to develop skills and handle the basic research work independently. The interested student has to select one research topic covering a contemporary issue in environmental science after the completion of third year final examination and undertake under the supervision of concern faculty. The duration of this project will be of one academic year. The duration can however be extended by the department/campus with the consent of the head of the department/concerned authority on request from the student and the recommendation of the concerned supervisor with reasonable explanation.

A supervisor (sometimes also a co-supervisor) is formally appointed to guide the student. However, the student will work independently and will take full responsibility of completing the proposed task on time. The supervisor will be available for consultation and review. The student has to make seminar presentation for the final evaluation and the research project will be evaluated by a committee of expert including an external examiner.

## Evaluation

The project work will be evaluated by a panel of experts comprising external examiner, supervisor, co-supervisor (where applicable) and head of the department or internal examiner allocated by the concerned authority of the department/campus. The evaluation includes three components:

a. research process and methodology,
b. quality of contents, and
c. quality of oral presentation (by panel of the experts).

The weightage marks for each examiner is presented in the following table:

| Examiner | Marks% |
|---|---|
| Supervisor/Co-supervisor | 60 |

| | |
|---|---|
| External Examiner | 20 |
| Internal Examiner | 10 |
| Head of the Department | 10 |
| **Total** | 100 |

Some major points related to the aforementioned project work:

1. The concerned campus/department may charge additional fee (as specified by IOST/research committee of the concerned department) to the student who are willing to take the project work as an elective subject for the partial fulfillment of their academic degree.
2. The work load for the project work will be three times more than that of theory paper however both the paper carry same weightage i.e. 100 marks.
3. The decision will be done at department/campus level that either to offer or not and if offered what will be the modality of selecting the project work as an elective subject on the basis of physical and human resources availability in their campus/department.
4. The department/campus may form a research cell to look after the research work at the department and formally appoint a coordinator for the same in order to conduct research activities smoothly.

**Course Title: Climate Change** **Lecture hours: 75**
**Course No: ENV. 407** **Full marks: 50**
**Nature of Course: Theory (Interdisciplinary)** **Pass marks: 17.5**

**Objectives**

- To develop understanding of climate change
- To enable student to use CC vulnerability assessments tools
- To understand climate change impacts and their mitigations
- To acquaint students with adaptation modules and approaches

**Unit 1: Introduction to Climate and Climate Change** **15 hrs**

Concept of climate and weather; Paleoclimatology: Introduction to the climate system; surface energy balance; Climate Archives, Data and Models; Global warming and science of climate change, Causes and major impacts of climate change; Climate change scenario in Nepal.

**Unit 2: Climate Change Impacts** **15 hrs**

Climate change impacts on: agriculture and food security, water resources and energy, human health, forests and biodiversity, settlement and infrastructure, tourism and economy.

**Unit 3: Climate Change Risk and Vulnerability Assessment 15 hrs**

Concept and terminologies; Criteria to identify vulnerability; Climate change vulnerability index; Vulnerability assessment methods and tools; Implication of vulnerability assessment and framework for developing CCA strategies.

**Unit 4: Climate Change Adaptation and Strategies 15 hrs**

Concept, adaptation characteristics and processes; Types of adaptation; Community based adaptation and Ecosystem based adaptation; Climate Change adaptation plans, policies and strategies; National plans, policies and strategies: Nepal's NAPA, climate change policy, LAPA and NAP process; Clean Development Mechanism (CDM): REDD, REDD+ and payment for carbon; Carbon sequestration: Concept, mechanism, driving factors of carbon sequestration.

**Unit 5: Climate Change Mitigation 15 hrs**

Concept; Greenhouse gas emission: scenario and projections; Mitigation gap: global carbon budget; Mitigation Strategies and Global effort to reduce emission; Responding to mitigation challenges and ways to reduce emission.

**References:**


1. Dazé, A., Ambrose, K., & Ehrhart, C. (2009). Climate Vulnerability and Capacity Analysis (Handbook). CARE International, London.
2. Houghton, J., (2004). Global Warming: The Complete Briefing. Cambridge University Press, Cambridge. w
3. Intergovernmental Panel on Climate Change (IPCC). (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, eds. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson. Cambridge , UK : Cambridge University Press, 976 pp.
4. Intergovernmental Panel on Climate Change (IPCC). 2014: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
5. Lal, D. S. (2013). Climatology, Revised Edition. Sharda Pustak Bhawan, Allahabad.
6. MOE-GON. (2010). Climate Change Vulnerability Mapping for Nepal. Ministry of Environment, Government of Nepal, Kathmandu

7. MOE-GON. (2010). Review of Community Based Vulnerability Assessment Methods and Tools. Ministry of Environment, Government of Nepal, Kathmandu
8. MOE-GON. (2010). National Adaptation Programme of Action (NAPA) to Climate Change. Ministry of Environment, Government of Nepal, Kathmandu
9. Morgan, C.L. (2011). Vulnerability Assessment: A Review of Approaches. IUCN, Gland, Switzerland.

# B.Sc. IV Year

# Geology (GEO.401)

**Subject: Exploration Geology and Mining Geology**

Nature of course: Theory | Course No.: GEO.401

Full marks: 100 | Total class period: 150

Pass marks: 35

## A. Exploration Geology

Total period: 75 | Total Marks: 50

| Main Topics | Contents | Period |
|---|---|---|
| **Introduction** | Importance of mineral resources. Stages of mineral resource development: prospecting, exploration, mining, processing and marketing. Factors affecting the distribution and localization of mineral deposits. Prospecting criteria, guides, wall rock alteration, primary and secondary haloes, metallogeny, metallogenic epochs, provinces, prognostic maps. | **20** |
| **Exploration** | Reconnaissance, prospecting, pre-feasibility, feasibility, engineering and mine exploration. Exploration methods: geological reconnaissance traverse, panning, remote sensing-landsat system, photogeology. Application of geophysical methods for mineral exploration: magnetic survey, gravity survey, radiometric survey, resistivity, seismic methods, Ground Penetration Radar (GPR) and borehole geophysics.<br><br>Application of geochemical methods for mineral exploration: geochemical anomalies, background, threshold, pathfinder elements, geochemical methods: metallometric, hydrochemical, geobotanical and gas prospecting. | **30** |

| | | |
|---|---|---|
| | Exploration openings: pitting and trenching, drilling and underground excavations, sampling and acquiring geological and geotechnical data. | |
| **Evaluation of deposits** | Reserve estimation, grade calculation,workable standards. Economic, sub-economic and non-economic deposits. | **10** |
| **Mineral Resources of Nepal** | Geological controls, current status and future prospects of different mineral resources of Nepal. Metallic, nonmetallic and fossil fuels. | **15** |

**Text books**:

Barrett W. M. et al. (2012): Introduction to mineral exploration, Blackwell Publication, 481p.
Kreiter V. M. (2004): Geological prospecting and exploration, University Press of the Pacific, 384p.
Rose, A. W., Hawakes, H. E. and Webb, J. S. (1970). Geochemistry for mineral exploration, Academic Press, 657 p.

**Reference books**:

DMG (2004): Mineral resources of Nepal.
ESCAP (1993): Atlas of mineral resources of Nepal, vol. 9, UN Publication.

### B. Mining Geology

Total period: 75 Total Marks: 50

| Main Topics | Contents | Period |
|---|---|---|
| **Introduction** | Introduction to Minerals, Mines and Exploration Methods: Mineral resources, Mineral/Ore deposit/ prospect, Mine/ Quarry, Mining of Metallic and Nonmetallic Minerals: Ore Minerals, Industrial Minerals, Precious and Semi-precious stones, Dimension/ decorative stones, Construction Materials/Minerals. Fuel Minerals. | **2** |

| | | |
|---|---|---|
| **Mining Terminology** | Mine opening, important parts of a mine, trench, pit, shaft, tunnel, adit, excavation, level, crosscut, stopping, loading, dumping, mine environment, mine ventilation, mineral transport system, mine drainage, light system, fire safety measures. | **10** |
| **Mining methods and Technology** | Definition, Mine and Mining, Stripping ratio, Ore and waste, Mine development, Mining plan, Mining methods and their selection, Type of Mines, Surface and Underground mine with examples from Nepal, Mine operation, Production, Sequences in the life of mine, Mine safety, Occupational health, Mine excavation. | **15** |
| **Drilling and blasting methods, Mining equipments and machines** | Shot hole drilling, Explosives, blasting methods, Excavator, loader, dumper, bulldozer, rock breakers. | **10** |
| **Ore processing and dressing** | Crushing, Grinding, washing, pulverizing, concentration, storage/stockpile/dumping site and waste management. | **8** |
| **Mineral Industries** | Basic infrastructures, mineral based industries examples, regular supply of materials (ore/ raw materials) to the industries, industrial production, quality of the product, quality control, regular supply in the market, market study. | **3** |
| **Basic Mineral economics** | Mine operation cost, production cost, market price/ selling price, internal and external price (ROM/CIF/FOB), Demand and supply situation, introduction to cost benefit analysis, Net Present value (NPV), Internal Rate of Return (IRR), Contribution to National GDP from mineral, mine, mining and Mineral industry sector. | **15** |
| **Existing Mines and Mineral Act** | Existing Mines and Mineral Act-2042 and Mines and Mineral Regulations-2056, Lease system, Prospecting License, Mining License, Government Policy, License fee, surface rental, Government taxes, royalties, local taxes and benefits, royalty in production. Petroleum act-2040 and regulation-2041, | **12** |

| | | |
|---|---|---|
| | environmental act-2053 and regulation-2054 with amendments. | |

**Text books**:


1. Marjoribanks, R., (2010): Geological Methods in Mineral Exploration and Mining, Springer-Verlag Berlin Heidelberg, 238p.
2. Peters, W. C., 1978. Exploration and Mining Geology, John Willy & Sons.
3. Cummins, A. B. and Given, I. A. (1973): Mining Engineering Hand Book. Society of Mining Engineers; New York.


**Reference books**:


Mines and Mineral Act 2042 BS and Mines and Mineral Regulation 2056.

Mines and Petroleum act-2040 and regulation-2041, environmental act-2053 and regulation-2054 with amendments.

NGS website, DMG website, PEPP website etc.

Publications of Department of Mines and Geology, Journals and Bulletins of Nepal Geological Society and Central Dept. of Geology.

# B.Sc. IV Year
# Geology (GEO.402)

**Subject: Exploration Geology and Mining Geology**

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

Course No.: GEO.402
Total class period: 150

## A. Exploration Geology

**Lab 1-6**: Study of metallic and non-metallic economic minerals in hand specimens.

**Lab 7-9**: Study and interpretation of geophysical data related to mineral exploration.

**Lab 10-12**: Statistical analysis of geochemical data, preparation and interpretation of geochemical maps and sections.

**Lab 13-16**: Computation of ore reserves and grading of ores.

**Lab 17-20**: Study of geological controls of important economic deposits of Nepal and other countries from maps and sections.

## B. Mining Geology

**Lab 1-4**: Draw diagrams of open pit/open cast and underground mine with examples from Nepal.

**Lab 5-8**: Calculation of grade and tonnage of an ore deposit on the basis of given data: surface trench and drill hole data and chemical analysis of ore samples.

**Lab 9-12**: Placer gold mining process and evaluation of placer gold deposit from given data.

**Lab 13-16**: Preparation of mining plan from given data.

**Lab 17-20**: Interpretation of the geophysical and borehole logging data.

**Text and Reference books**:


Babu, S. K. and Sinha, D. K. (1988): Practical manual of exploration and prospecting. CBS publishers, India, 167 p.

ESCAP (1993): Atlas of mineral resources of Nepal, vol. 9, UN Publication.

Smirnov, V. I. (1976): Geology of mineral deposits, Mir Publications.

# B.Sc. IV Year
# Geology (GEO.403)

**Su**bject: Engineering Geology and Hydrogeology
Nature of course: Theory Course No.: GEO.403
Full marks: 100 Total class period: 150
Pass marks: 35

## A. Engineering Geology

Total marks: 50 Total Period: 75

| Main Topics | Contents | Period |
|---|---|---|
| **Introduction to engineering geology** | Development of engineering geology, aims of engineering geology, essential definitions. | **2** |
| **Description, properties and behavior of soils and rocks:** | Engineering soil classification, coarse soils, silts and loess, clay deposits, tropical soils, dispersive soils, soils of humid and arid regions, tills and glacially associated soil, frost action in soil, organic soils, peat, description of rocks and rock masses, engineering aspects of igneous, metamorphic and sedimentary rocks. | **5** |
| **Geological materials** | Important characteristics of geological materials, sediments, intact rock materials, fluids and gasses, description of geological materials, material properties and their measurement, types of test, limitations of testing, size and shape of sample, standards, density and unit weight, porosity and permeability, strength, types of rock deformation, consolidation of soils, Abrasiveness, environmental reactivity, index tests, range of values for soils and rocks, field test of soils and estimation of soil parameters. | **8** |
| **Geological masses** | Discontinuities, shear strength and discontinuities surface characteristics, field estimate of discontinuity friction angle, persistence, orientation, spacing, influence of weathering on rock | **7** |

| | | |
|---|---|---|
| | mass properties, standard weathering description and weathering zonation, drilling and sampling in soils, drilling and sampling in soil and rocks, core logging for ground description. | |
| **Engineering geology of slopes** | Landslides and their classifications, landslide recognition and identification, rate of landslide movement, extent of landslide, causes and mechanism of failures, the stability of slopes in soil, benching on slopes, slope drainage, effect of excavation technique on slope stability, slope stability analysis in rock, kinematic analysis of rock slopes, use of stereonets for rock slope failure analysis, rock mass rating (RMR) and Q-system, slope mass rating (SMR), severity of slope instabilities and remedial works. | **8** |
| **Engineering geological maps** | Published geological and engineering geological maps, engineering geological map making, understanding of geological maps, interpretation of geological maps for engineering purpose, mapping at a small scale, mapping at a large scale specially for foundation areas and excavations, rock slopes, outcrops, tunnels, mines, natural cavities, symbology in engineering geological maps, quality of published information | **6** |
| **Geological materials used in construction** | Building or dimension stone, roofing and facing materials, armourstone, Crushed rock: concrete aggregate; road aggregate; gravels and sands; lime, cement and plaster; clays and clay products. | **5** |
| **Excavation and ground loading** | Excavation issues, blasting, ground improvement, site investigation for underground excavations, subsidence, types of foundation, ultimate bearing capacity, safe bearing capacity and allowable pressures, bearing capacities on boulder bearing soils, settlement on soils, bearing capacity on rock masses, foundation settlement on rock, Foundations on slopes. | **7** |
| **Engineering geology and construction** | Open excavation, tunnels and tunnelling, underground caverns, shafts and raises, reservoirs, dams and dam sites, highways, railroads, bridges, buildings. | **5** |
| **Field tests and measurements** | Tests in boreholes, tests in large diameter boreholes, shafts and tunnels, measurements in boreholes and excavations, choice of geophysical methods, seismic methods and their particular applications, use of electrical resistivity methods, magnetic | **7** |

| | | |
|---|---|---|
| | methods and gravity methods in engineering geological site investigation. | |
| **Engineering geology and earthquakes** | Characteristics of Earthquakes (magnitude, intensity), ground response analysis, assessing seismic risk and seismic hazard, ground engineering design against earthquake hazards. | **5** |
| **Design and reporting of site investigations** | Introduction, stages of Investigation, design of site investigations, progressive evaluation of site investigation data, investigation progress, supervision of investigating works, investigation reports, form of the report. | **5** |
| **Engineering geology, planning and development** | Introduction, geological hazards, risk assessment and planning, landslide hazard maps, derelict and contaminated land. | **5** |

Text books:

Bell, F. G. (2007): Engineering Geology, 2nd edition, Elsevier Publication, 583p.
Price, D. G. and Freitas, M., (editors) (2008:) Engineering Geology - Principles and Practice, Springer, 460p.

**Reference books:**

Dahal, R. K. (2006) Geology for Technical Students, Bhrikuti Academic Publications, 756p.

Hoek, E. (2014): Practical Rock Engineering Available in http://www.rocscience.com.

Johnson, R. B. and Degraff, J. V. (1988): Principles of Engineering Geology, 1988, John Wiley Publication, 497p.

## B. Hydrogeology

Total marks: 50 Total Period: 75

| **Main Topics** | **Contents** | **Period** |
|---|---|---|
| **Soil moisture and groundwater** | Porosity of earth materials, classification of sediments, forces acting on groundwater, vertical distribution of groundwater, water table, infiltration, soil moisture, permeability of sediments. | **5** |

| | | |
|---|---|---|
| **Geology of groundwater occurrence** | Aquifers, types of aquifers, Unconsolidated aquifers (alluvial valleys, alluvium in tectonic valleys) Rocks as aquifers. | **8** |
| **Groundwater exploration** | Surface and subsurface investigations of groundwater: Geological methods, remote sensing, test drilling, geophysical logging (resistivity logging, spontaneous potential logging and other subsurface methods. | **8** |
| **Groundwater movement** | Darcy's Law, groundwater flow rates, specific yield, hydraulic conductivity of earth materials (Darcy's experiment, hydraulic conductivity, permeability of sediments, permeability or rocks), storage coefficient, effective porosity, groundwater flow directions, general flow equations. | **10** |
| **Water wells** | well drilling methods (direct rotary, reverse rotary, percussion, down the hole, types and applications of drilling fluids, well screens and their types and method of sediment size analysis, water well designs, casing diameter, casing materials, well depth, well screen length, well screen slot openings, open area, entrance velocity, design of wells. Installation and removal of well screens, well development methods, aquifer development techniques, factors that affect development. Pumping test, conducting a pumping test, measuring drawdown in wells, well efficiency, step drawdown test, problems of pumping test analysis. multiple well systems, well losses and specific capacity, Thiem equation, Theis equation, Cooper-Jacob equations, Hantush equations and their applications. Water well pumps: | **22** |
| **Groundwater quality and pollution** | Sources of salinity, measures of water quality, chemical analysis, Graphic representations, physical analysis, biological analysis, groundwater samples, water quality criteria, changes in chemical composition, dissolved gases, temperature, water pollution due to mining, agricultural sources of pollution. Water quality protection for wells and nearby groundwater resources. | **7** |
| **Groundwater** | Dynamic equilibrium in natural aquifers, groundwater budgets, | **7** |

| | | |
|---|---|---|
| **development and management** | management of potential aquifers, water law, conjunctive use of groundwater and surface water. Groundwater monitoring technology, artificial recharge, groundwater modelling, | |
| **Groundwater resources of Nepal** | Distribution, utilization, quality, and management. Types of aquifer and springs in different geological regions of Nepal. Groundwater legislation. | **8** |

**Text book:**

Driscoll, F. G., (1989): Groundwater and wells, Johnson Filtration Systems Inc., Minnesota.

Todd, D.K., Mays, W.M. (2005): Groundwater Hydrology. John Wiley & Sons, New York, third edition

**Reference books**:

Fetter, C.W. (1994): Applied Hydrogeology. Macmillan, New York

Freeze R. A., Cherry J. A. (1979): Groundwater, Prentice Hall.

# B.Sc. IV Year
# Geology (GEO.404)

**Subject: Engineering Geology and Hydrogeology**

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

Course No.: GEO.404
Total class period: 160

## A. Engineering Geology

**Lab 1-10**: Determination of index properties of soil and rock (Natural moisture contents, grain size distribution, hydrometer analysis, Atterberg Limits, Unit weight, Specific Gravity, Permeability test, direct shear, point load test).

**Lab 11-12**: Evaluation of mechanical properties of aggregates.

**Lab 13-16**: Selection of possible sites using topographic maps for dams, tunnels, bridges, highways and other civil engineering structures.

**Lab 17-20**: Analysis of engineering geological data for solving engineering problems.

### B. Hydrogeology

**Lab 1-2**: Determination of water content of soils.

L**ab 3-7**: Preparation of groundwater flow maps and determination of flow directions.

**Lab 8-10**: Calculation of groundwater storage potentials.

**Lab 11-15**: Analysis of pumping test data to calculate aquifer parameters.

**Lab 16-20**: Analysis and presentation of groundwater quality parameters for drinking and domestic use of groundwater resources.

# B.Sc. IV Year
# Geology (GEO.406)
### Subject: Field Work

Nature of course: Practical — Course No.: GEO.406
Full marks: 100
Pass marks: 35 — Field work duration: 28 days
**Course Load:** 7 hours per day per teacher**.**

**General Objectives**: The principal objectives of filed work are to introduce students to various geological rock successions of the Nepal Himalaya, and to familiarize them various criteria and techniques to study geological elements to produce geological maps of 1:25,000-scale.

There will be two MODULES in the field work.

| Module I | Module II |
|---|---|
| Full marks: 50 | Full marks: 50 |
| Duration: 14 days | Duration: 14 days |

**Field Report:** Each student should submit field report individually after completion of the field work

### A. Field Work Module I (14 days)

**General objectives**:

- Geological study of the Siwalik Group and the Quaternary Sediments
- Geological study of the Lesser Himalayan succession

**Specific objectives**:

To carry out the following tasks

- Field techniques of recording lithological information: composition, texture, and structure of rocks:
    - Maintaining Field Diary, Graphic logging, Sketching, etc.
    - Measuring paleocurrent data,
    - Sampling and describing rocks and fossils
    - Route mapping
- Delivering concept on order of superposition, and correlation of rock units
    - Using various sedimentary structures and cross-cutting relations of geological structures
    - Using concept of litho- and bio-stratigraphic correlations
- Identifying various geological structures in the field
    - Joints, lineation, foliation, fault, fold, unconformity, etc.
- Understanding the criteria of lithostratigraphic sub-division of geological units
    - Preparation of lithostratigraphic columns
    - Classification of successions into different units (Bed, Member, Formation, Group, Supergroup)
- Studying geological mapping techniques after following all the previous mentioned tasks
    - Producing a geological map and a geological cross-section
    - Interpreting various geological structures, and litho-stratigraphic units

**Subtitles of Module I**

| | Subtitle of Module I | Fieldwork marks |
|---|---|---|
| A | Study of geology of the Siwalik Group and Quaternary Sediments: Lithostratigraphy, sedimentology, fossil occurrence, geological structures, and geological mapping | 25 |
| B | Study of geology of Proterozoic-Early Cenozoic successions (Kaligandaki Supergroup and Tansen Group of western Nepal or similar successions of mid-western or eastern Nepal Lesser Himalaya): Lithostratigraphy, sedimentology, fossil occurrence, geological structures, and geological mapping | 25 |

**Field Work Plan**

| | Subtitle of Module I |
|---|---|
| | Day 1: Departure to Field work area and Field orientation and preparation |
| A | Study of geology of the Siwalik Group and Indo-Gangetic Plain: |
| | Day 2: Traverse within the Indo-Gangetic Plain |
| | Day 3: Traverse within the Lower-Middle Siwaliks |

| | |
|---|---|
| | Day 4: Traverse within the Middle-Upper Siwaliks<br>Day 5:Geological Route Mapping in an appropriate scale |
| B | Study of geology of Proterozoic-Early Cenozoic successions (Kaligandaki Supergroup and Tansen Group of western Nepal or similar successions of mid-western or eastern Nepal Lesser Himalaya): |
| | Day 6: Traverse within the Proterozoic-Early Cenozoic successions (mainly Kaligandaki SG or equiv.) |
| | Day 7: Traverse within the Proterozoic-Early Cenozoic successions (mainly Kaligandaki SG or equiv.) |
| | Day 8: Traverse within the Proterozoic-Early Cenozoic successions (mainly Tansen Group or equivalent) |
| | Day 9: Traverse within the Proterozoic-Early Cenozoic successions (mainly Tansen Group or equivalent) |
| | Day 10: Geological Route Mapping in an appropriate scale |
| | Day 11: Individual Group Field work: Geological Mapping in 1:25,000 scale |
| | Day 12: Individual Group Field work: Geological Mapping in 1:25,000 scale |
| | Day 13: Field Report writing |
| | Day 14: Field Report submission and Field viva. Retreat from the field to College |

**B. Field Work Module II (14 days)**

**General objectives**:

- to familiarize students with
  - methods of mineral Exploration and mining (EXPLORATION AND MINING GEOLOGY)
  - various techniques of characterizing properties of soil and rock, and to prepare engineering geological maps (ENGINEERING GEOLOGY)
  - groundwater exploration technique such as bore hole drilling, and estimating discharge and recharge (HYDROGEOLOGY)

**Specific objectives**:

- To familiarize students with various techniques of characterizing properties of soil and rock, and to prepare engineering geological maps (ENGINEERING GEOLOGY)
  - To classify soils using USCS
  - To classify rocks using RMR, Q-system, GSI, Rmi
  - Technique of preparing Engn Geol. map for road or tunnel or canal alignment
  - Technique of preparing Engn. Geol. maps and profiles of landslides; Factor of Safety Analysis
- to familiarize students with groundwater exploration technique such as bore hole drilling, and estimating discharge and recharge (HYDROGEOLOGY)
  - Technique of bore hole drilling: equipments and method
  - Logging bore hole: Litho logging, geophysical well logging
  - Techniques of estimating discharge: wells and springs
  - Techniques of estimating recharge: wells and ponds

- To familiarize students with exploration methods, evaluation of deposits, mining and processing methods (EXPLORATION AND MINING GEOLOGY)
    - Introducing mineral exploration and Sampling techniques of ore minerals, minerals, rocks and rock materials.
    - Mapping of a reserve in an appropriate scale, Estimation of reserve
    - Introducing a quarry site, equipments, and quarry methods
    - Introducing mineral or rock processing (e.g., limestone processing)

**Field work subtitles based on course load**

| | Subtitle of Field Work Phase II | Subject | Field work marks |
|---|---|---|---|
| A | (a) To familiarize students with various techniques of characterizing properties of soil and rock, and to prepare engineering geological maps | ENGINEERING GEOLOGY | 12.5 |
| | (b) To familiarize students with groundwater exploration technique such as bore hole drilling | HYDROGEOLOGY | 12.5 |
| B | To familiarize students with exploration methods, evaluation of deposits, mining and processing methods | EXPLORATION AND MINING GEOLOGY | 25 |

| | | Days |
|---|---|---|
| | Day 1: Departure to Field work area and Field orientation and preparation | 1 |
| A | **(a) Techniques of characterizing properties of soil and rock, and to prepare engn. geol. maps** | |
| | Day 2: Characterization of soil and rock mass including Technique of preparing Engn Geol. maps | |
| | Day 3: Technique of preparing Engn. Geol. maps for road or tunnel or canal alignment<br>including characterization of soil and rock mass | |
| | Day 4: Technique of preparing Engn. Geol. maps and profiles of landslides; Factor of Safety Analysis | 3 |
| A | **(b) To familiarize students with groundwater exploration technique such as bore hole drilling** | |
| | Day 5: Technique of bore hole drilling: equipments and method; Logging bore hole | |
| | Day 6: Hydrogeological investigation | |
| | Day 7: Estimation of discharge and recharge | 3 |

| | | |
|---|---|---|
| B | **To familiarize students with exploration methods, evaluation of deposits and mining methods** | |
| | Day 8: Introducing mineral exploration and Sampling techniques | |
| | Day 9: Mapping of ore bodies and host rocks in an appropriate scale | |
| | Day 10: Mapping of ore bodies and host rocks in an appropriate scale and reserve estimation | |
| | Day 11: Study of mining sites and observation of mining equipment and mining methods | |
| | Day 12: Study of ore processing and dressing in industrial plants | 5 |
| | Day 13: Field Report writing | 1 |
| | Day 14: Field Report submission and Field viva. Retreat from the field to College | 1 |
| | | Days |
| | Day 1: Departure to Field work area and Field orientation and preparation | 1 |
| A | **(a) Techniques of characterizing properties of soil and rock, and to prepare engn. geol. maps** | |
| | Day 2: Characterization of soil and rock mass including Technique of preparing Engn Geol. maps | |
| | Day 3: Technique of preparing Engn. Geol. maps for road or tunnel or canal alignment<br>including characterization of soil and rock mass | |
| | Day 4: Technique of preparing Engn. Geol. maps and profiles of landslides; Factor of Safety Analysis | 3 |
| A | **(b) To familiarize students with groundwater exploration technique such as bore hole drilling** | |
| | Day 5: Technique of bore hole drilling: equipments and method; Logging bore hole | |
| | Day 6: Hydrogeological investigation | |
| | Day 7: Estimation of discharge and recharge | 3 |
| B | **To familiarize students with exploration methods, evaluation of deposits and mining methods** | |
| | Day 8: Introducing mineral exploration and Sampling techniques | |
| | Day 9: Mapping of ore bodies and host rocks in an appropriate scale | |
| | Day 10: Mapping of ore bodies and host rocks in an appropriate scale and reserve estimation | |

# B.Sc. IV Year
# Geology (GEO.407)

Subject: Fundamentals of Economics and Management

Nature of course: Theory (Interdisciplinary) Course No.: GEO.407
Full marks: 50 Total class period: 75
Pass marks: 17.5

**A: Economics**

Total period: 40

| Main Topics | Contents | Period |
|---|---|---|
| **Introduction** | Origin of Engineering Economy, Principles of Engineering Economy, Role of Geologists in Decision Making, Cash Flow Diagram. | **2** |
| **Interest and Time Value of Money** | Introduction to Time Value of Money, Simple Interest, Compound Interest, Nominal Interest rate, Effective Interest rate, Continuous Compounding, Economic Equivalence, Development of Interest Formulas, The Five Types of Cash flows, Single Cash flow Formulas, Uneven Payment Series, Equal Payment Series, Linear Gradient Series, Geometric Gradient Series. | **4** |
| **Basic Methodologies of Engineering Economic Analysis** | Determining Minimum Attractive (Acceptable) Rate of Return (MARR), Payback Period Method, Equivalent Worth Methods, Present Worth Method, Future Worth Method, Annual Worth Method, Rate of Return Methods, Internal Rate of Return Method, External/Modified Rate of Return Method, Public Sector Economic Analysis (Benefit Cost Ratio Method). Introduction to Lifecycle Costing, Introduction to Financial and Economic Analysis. | **6** |

| | | |
|---|---|---|
| **Comparative Analysis of Alternatives** | Comparing Mutually Exclusive Alternatives having Same useful life by Payback Period Method and Equivalent Worth Method, Rate of Return Methods and Benefit Cost Ratio Method, Comparing Mutually Exclusive Alternatives having different useful lives by Repeatability Assumption, Co-terminated Assumption, Capitalized Worth Method, Comparing Mutually Exclusive, Contingent and Independent Projects in Combination. | **6** |
| **Replacement Analysis** | Fundamentals of Replacement Analysis, Basic Concepts and Terminology, Approaches for Comparing Defender and Challenger, Economic Service Life of Challenger and Defender, Replacement Analysis When Required Service Life is Long, Required Assumptions and Decision Framework, Replacement Analysis under the Infinite Planning Horizon, Replacement Analysis under the Finite Planning Horizon. | **6** |
| **Risk Analysis** | Origin/Sources of Project Risks, Methods of Describing Project Risks, Sensitivity Analysis, Breakeven Analysis, Scenario Analysis, Probability Concept of Economic Analysis, Decision Tree and Sequential Investment Decisions. | **6** |
| **Depreciation and Corporate Income Taxes** | Concept and Terminology of Depreciation, Basic Methods of Depreciation, Straight line method, Declining Balance Method, Sinking Fund Method, Sum of the Year Digit Method, Modified Accelerated Cost Recovery System (MACRS), Introduction to Corporate Income Tax, After Tax Cash flow Estimate. General Procedure for Making After Tax Economic Analysis. | **6** |
| **Inflation and Its Impact on Project Cash flows** | Concept of Inflation. Measuring Inflation, Equivalence Calculation Under Inflation, Impact of Inflation on Economic Evaluation. | **4** |

**B: Management**

Total period:35

| Main Topics | Contents | Period |
|---|---|---|
| **Introduction to management:** | Concept, meaning and essence of management, Functions of Management, Types of Managers, Managerial Roles and Skills, Becoming a Manager: Role of Education, Experience and Situation, Business and Society, Corporate Social Responsibility, Ethics and Ethical Standards, Corporate Governance. | **3** |
| **Perspectives in Management** | Early Developments, The Classical perspective, The Behavioral Perspective, Quantitative Perspective, Integrating Perspective, Contingency Perspective, Contemporary Perspective on Management, Emerging Management Issues and Challenges. | **4** |
| **Planning and Decision Making:** | Planning: Meaning of Planning, The Planning System, Levels of Planning, Hierarchy of Plans, Steps in Planning, Tools for Planning, Planning Premises, Pitfalls of Planning, Improving Planning. Decision Making: Meaning and Concept, Types of Decisions, Decision Making Process, Decision Making Conditions. | **8** |
| **Organizing and Staffing:** | Organizing: Meaning of Organizing, Principles of Organizing, Process of Organizing, Organizational Architecture, Vertical Differentiation, Horizontal Differentiation, Responsibility, Authority, Delegation of Authority, Centralization, Decentralization and Devolution. Staffing: Concept of Staffing, Stafffing and Human Resource Management, Objectives of Staffing, Importance of Staffing, Components of Staffing Function. | **10** |
| **Leadership, Motivation and Communication**: | Meaning of Leadership, Qualities of Leadership, Understanding Individual Differences and Psychological Contacts, Leadership Styles. Concepts of Work Groups. Managerial Ethics. Concept of Motivation, Importance of Motivation, Techniques of Motivation. Meaning of Communication, Importance of Communication in Organizations, | **10** |

| | | |
|---|---|---|
| | Purpose of Organizational Communication, The Communication Process, Communication Networks, Concept of Active Listening, Communication Flows in Organizations, Types of Communications, Barriers of Effective Communications, Enhancing Organizational Communication. | |

**Text and Reference Books**:


Chan S. Park, Contemporary Engineering Economics, Prentice Hall, Inc.

GS Gupta (2011), Managerial economics, Tata McGraw Hill Education Pvt. Ltd. New Delhi. 432p.

James L. Riggs, David D. Bedworth and Sabah U. Randhawa, Engineering Economics, Tata MCGraw Hill Education Private Limited.

MS Bhat and AV Rau (2008), Managerial Economics and Financial Analysis, BS Publications, Hyderabad, 364p.

Paul De Garmo, William G. Sullivan and James A. Bonta delli, Engineering Economy, MC Milan Publishing Company.

PR Pant, 2014. Principles of management. Buddha Academic Publishers and Distributors Pvt. Ltd.

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

**Course Title:** Modern Algebra **Full Marks:** 100
**Course No. :** MAT 401 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course Description**
This course is designed for fourth year of B.Sc. four years level. The main aim of this course is to provide knowledge of modern algebra and Theory of equations.

**Course Objective**
The main objectives of this course structure is to enable the students to;

(i) develop in-depth knowledge and good theoretical background in algebra,
(ii) make interest in and promote enjoyment of algebra and its applications in various branches of mathematics and physical and social sciences,
(iii) get associated with teaching in the field related to algebra,
(iv) compare with graduates from various other universities in the field of algebra.

**Course Contents**

**Unit 1 Groups and Subgroups**: Introduction and examples, Binary operations, Isomorphic binary structures, Groups, Subgroups, cyclic groups, Generating sets and Cayley diagraphs. [15 Lectures]

**Unit 2 Permutations, Cosets, and Direct Product**: Groups of permutations, Orbits, Cycles, and the alternating groups, Cosets and Theorem of Lagrange's, Direct products. [15 Lectures]

**Unit 3 Homomorphism and Factor Groups**: Homomorphisms, Factor groups, Factor group computations and simple groups. [15 Lectures]

**Unit 4 Rings and Fields**: Rings and fields, Integral domains, Fermat's and Euler's theorems, The field of quotients of an integral domain, Rings of polynomials, Factorization of polynomials over a field. [15 Lectures]

**Unit 5 Ideals and Factor Rings**: Homomorphisms and factor rings, Prime and maximal ideals. [15 Lectures]

**Unit 6 Extension Fields**: Introduction to extension fields, Algebraic extensions. [15 Lectures]

**Unit 7 Advanced Group Theory**: Isomorphism theorem, Sylow theorem ( No Proof ), Applications of Sylow theory. [15 Lectures]

**Unit 8 Factorization**: Unique factorization domains, Euclidean domains, Gaussian integers. [15 Lectures]

**Unit 9 Theory of Polynomial Equations**: Polynomial over an integral domain, division algorithm, division of a polynomial, zero of a polynomial, Rolle's theorem(no proof),properties of equations,

Descartes rule of signs, relation between roots and coefficients, application to the solution of an equation, symmetric function of roots, transformation of equations, transformation in general, multiple roots, sum of the power of roots, reciprocal equations, Binomial equation.

[15 Lectures]

**Unit 10 Cubic and Biquadratic Equations**: Algebraic solution, algebraic solution of the cubic, nature of roots of cubic, equation of square difference of cubic, nature of roots from Cardan's solution and application to the numerical examples, solution by symmetric functions of roots, solution of the biquadratic and the radical. [15 Lectures]

**Text Books**


1. John. B. Fraleigh; *A First Course in Abstract Algebra*, Seventh Edition, Pearson.
2. R.M. Shrestha & S. Bajracharya; *Linear Algebra, Groups, Rings & Theory of Equations*, Sukunda Pustak Bhavan, Kathmandu.
3. T.P. Nepal, C.R. Bhatta & Ganga Ram D.C.; *A Text Book on Algebra*, Pradhan Book House Exhibition Road, Kathmandu.

**Reference Books**

4. H.N. Bhattarai & G.P. Dhakal; *Undergraduate Algebra,* Vidharthi Pustak Bhandar, kathmandu.
5. I.N. Herstein; *Topics in Algebra*, Vikas Publication, India.
6. N.S. Gopal Krishan; *University Algebra*, Orient Longman, India.
7. P. B.Bhattacharya, S.K. Jain & S.R. Nagpaul; *Basic Abstract Algebra*, Cambridge, 1995.

A.R. Vasishtha; *Modern Algebra*, Krishna Prakashan Mandir,Meerut.


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

**Course Title:** Mathematical Analysis **Full Marks:** 100
**Course No. :** MAT 402 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course description**

This course is designed for fourth year of Four years B.Sc. program. The main aim of this course is to provide advanced knowledge of analysis to students offering mathematics as a major subject. Pre-requisite for this course is Real Analysis, which the students have studied in the third year.

**Course objectives**

The general objectives of this course is

a) To develop theoretical knowledge and analytical skill in the emerging areas of mathematics
b) To raise interest of students in the field of analytical world so that they can take up any course easily in modern mathematics.
c) To acquire and develop skill in the use and understanding of mathematical language.

d) To acquire knowledge an understanding of the language of mathematical terms, symbols, statements formulae, definitions, logic etc.
e) To construct solutions and proofs with their own independent efforts.
f) To prepare a sound base for higher studies in Mathematics.

**Course Contents**

**Unit 1. Euclidean spaces and metric spaces**

Set $\mathbf{R}^n$, Algebraic structure of $\mathbf{R}^n$, Metric structure of $\mathbf{R}^n$, Cauchy-Schwarz Inequality, Topology in $\mathbf{R}^n$, Metric spaces, Pointset topology in metric spaces. [12 Lectures]

**Unit 2. Compactness**

Bolzano-Weierstrass theorem, Cantor intersection theorem, Lindelof covering theorem, Heine-Borel covering theorem, Compactness in $\mathbf{R}^n$, Compactness ofa metric space

[8 Lectures]

**Unit 3. Limits and Continuity**

Convergent sequence in a metric space, Cauchy sequences, Complete metric spaces, Sequences and Compactness, Bolzano-Weierstrass theorem for sequences, Limits of a function, Continuous functions, Continuity and inverse images, Functions continuous on compact sets, Bolzano's theorem and intermediate value theorem, Uniform continuity, Uniform continuity and compact sets. [20 Lectures]

**Unit 4. Multivariable Differentiation**

Linear operator and its matrix representation, Total derivative,Partial Derivatives, Directional derivatives, Jacobean matrix, Mean Value theorem, Higher order partial derivatives,Equality of mixed partial derivatives. [16 Lectures]

**Unit 5. Functions of Bounded Variation**

Properties of monotonic functions, functions of bounded variation, Total variation, Its additive property. Total variation on $[a, x]$ as a function of $x$, Functions of bounded variation expressed as the difference of increasing functions, Continuous function of bounded variation.

[9 Lectures]

**Unit 6. Riemann-Stieltjes Integration**

Riemann-Stieltjes integrals, Linear properties, Integration by parts, Change of variable, Reduction to a Riemann integral, Step-functions as integrators, Increasing integrators, Upper and lower integrals, Riemann's condition, Comparison theorems, Necessary and sufficient conditions for existence of Riemann-Stieltjes integrals, Mean Value theorem, Integral as a function of the interval, Second Fundamental theorem, Second Mean Value theorem.

[22 Lectures**]**

**Unit 7. Sequences and series of functions**

**Sequences of Functions**: Pointwise convergence, Uniform convergence, Criterion for non-uniform convergence, Cauchy Condition for Uniform Convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation.

**Series of functions**: Uniform convergence of series of functions, Cauchy condition, Weierstrass *M*-test, Dirichlet's test, and Abel's test for uniform convergence. Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation

[19 Lectures]

**Unit 8. Improper Integrals**

Classification of improper integrals, Convergence, Divergence, Application of Fundamental Theorem of calculus, Simple properties, Conditions and tests for convergence, Absolute convergence, Abel's test and Dirichlet's test [18 Lectures]

**Unit 9. Complex Numbers and Functions**

Algebraic and Geometric properties of complex numbers, Polar coordinates and Eulers formula, Products and quotients in exponential form, Roots of complex numbers, Regions in the complex plane, Complex functions, Complex functions as mappings. [10 Lectures]

**Unit 10. Analytic Functions**

Limits and Continuity, Differentiability, Cauchy-Riemann Equations, Sufficient conditions for differentiability, Analytic functions, Reflection principles, Harmonic functions [16 Lectures

**Text books**


1. Tom Apostol, *Mathematical Analysis*, Narosa Publishing House, India.
2. David V. Widder, *Advanced Calculus*, Prentice Hall.
3. James Ward. Brown and Ruel V.Churchill, *Complex Variables and its Applications*,McGraw-Hill.Inc.


**Reference books**


4. Pahari,N.P., *A Textbook of Mathematical Analysis*, Sukunda Pustak Bhawan, **Kathmandu.**
5. **Brian S. Thomson, Judith B. Bruckner, Andrew M. Bruckner, *Elementary real analysis***
6. **R. G. Bartle, *The Elements of Real Analysis*, John Wiley and Sons.**
7. S. Ponnusamy, *Foundations of Mathematical Analysis*, Springer.
8. V. A. Zorich, *Mathematical Analysis* I and II, Springer.
9. Dennis G.Zill and Patrick D.Shanahan,*Complex Analysis with Applications* , Jones and Bartlett Publisher.
10. John H.Mathews and Russel W.Howell, *Complex Analysis for Mathematics and Engineering*, Jones and Bartlett Learning.


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

**Course Title**: Mechanics **Full Marks**: 50
**Course No**. : MAT 403 **Pass Marks**: 17.5
**Level** : B.Sc. **Year**: IV
**Nature of Course**: Theory **Period per week**: 5 Lecture Hrs.

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

**Course Objectives**

The objective of this course is to acquaint students with the concept of mechanics like coplanar forces, virtual work, catenary, centre of gravity, kinematics in two dimensions, rectilinear motion, moments and product of inertia. It aims at enabling students to build good knowledgebase in the subject of mechanics.

## Course Contents:

**Unit 1. Coplanar Forces & Virtual Work**:

Resultant of coplanar forces, Equation to the resultant, Equivalent force and couple, General condition of equilibrium, Work done by the resultant, Virtual displacement, Virtual work, Principle of virtual work for a system of coplanar forces acting on a particle. 20 Lectures

**Unit 2. Catenary**:

Definition, Equation of common catenary in intrinsic and Cartesian forms, Properties of common catenary, Approximations to the common catenary, Sag of a tightly stretched wire 12 Lectures

**Unit 3. Center of Gravity**:

Center of mass, Center of gravity, Center of gravity by integration, Center of gravity of an arc, Center of gravity of a plane area, Center of gravity of a solid revolution, Center of gravity of a surface of revolution, Center of gravity of the sum or difference of two bodies. 16 Lectures

**Unit 4. Kinematics in Two Dimensions**:

Motion in plane- velocity and acceleration, Radial and transverse components, of velocity and acceleration, Angular velocity and acceleration, Tangential and normal components of acceleration 13 Lectures

**Unit 5. Rectilinear Motion, Moments and Products of Inertia**:

Simple harmonic motion, Motion under inverse square law, Motion under laws of forces, Definition of moments and product of inertia, Motion of inertia in some simple case 14 Lectures

**Text books**


1. R.S. Verma; *Text Book on Statics,* Pothishala Pvt. Ltd. Allahabad, India
2. M.Ray; *Text Book on Dynamics,* S. Chand & Company Ltd. India


**Reference Book**


3. C.M. Joshi, J.C. Joshi & R.D. Joshi ; *A Text Book on Mechanics*, Buddha Academic Publishers & distributers, Kathmandu.

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

**Course Title**: Linear Programming
**Course No**.: MAT 404
**Level:** B.Sc.
**Nature of the Course**: Theory

**Full Marks**: 50
**Pass Marks**: 17.5
**Year**: IV
**Period per week**: 5 Lecture Hrs.

**Course Description**
This course is designed for fourth year of Four years B.Sc. program.

**Course Objectives:** Linear Programming is the first course in optimization. This course aims at introducing techniques of linear programming and informs students the solution status of the related problems in LP. After the completion of this study, students will be familiar with LP models and their real life applications. They will be able to tackle the LP solution algorithms.

## Course Contents

**Unit 1. Mathematical Background**:

System of linear equations and inequalities, Basic solutions, Lines and hyper planes, Convex sets and functions, Convex sets and hyper planes, Convex cones, Polyhedron, Concepts on graphs, Time complexity and reduction relations. 15 hrs

**Unit 2. LP-Models and Complexity**

Variables and constraints, Cost function, Two-variable LP models and graphical solution methods, General, Canonical and standard forms of LP models, Slack and surplus variables, The equivalency of different LP-forms, Decision versions of the optimization problems. 15 hrs

**Unit 3. Simplex Algorithm**

Extreme points, Basic feasible solutions, Solution of LP problems by simplex method, Complexity of simplex method, Relation of extreme points and basic feasible solutions 15 hrs

**Unit 4. LP Duality Theory**

Alternate formulations of LPs, The dual LP formulation, Complementary slackness conditions, The dual simplex algorithm. 15 hrs

**Unit 5. Applications**

Models of transportation problem, Assignment problem, Maximal flows in a network, Minimum cost flow problem, Transshipment problem, Diet problem, LP models of scheduling problems, Production planning, Scheduling problems. 15 hrs

**Text/Reference Books**


1. G. Hadley; *Linear Programming*, Narosa, Publishing House.
2. Hamdy A. Taha; *Operations Research*, Prentice Hall-Pearson.
3. Lueberger, D.G; *Linear and Nonlinear Programming*, Addison-Wesley.

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

Course Title: Project Work — Full Marks: 100
Course No. : MAT 406 — Pass Mark: 35
Level : B.Sc. — Year: IV
Nature of Course: Project .

**Course Guidelines: -** The project work must have connection with mathematics course taught in the B.Sc. Level in Mathematics.

For example, application of differential equations, Linear Programming, Algebra, Analysis, Mechanics, Geometry and so on in real life problems.

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

**Course Title:** Teaching Methodology (Elective) — **Full Marks:** 100(75 Theory+ 25 practical)
**Course No:** MAT 405 — **Pass Marks:** 35(26.25 Theory + 8.75 Practical)
**Level:** B. Sc — **Year:** IV
**Nature of course**: Theory and practical — **Period per Week**: 9 Lecture Hrs.

**Introduction**

This course is designed for fourth year of Four years B.Sc. program as an elective subject..What we teach and how we teach mathematics are inextricably linked and very much dependent on one another. Even though both are tightly linked, they are still separate. Growth of content knowledge doesn't automatically improve teaching efficiency. The present course supports questioning about teaching and learning mathematics. This course provides an introduction to teaching mathematics in schools. It introduces effective teaching of mathematics combining an understanding of how children learn, how to promote that learning by teaching through problem solving, and how to plan for and assess that learning on a daily basis. Thus, this course is designed to help students develop pedagogical strategies for teaching in the future.

**Learning outcomes**

At the end of this chapter the student will be able to:

• Recall various theories of learning

• Make links between these theories and the teaching of mathematics

• Appreciate the importance of teaching the skills and concepts in math as well as problem-solving.

• Appreciate the importance of the teacher-pupil relationship

• Choose the most appropriate teaching strategy for the classes

• Design the most appropriate unit lesson plan for a particular topic

• Ensure the key issues of good classroom management

• Use intrusive strategies to control the class.

•Appreciate the role of practical work in school maths;

• Discuss the pedagogical approaches used for teaching school math.

• Plan for and understand the needs of gifted students in your class

•Promote learning by teaching through problem solving

• Discuss strengths and weaknesses of different contexts

• Describe a variety of ICT resources suitable for use in the math classroom

• Discuss factors which influence the decision on the type of ICT being used

**Examination:** There will be a final examination of the theory part of 75 marks for the period of three hours. However practical part of 25 marks will be conducted by the concerned Department of Mathematics and the marks will be submitted to office of the controller of examination. The candidate must pass in theory and Practical part separately.

**Course Contents**

**Unit 1: Teaching for Understanding: Mathematical Knowledge or Enquiry:** Theories of how children learn, Perspectives on teaching, Twofold nature of math, Mathematics as a mode of enquiry, Mathematics as a body of knowledge. [20 Lectures]

**Unit 2: Being an Effective Mathematics Teacher:** Requirements for an effective teacher of mathematics, Effective lesson planning and its pedagogical analysis, Exemplars/non-exemplars and criterial attributes. Stones' heuristic for teaching subject knowledge, Establishing a positive learning environment, Dealing with underachievement in math, Gender issues in math, Available resources for teaching mathematics. [10 Lectures]

**Unit 3: Classroom Management and Working with Pupils:** Teacher-pupil relationship, Teaching strategies Discipline and behavior management, Flowing lesson, Maintaining a continuous signal, Importance of advance preparation, Sequence of a lesson, Use of the 'tactical ignore', Strategies for classroom control, Structure for dealing with disruptive pupils. [15 Lectures]

**Unit 4: Designing an Effective Lesson Plan:** Components of a Lesson Plan, Planning Paths of Differentiated Instruction, Planning Group Work in the Math Classroom, Teacher-Centered Versus Student-Centered

Instructional Models, Solving Systems of Equations Using the Developmental Lesson Model and the Workshop Model, Designing the Homework Assignment, Routines for Checking Homework, Importance of Planning Board Work, Planning a Series of Lessons (Unit Planning).
[20 Lectures]

**Unit 5: Some Specific Ideas for Teaching Certain Lessons:** Angle Measurement with a Circle by Moving the Circle, Sum of an Arithmetic Progression, Introducing the Product of Two Negatives, Rationalizing the Denominator, Pythagorean Theorem, Introduction to Nonpositive Exponents, Introducing the Notion of a Function, Intuition Versus Justification, Art of Classroom Questioning. [15 Lectures]

**Unit 6: Teaching Number Sense, Algebra and Geometry:** Reasoning and sense making, Teaching of number sense, Sample lesson plan: number sense, Number sense – activities sampler, Teaching of algebra, Sample lesson plan: algebra, Algebra – activities sampler, Teaching of geometry, Sample lesson plan: Geometry, Geometry – activities sampler. [15 Lectures]

**Unit 7: Strategies for Understanding Problem Solving:** *Problem-Solving*: Overview, Difficulty Factors, Teaching the process, *Strategies for Problem Solving*: Drawing a Diagram, Using Concrete Materials, Creating a Table, Looking for a Pattern, Guessing and Checking, Creating an Organized List, Working Backwards, Creating a Tree Diagram, Using Simpler Numbers, Using Logical Reasoning, Analyzing and Investigating Solving Open-Ended Problems. [20 Lectures]

**Unit 8: Mathematics in Context:** Skills for learning mathematics in context, Strengths and weaknesses of different contexts, problems with using contexts in teaching, teaching mathematics in context. [10 Lectures]

**Unit 9: Responsibility of Assessment:** Evaluative Assessment, Diagnostic Assessment Designing the Classroom Test, Informing Students of Their Grades, Improving Their Test Scores, Assessing the Assessment, Remedy of Poor Class performance, Testing Students of Varying Ability Levels, Handling Absentees on Test Days, Comprehensive Assessment. [15 Lectures]

**Unit 10: The Role of ICT in the Mathematics Classroom:** Forms of educational technology, Deciding to use ICT (Information and communication technology), Logistics of using ICT in mathematics, Areas for, and examples of, the incorporation of ICT in secondary mathematics lessons, Enhancing the teaching of mathematics using ICT, Internet as an ICT. [10 Lectures]

**Recommended Books**


1. Pamela Cowan, *Teaching Mathematics a Handbook for Primary and Secondary School Teachers* (for units 1, 2, 3, 10)
2. Alfred S. Posamentier and et al., *Exemplary practices for secondary math teachers* Association for Supervision and Curriculum Development, USA 2007 (for units 4, 5, 9)
3. D. J. Brahier, *Teaching secondary and middle school mathematics*, Pearson 2013 (for units 6)
4. Deborah V. Mink, Ph. D. *Strategies for Teaching Mathematics* Shell Education Publishing Inc. 2010 (for units 7)

**5.** Sue Johnston-Wilder and et al., Learning to Teach Mathematics in the Secondary School: a companion to school experience, Routledge, 2011 (for unit 8)

**References**

1. C. Kyriacou, *Essential, Teaching Skills*, Nelson Thornes Ltd, 2007
2. C. Kyriacou, *Effective Teaching in Schools Theory and practice*, Nelson Thornes Ltd, 2009
3. Anthony Haynes, *The Complete Guide to Lesson Planning and Preparation*, Continuum International Publishing Group, 2010
4. Rosamund Sutherland, *Teaching for Learning Mathematics*, Open University Press, McGraw-Hill, 2007
5. Polya, G., *How to solve it*, Princeton,1973.
6. L. Fazio and R.Siegler, *Teaching fractions*, IAE Educational Practices Series 2011

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

**Course Title:** Bio Mathematics (Elective) **Full Marks:** 100
**Course No. :** MAT 407 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course Description**

This course is designed for fourth year of Four years B.Sc. program as an elective subject. The main aim of this course is to provide knowledge of Mathematics in Biology.

**Course Objectives**: The objective of this course is to acquaint students with the basic concepts of mathematics, in population modeling and disease modeling. Also, the idea of solving biological problems.

**Course Contents**

**Unit 1**. **Dynamic Modeling with Difference Equations :** The Malthusian Model , Nonlinear Models Analyzing Nonlinear Models , Variations on the Logistic Model , Comments on Discrete and Continuous Models [20 Lectures]

**Unit 2. Linear Models of Structured Populations:** Linear Models and Matrix Algebra , Projection Matrices for Structured Models , Eigenvectors and Eigenvalues, Computing Eigenvectors and Eigenvalues [20 Lectures]

**Unit 3. Nonlinear Models of Interactions :** A Simple Predator–Prey Model , Equilibria of Multipopulation Models, Linearization and Stability , Positive and Negative Interactions. [20 Lectures]

**Unit 4. Modeling Molecular Evolution:** Background on DNA, An Introduction to Probability, Conditional Probabilities, Matrix Models of Base Substitution , Phylogenetic Distances. [20 Lectures]

**Unit 5. Constructing Phylogenetic Trees:** Phylogenetic Trees, Tree Construction: Distance Methods – Basics, Tree Construction: Distance Methods – Neighbor Joining. [20 Lectures]

**Unit 6. Genetics:** Mendelian Genetics, Probability Distributions in Genetics. [15 Lectures]
**Unit 7. Infectious Disease Modeling:** Elementary Epidemic Models ,Threshold Values and Critical Parameters, Variations on a Theme, Multiple Populations and Differentiated Infectivity. [20 Lectures]
**Unit 8. Curve Fitting and Biological Modeling :** Fitting Curves to Data , The Method of Least Squares, Polynomial Curve Fitting . [15 Lectures]

**Text Books/Reference Books**


1. Elizabeth S. Allman, and John A. Rhodes, *Mathematical Models in Biology An Introduction,* Cambridge University Press**,** 2004.
2. Nicholas F. Britton **,** *Essential Mathematical Biology,* Springer-Verlag London Limited 2003.


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

**Course Title:** Mathematical Economics (Elective) **Full Marks:** 100
**Course No. :** MAT 408 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course Objectives:** This course is designed for fourth year of Four years B.Sc. program as an elective subject**.**This course aims to introduce mathematical modes of economic problems in the society and industry. The students will be able to understand modeling techniques of different economic problems and apply mathematical tools to solve them theoretically. The focus has been given to the equilibrium, cooperative-static and dynamic analysis, and optimization techniques in theory and practice.

**Unit 1.** Concept of modeling, meanings of mathematical economics and econometrics, equilibrium analysis, market equilibrium linear, nonlinear and general models, graphical solutions, solution techniques and applications to national-income analysis and finite Markov chains, non singularity of a matrix and applications to market and income models. [30 Lectures]

**Unit 2.** Modeling of the marginal and average revenue functions, relationships between the cost-functions, geometric interpretations of partial derivatives in economic terms, gradient vector of the production function, applications to comparative static analysis, comparative static analysis of general function models and application to economical problems [30 Lectures]

**Unit 3.** Optimization methods for equilibrium analysis, types of extreme points, first, second and nth derivative tests, necessary and sufficient conditions, conditions for profit maximization, the growth function and its variants, extensions to multivariables, conditions to convexity and concavity and economic applications. [30 Lectures]

**Unit 4.** Effects of constraints in optimization methods, stationary values, Lagrange-multiplier method, second order conditions, multivariable and multi constraints, quasiconcavity and quasiconvexity, utility maximization and consumer demand, changes in price and demands, NLP and KKT-conditions, the constraint qualifications, sufficient conditions to nonlinear programming and economic applications.

[30 Lectures]

**Unit 5.** Meaning of economic dynamics, economic applications of integrals, the growth model, dynamics of market price, the qualitative-graphic approach, the market model, Inflation and unemployment models, applications of difference and higher order differential equations to economic problems. [30 Lectures] ]

**Text/Reference Book(s):**


1. A. C. Chiang, Kervin Wainwright; *Fundamental Methods of Mathematical Economics*, McGraw Hill Publishers.
2. Hoy Michael, et al.; *Mathematics for Economics*, Third edition, PHI Learning Private Limited


# Tribhuvan University

Institute of Science and Technology

Course of Study for Four Year Mathematics

Course Title**:** Mathematical Modeling
Course No: MAT 409
Level: B. Sc
Nature of course: Theory

Full Marks: 50
Pass Marks: 17.5
Year: IV
Period per Week: 5 Lecture Hrs.

**Course Objectives:** The objective of this course is to acquaint students with the basic concepts of modeling like modeling change, the modeling process, proportionality and geometric similarity, model fitting, optimization of discrete models and modeling with a differential equation. It aims at enabling students to build good knowledgebase in the subject of modeling.

**Course Contents**

**Unit 1. Modeling Change**

Introduction, Mathematical models, Modeling change with difference equations, Approximating change with difference equations, Solution to dynamical systems, Systems of difference equations. [ 15 Lectures]

**Unit 2. The Modeling Process, Proportionality and Geometric Similarity**

Mathematical models, Modeling using proportionality, Modeling using geometric similarity, Automobile gasoline mileage, Body weight and height, Strength and agility. [15 Lectures]

**Unit 3: Model Fitting**

Fitting model to data graphically, Analytical methods of data fitting, Applying the least squares criterion, Choosing a best model. [15 Lectures]

**Unit 4: Optimization of Discrete Models**

Introduction, An overview of optimization modeling, Linear programming, Geometric, Algebraic, Simplex method [15 Lectures]

**Unit 5: Modeling With a Differential Equation**

Population growth, Prescribing drug dosage, Braking distance revisited, Graphical solutions of autonomous differential equations [15 Lectures]

**Text book**

1. Frank R. Giordano, William P. Fox, Steven B. Horton, Maurice D. Weir; *Mathematical Modeling, Principles and Applications*, Cengage Learning, India Edition.

**Reference books**

2. Sandip Banerjee; *Mathematical Modeling, Models, Analysis and Applications*, A Chapman and HallBoyce, W. and Book.
3. Boyce, W. and DiPrima, R.; *Elementary Differential Equations and Boundary Value Problems*, 9th Ed., Wiley India.

**Note** : It is mandatory for B.Sc. 4th year Mathematics Students to select one paper out of 4 papers( Math 405/ 406/407/ and 408) designed by Mathematics Subject Committee.

# Fourth Year

## Fluid Dynamics and Dynamical Meteorology

Course Title: Fluid Dynamics and Dynamical Meteorology

Course Number: MET 401 Full Marks: 100

Nature of Course: Theory Pass Mark: 35

**Course objectives**

Course of Fluid Dynamics is designed to provide students with depth knowledge on various aspects of fluid which are associated with different physical conditions. Dynamical Meteorology course is designed to provide the students with the basic knowledge on conservation principals of mass, momentum and energy. This course will help student to understand the application of these principles on dynamics of atmospheric motion, which in turn leads to the climate model development.

**Course contents**

**Definitions and Properties of Fluids:** Matter-its classification; Classification of fluids- liquids and gases; Types of Fluid – ideal, real, Newtonian, non-Newtonian, ideal plastic, thyxotropic fluids; Liquids and their properties-density, specific weight, specific gravity, compressibility; surface tension, capillarity, viscosity; Composition of Forces- triangle law, parallelogram law and polygon law; Dimensions, Units and Systems of measurement.

10 hrs

**Viscosity- dynamic and Kinematic viscosity:** Surface tension-pressure intensity inside a droplet, pressure intensity inside a hollow bubble; Thermodynamic properties-isothermal and adiabatic process; Capillarity of water 8 hrs

**Fluid Pressure and its Measurement:** Fluid pressure; pressure head; Pascal's Law; Atmospheric Pressure; Gauge pressure; Negative pressure or vacuum pressure; Barometer-aneroid and Siphon barometer; Pressure in compressible fluids-isothermal and adiabatic process.

6 hrs

**Hydrostatics and Its Applications:** Definition, Total pressure on an immersed surface-horizontal, vertical and inclined surfaces; Centre of pressure for vertically and inclined immersed surfaces; Pressure diagrams- (a) pressure due to one kind of liquid on (i) one side, (ii) over another, on one side and (b) pressure due to liquids on both sides; Practical applications of hydraulics on – Sluice gate, lock gates, masonry walls and dams 14 hrs

**Equilibrium of Floating Bodies:** Buoyancy; Centre of buoyancy; Conditions of Equilibrium of a floating body-stable, unstable and neutral equilibrium 3 hrs

**Kinematics of Fluid Flow:** Introduction; Methods for describing fluid motion- Lagrangian and Eulerian methods; Lines of flow- path line, stream line, streak (or filament) line, potential lines; Types of fluid flow- (i) Laminar flow and turbulent flow, (ii) Steady and Unsteady flow, (iii) Uniform and Non-uniform flow, (iv) Rotational and Irrotational flow (v) Critical, sub-critical and super critical flow, (vi) Compressible and incompressible flow; Various types of fluid movements- (i) a pure translation (ii) pure rotation, (iii) linear deformation, (iv) angular (shearing) deformation; One, two and three dimensional fluid flow; Rate of flow or discharge

12 hrs

**Dynamics of Fluid Flow:** Energy possessed by a fluid in motion- potential, kinetic, pressure and total energy or head; Energy Equation- General energy equation for a steady flow; Bernoulli's theorem and its statement; Bernoulli's theorem for liquids; Euler's equation of motion and derivation of Bernoulli's equation; Derivation of Bernoulli's equation from Euler's equation of motion for a stream tube; Euler's equation for motion normal to streamline; Assumptions underlying Bernoulli's equation; Limitations of Bernoulli's equation; Kinetic energy correction factor; Practical applications of Bernoulli's equation-Venturimeter, Orificemeter, Pitot tube, Flow nozzle; Discharge through a venturimeter; Rate of change of momentum; Head and Power; Power of a jet of water, Momentum Equation- Linear momentum equation and Impulse-Momentum Theorem; Some applications of Impulse-Momentum Theorem; Moment of momentum equation; Fluid Motion- Types of fluid motion; Radial motion (or flow); Free cylindrical vortex; Spiral forced vertex.

22 hrs

**Introduction:** Dynamic meteorology, field variables and their derivatives, total differentiation, total differentiation of a vector in a rotating system, vector operators, unit vectors, the atmospheric continuum**,** Taylor series expansion, physical dimension and unit (Frequency, force, pressure, energy, power). 8 hrs

**Atmospheric coordinates:** Inertial (absolute, fixed, non-rotating) and non-inertial (relative, moving, rotating) frame of references, geocentric reference frame, Cartecian and spherical coordinates, height, pressure and potential temperature as vertical coordinates, Lagrangian and Eulerian control volume, natural coordinates, generalized vertical coordinate.

8 hrs

**Static atmosphere:** Hydrostatic equation, hypsometric equation, geopotential height.

4 hrs

**Atmospheric forces:** Fundamental and apparent forces, *b*ody forces or surface forces, pressure gradient force, gravitational force, viscous force, centripetal acceleration and centrifugal force, gravity force, the coriolis force and the curvature effect. 10 hrs

**Conservation of momentum:** Newton's first law of motion, the vectorial form of the momentum equation in rotating coordinates, the component equations in spherical coordinates, scale analysis of equations of motion. 10 hrs

**Conservation of mass:** Lagrangian and Eulerian derivations and scale analysis of equation of motion. 8 hrs

**Conservation of energy:** The first law of thermodynamics, internal and kinetic energy, thermal and mechanical energy equations, thermodynamics of dry air, potential temperature, adiabatic lapse rate, Static stability. 8 hrs

**Basic equations:** Basic equations in height and pressure coordinates (horizontal momentum, continuity and thermodynamic energy equations), balanced flow in natural coordinates, geostrophic flow, inertial flow, cyclostrophic flow, gradient wind approximate, thermal wind, barotropic and baroclinic atmosphere, vertical motion (kinematic and adiabatic methods), surface pressure tendency. 12 hrs

**Circulation and vorticity:** Circulation theorem (Kelvin's Circulation theorem), relative, absolute and planetary vorticities, vorticity in natural coordinate, shear and curvature vorticities,

potential vorticity, conservation of vorticity, easterly and westerly flows over mountain barriers.

7 hrs

**Text Books**

- Jagdish Lal; Fluid Mechanics and Hydraulics; Ninth Edition, Metropolotan Book Co. Pvt. Ltd; New Delhi
- Holton J. R., 2004, An Introduction to Dynamic Meteorology, 4th edition Volume 48, International Geophysical series, Academic Press, New York.

**Reference Books**

- A text book of Hydraulics, Fluid Mechanics and Hydraulic Machines; Khurmi, R.S; S. Chand and Company Ltd; ,Ninth Edition, New Delhi
- A Textbook of Fluid Mechanics, Rajput, R.K; S. Chand and Company Ltd; ,Second Edition, New Delhi
- Hydraulics Fluid Mechanics and Fluid Machines, Ramamrutham. S; Dhanpat Rai Publishing Company (P) Ltd., New Delhi
- George J. Haltiner and Frank L. Martin, Dynamical and Physical Meteorology, McGraw-Hill Book Company.
- WMO Publication, Dynamical Meteorology, Geneva, Switzerland.

## Engineering Hydrology

Course Title: Engineering Hydrology

Course Number: MET 403 Full Marks: 100

Nature of Course: Theory Pass Mark: 35

**Course objectives:**

Engineering hydrology course is designed to provide the students in depth knowledge on various aspects of hydrology. Students will learn about the precipitation, water loss, runoff, hydrograph, sedimentation, water quality and its applications.

**Course content**

**Introduction**: Definition, scope of hydrology, hydrological cycle, availability of water on earth and Nepal, history of hydrology, importance and application of hydrology in engineering field.

2 hrs

**Catchment Characteristic :** Stream pattern, drainage, slope, shape, altitude, stream length, catchment area, drainage density, relief, stream density and stream order, hypsometric curve, area length relation, river basin of Nepal. 5 hrs

**Precipitation:** Probability and random variable, distribution functions, selection of distribution function and estimation of parameters, frequency analysis, correlation, regression analysis, depth area duration curve, intensity duration curve, probable maximum precipitation (PMP).

5 hrs

**Flood hydrology:** Sources of runoff, factors affecting runoff, basin yield, rainfall-runoff relationship, computation of runoff, time of concentration, runoff characteristic of stream, flow duration curve, river system and surface water resources of Nepal, Flow and Flood, Flood prediction by different methods, estimation of design flood, flood frequency analysis, probable maximum flood (PMF), flash flood and landslide dam outburst flood (LDOF), inundation, flood routing. 8 hrs

**Ground water exploration** : Safe yield, yield of dug well, artificial ground water recharge, springs (depression, contact, artesian, impervious rock, tubular), hydrothermal phenomena, aquifer properties and groundwater flow, surface investigations of ground water, well hydraulics (steady and unsteady flow into well), well loss, groundwater pollution and legislation, ground water resources and its distribution in Nepal.

5 hrs

**Limnology:** Lakes/pond and its classification, dynamic processes in lake/pond, thermal stratification**,** methods of bathymetric survey**,** morphological parameters of the lake, depth-area-volume relationship. 5 hrs

**Measurement of Stage:** definition, non recording water level recorder (staff gauge –vertical, inclined and sectional, wire gauge, recording gauge (floating, bubble and radar), data logger, crest gauge and its importance, bench mark, flood mark, stage hydrograph, estimation of missing

stage data, network design (optimum number of hydrometric stations, ideal location), stage measurement practices in Nepal, hydrological network of Nepal.

5 hrs

**Measurement of Discharge**: Definition, direct method- area velocity (Current meter, Floats-surface, subsurface and rod float), calculation of area and mean velocity, vertical velocity distribution, wading, cable way, bank operating and bridge under measurement method, types of current meter, calibration of current meter, sounding weights, adopted procedures for discharge measurement by using current meter, computation of discharge, angle correction, dilution method, electro-magnetic method, ultrasonic method, volumetric method, indirect method *(*slope area method), roughness coefficients, estimation of peak flow, hydraulic structures (uniform and non-uniform flow, notch, weirs, flume

10 hrs

**Station calibration**: Stage discharge relation, controls (permanent and shifting controls) extension and interpolation of rating curves (Steven's, logarithmic and regression analysis), rating table, validation of rating curves. 5 hrs

**Erosion and Sedimentation**: Erosion and sedimentation, types of erosion, sources of sediment, control measure of sedimentation, factors affecting sediment yield, suspended and bed sediment load measurement and analysis, 5 hrs

**Water quality**: Water pollution, major ions, water quality requirements for domestic, industry and irrigation, drinking water quality standard of Nepal and WHO. 5 hrs

**Surveying**: Definition and principle of hydrological survey, level, theodolite and total station, accuracy and error, measurement of horizontal and vertical angle, longitudinal and cross section survey of river, estimation of peak flow from hydrological survey.

10 hrs

**Hydropower:** History of hydropower development in Nepal, hydropower potential of Nepal, types and classification of hydropower and their arrangements, estimation of hydropower, firm power and secondary power, current demand and load forecast in Nepal

5 hrs

**Municipal/rural water supply:** History of pipe water supply in Nepal, Municipal/rural water supply demand, distribution system, methods of supplying water, status of municipal/rural water supply in Nepal. 5 hrs

**Irrigation:** History of irrigation development in Nepal, classification and types of irrigation, irrigation system, methods of irrigation, crop water requirement, potential and status of irrigation facility in Nepal 5 hrs

**Flood risk management and river training:** Definition and importance of FRM, FRM cycle, automatic data acquisition, telemetry and flood early warning, forecast verification, flood hazard, vulnerability and risk assessment (mapping of flood exposure, depth damage curve, vulnerability mapping, flood risk mapping), flood risk management, definition and concept of river training, classification of river training works, river training structures

5 hrs

**Text Books**


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


**Reference Books**


- C.K. Sharma, A Treatise on Water Resources of Nepal, 1997, Sangeeta Sharma.
- David Keith Todd, Groundwater Hydrology, Second Edition 1995, John Wiley & Sons.
- Dr. B.C. Punmia, Ashok K. Jain and Arun Jain, Survey Volume 1, 2005, Laxmi Publication
- Dr. B.C. Punmia, Askok K. Jain and Arun Jain, Survey Volume 2, 2005, Laxmi Publication
- H.M Raghunath, Hydrology Principles, Analysis, Design 1997, New Age International Publications
- John C Rodda, Facets of Hydrology II, 1985, John Wiley & Sons.
- K.C.Patra, Hydrology and Water Resources Engineering, 2002, Narosa Publishing House.
- KN Mutreja, Applied Hydrology, 1986, Tata McGraw-Hill Publication Company Limited.

- M.M. Dandekar, K.N. Sharma, Water Power Engineering, 1997, Vikas Publication House Pvt. Ltd.
- Manual on Stream Gauging (Computation of Discharge Report No.13) Volume 2 Field Work, World Meteorological Organization.
- Manual on Stream Gauging (Operational Hydrology Report No.13) Volume I Field Work, World Meteorological Organization.
- Reddy JR Hydrology, 2010, Laxmi Publications
- S Subramanya, Engineering Hydrology, Tata McGraw-Hill Publication Company Limited, 2012.
- Yogacharya Kiran Shankar and Shrikrishna Shrestha, Jalbigyan, 1987, Curriculum Development Center, Tribhuvan University


## Atmospheric pollution and Climate Change

## (Applied Science)

**Course Title:** Atmospheric pollution and Climate change

**Course Number:** MET 405 Full Marks: 100

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

**Composition of the atmosphere:** Atmospheric composition, global cycle and lifetimes, the global temperature records, solar variability. Introduction to greenhouse gases (GHGs).

5 hrs

**The Atmosphere:** The atmospheric boundary layer, local wind structure, stability criteria, plume behavior, logarithmic profile, the Ekman spiral, turbulence, boundary layer scaling.

5 hrs

**Pollutant and their properties:** Major source of gases ($CO_2$, $SO_x$, $NO_x$) and their residence time, physical chemical and optical properties of aerosol. Stratospheric aerosol, chemical component of tropospheric aerosol, size of atmospheric pollutant, CCN. 7 hrs

**Dispersion of pollutants:** Statistical theories of pollutant diffusion, Gaussian plume model, plume rise, effective stack height (Brigg's and Holland's equation) 5 hrs

**Ozone:** Tropospheric and stratospheric ozone, Chapman theory, depletion of ozone, ozone hole.

5 hrs

**Climate change:** Introduction, global carbon cycle, global carbo budget, feedback of global climate, direct and indirect impact of aerosol, role of IPCC in climate change.

8 hrs

**Climate and human affairs, Climate and civilization, Earth Atmosphere:** Temperature of Atmosphere and its control factors, Heating and cooling process of the atmosphere, Temperature inversion and anomalous temperature, Vertical distribution of temperature and lapse rate, horizontal distribution of Temperature, Seasonal distribution. Precipitation:- Types, forms, relation between precipitation and altitude.

12 hrs

**Climatic controls:** Sun and Solar Radiation:-Sun, solar altitude, solar input, solar radiation, disposition of solar radiation, seasonal variation in radiation, seasonal variation in day light, the length of day, Terrestrial and atmospheric radiation, The planerary radiation balance, solar and net radiation; Greenhouse gasses (GHGs), Green house effects and radiative forcing Rotation and Revolution of Earth and season General circulation of air and transfer of heat and moisture in atmosphere; Effects of Latitude, Altitude, Latitude, Altitude, Continentality, Ocean currents, Insolation, Prevailing winds, Natural vegetation and Soil in climate; Interactions between Atmosphere and Ocean.

12 hrs **Definition, History of climate change; Recent Climate Change Evidences**:- Global temperature, sea level and snow cover in the Northern Hemisphere, Hydrological changes (water vapor and precipitation), Warming trends (IPCC), Increased averages and extremes of climate, Frequency of frost days, cold days, cold nights, heat waves, warm days and warm nights. Climate systems within oceans and cryosphere (Sea ice, Great ice sheets of Greenland and Antarctica, glaciers, snow, frozen land and ice on lake and rivers). Interactions among different climate systems. 10 hrs

**Extraterrestrial factors:** Variation in the Earth's orbital characteristic:-Eccentricity, obliquity, wobbling**,** Solar output: Sunspots, Degree of hydrogen contain. 3 hrs

**Internal Factors:** Change in the composition of atmosphere, Change in the composition of greenhouse gas (specially carbon-dioxide), Volcanic Dust, Displacement of Continents, Human

Influence on Climate System:- Anthropogenic perturbation of the atmospheric composition, the enhanced greenhouse effect, Direct and Indirect effect of aerosols, land use change.

**Climate Change Impacts:** Climate change impacts on water resources, bio-diversity, Agriculture, human health, socio-economy, coastal area etc. 10 hrs

**Climate resilience, adaptation technique and mitigation of climate change:**

Climate resilience Concept of adaptation, adaptation characteristics and process, 10 hrs community based adaptation, Ecosystem based adaptation, NAPA, LAPA, Capture or sequester carbon emissions, Reduce global warming. 10 hrs

**Projections of future changes: C**limate change over the 21st century, Climate scenarios, Regional climate change, Carbon cycle, Physical and chemical characteristics of the oceans, Predicted change in polar and lower latitude regions. 5 hrs

**Text Books**


- Lyons T. J. Scott. W. D. Principal of air pollution Meteorology
- Seinfeld John and Pandis Spyros N., Atmospheric Chemistry and Physics from air pollution to climate change, A Wiley- Inter – science Publication 1997.
- David A. Lynn, Air Pollution threat and response, Addison- Wesley Publication Company.


**Reference Books**


- Microsyllabus and teaching metrerials of climate change for B.Sc. Mereorology, Prepared by Central Department of Hydrology and Meteorology T.U
- PCC, 1996b: Climate Change 1995- Impacts, adaptations and mitigation of climate change: scientific-technical analyses. Contribution of Working Group II to the Second Assessment.
- Report of the Intergovernmental Panel on Climate Change [Watson, R.T., M.C. Zinyowera, R.H. Moss and D.J. Dokken (eds.)], Cambridge University Press, 880 pp.
- IPCC, Climate Change 2007, 2013: The Physical Science Basis. Summary for Policy Makers. Working Group I Contribution to the Intergovernmental Panel for Climate Change Fourth Assessment Report. Cambridge University Press

- W. M. O. (2003) Climate into the 21st Century, Cambridge University Press

## Dynamical Meteorology Practical

**Course Title:** Dynamical Meteorology Practical

**Course Number:** MET 402 Full Marks: 50

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

**Practical 1:** Computation of pressure gradient force

**Practical 2:** Computation of gravitational force

**Practical 3:** Computation of viscous force

**Practical 4:** Computation of centrifugal force

**Practical 5:** Computation of coriolis force

**Practical 6:** Computation of geopotential height

**Practical 7:** Computation of tendencies

**Practical 8:** Computation of geostrophic motion

**Practical 9:** Computation of gradient wind speed

**Practical 10:** Computation of thermal wind

**Practical 11:** Computation of vertical velocity

**Practical 12:** Computation of horizontal divergence

**Practical 13:** Computation of vorticity

**Practical 14:** Computation of circulation

## Engineering Hydrology Practical

**Course Title:** Engineering Hydrology Practical

**Course Number:** MET 404 Full Marks: 50

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

**Practical 1:** Basin map delineation

**Practical 2:** Calculation of morphological parameter of the basin

**Practical 3:** Preparation of hypsometric curve and river profile

**Practical 4:** Preparation of flow duration curve

**Practical 5:** Frequency analysis of flood

**Practical 6:** Preparation of stage hydrograph and computation of missing stage data

**Practical 7:** Calculation of discharge in completely penetrates a confined and unconfined aquifer

**Practical 8:** Calculation of drawdown in aquifer

**Practical 9:** Calculation of morphological parameters of the lake/pond,

**Practical 10:** Preparation of area volume relationship of the lake/pond

**Practical 11:** Measurement and analysis of discharge data from (current meter, surface float, sub-surface float, rod float, volumetric method)

**Practical 12:** Measurement and analysis of discharge by dilution method and tracer method

**Practical 13:** Estimation of discharge by using Notch or Weirs

**Practical 14:** Preparation of rating curve, rating tables, rating equations and their alidation

**Practical 15:** Extension and Interpolation of Rating Curves (Steven's method, Logarithmic and Regression analysis method)

**Practical 16:** Measurement and analysis of suspended and bed load

**Practical 17:** Preparation and analysis of grain size curve of the given sediment sample and bed materials

**Practical 18:** Water quality analysis of given irrigation water sample.

**Practical 19:** Hydropower potential analysis of river and preparation of energy table.

**Practical 20:** Water supply analysis of Kathmandu valley**.**

**Practical 21:** Irrigation potential analysis of river.

**Practical 22**: Surveying (instrumentation)

a. Study of the essentials of the theodolite.

b. Temporary adjustments of station.

**Practical 23** : Surveying (operational measurement)

a. Measurement of magnetic bearing of a line.

b. Measurement of vertical and horizontal angles.

c. Calculation of distance by using theodolite.

d. Calculation of R.L. by using theodolite.

e. Surveying and ploting of the terrace of given surface.

f. Calculation of area by sub-division into triangles.

g. Calculation of area by using a planimeter.

h. Plot and draw contour of the given station from the given data.

**Practical 24:** Estimation of peak flood from hydrological survey data

**Practical 25:** Hydrological Field visit (3 weeks)

a. Preparation of longitudinal and cross section profile of the river.

b. Measurement of discharge of the river from different method

c. Visit of hydropower, irrigation and water supply project.

**Tribhuvan University**
**Institute of Science and Technology**
**Four Years B. Sc. Meteorology Course of Study**

**Course Title: Project Work** **Full Marks : 100**
**Course No. : MET 406** **Pass Marks: 40**
**Nature of Course: Research Work / Presentation** **Year: IV**
**Objective of the Course:**
This course offers students to strengthen the knowledge in research based academic activities related with Meteorology.

## Monsoon Meteorology

**Course Title:** ygoloroteM noosnoM

**Course Number:** MET 407 Full Marks: 50

**Nature of Course:** Theory Pass Marks: 17.5

**Course contents:**
**Zonal average tropical circulation:** Introduction, zonal velocity, mean meridional circulations, temperature field, moisture field, meridional transports by zonally symmetric circulations.
4 hrs
**Zonally asymmetric features of the tropics:** Introduction, gradient level winds, the moisture field in the upper troposphere, the temperature field, east west circulation in the tropics, the moisture field sea level pressure, other parameters. 3 hrs

**Introduction of monsoon:** Definition, historical background features of the monsoon winds, a simple theoretical work of the monsoon, the differential heating that drives monsoon circulation, monsoon index. 4 hrs

**Synoptic component of the monsoon:** Role of ITCZ on monsoon circulation, dynamic thermodynamics of the monsoon, easterly waves, near equatorial monsoon trough, trans-equatorial flow, squall lines in the monsoon area, planetary scale monsoons, corresponding elements of winter and summer monsoon. The easterly jet stream different components of SW Indian monsoon. 4 hrs

**Precipitation and mesoscale feature of the monsoon:** General features of monsoon rainfall; 100 years of monsoon rainfall; heat low, monsoon depressions, the monsoon inversion, on set of monsoon, withdrawal of monsoon, active and break monsoon, floods and drought trends of monsoon. 4 hrs

**Climatological features of monsoon:** Summary of mean climatological features, normal wind and pressure distribution, normal temperature, distributions. 3 hrs

**March of the seasons:** Role of the Himalayan-Tibetan Massif in the monsoons during different seasons, general discussion of monsoon- equatorial Africa, Indonesia, Malaysian region, Indian Ocean, North Africa, Transition of circulation during autumn, winter, spring, early summer and summer season. 4 hrs

**Walker circulation:** Elnino, Lanino, ENSO 2 hrs

**Monsoon in Nepal:** Background, socio-economic effect, rainfall and wind characteristics, summer and winter monsoons in Nepal, Temporal and special domain of SW monsoon in Nepal, active and break situation during monsoon. 2 hrs

**Text Book:**

- Das P. K. the monsoon 2nd ed. National Book trust, India 1988.

**References**:


- Ramage, C. S., *Monsoon Meteorology* Academic Press, New york and London, 1971
- Rao, Y.P., *Southweast Monsoons*, Meteorological Monograph, Synoptic meteorology no 1/1976 IMD. 1976
- WMO, UNESCO: *Meteorological Results of the Int Indian Ocean Expedition*. Paris, 1965
- Riehl, H. *Tropical Meteorology*, Mc Graw Hill Book Com. Inc., New York 1970
- Krishnamurti, T.N. *Compendium of Meteorology Vol II Part 4 Tropical Meteorology*, WMO publication No 364, Geneva, 1979
- Lighthill and Pearce, *Monsoon Dynamics*, Cambridge University Press, London, 1980

# Microbiology

## Agriculture and Food Microbiology

### Description of the Course

**Course Title:** Agriculture and Food Microbiology
**Course No:** MB 401 (Major)
**Nature of the Course**: Theory

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

### Course Objectives

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

a) understand microbial ecology and their role in environment
b) understand the role of micro-organisms in soil fertility, mineral cycles of nature, and plant disease management
c) understand various microbes found in different kinds of food, food borne infections and food preservation methods.

### Course Contents

**Soil and its constituents** **3 hrs**

Introduction and formation of soil, physical, chemical and biological factors, mineral and organic matters, soil solution, gases

**Microorganisms in soil and their roles** **3 hrs**

Bacteria, fungi, actinomycetes, protozoa, blue-green algae (cyanobacteria)

**Microbial ecology** **5 hrs**

Microbial association in soil, water and air, components of microbial ecology, ecosystem and energy, tools and techniques of experimental microbial ecology

**Rhizospheric and phyllospheric microorganisms** **3 hrs**

Introduction, functions, factors influencing their growth and activities

**Microbial interactions** **6 hrs**

Microbial interactions in ecosystem, types of interactions- synergism, commensalism, mutualism, competition, amensalism, predation, and parasitism

**Microbiology of extreme environments** **6 hrs**

Growth and survival of microorganisms in extreme temperature, pH, humidity, salinity, and applications of extremophiles

**Biogeochemical cycles and role of microorganisms** **12 hrs**

Introduction, nitrogen cycle, carbon cycle, phosphorous cycle, sulphur cycle

**Microbial degradation** **10 hrs**

Difference between degradation and deterioration, mechanisms of microbial degradation of cellulose, hemi-cellulose, lignin, chitin, pectin, recycling of organic waste

**Bioremediation** **5 hrs**

Principles of bioremediation, *in situ* and *ex situ* bioremediation of soil, water and air pollution, steps and approaches in bioremediation, removal of xenobiotics, bioleaching, petroleum degradation

**Aerobic and anaerobic decomposition of organic compounds and application** **12 hrs**

Anaerobic decomposition of typical organic compounds, mechanism of aerobic and anaerobic composting, mechanism of methane gas production from agricultural waste including animal waste, biochemistry of methane formation and application

**Plant pathogens** **10 hrs**

Agents of plant diseases: a) Bacterial diseases- Citrus canker causing microorganism, Rickettsia, Mycoplasma, (MLD), Spiroplasma b) Fungal diseases c) Diseases caused by Nematodes, d) Mesobiotic-viral disease

**Microorganisms in various foods** **10 hrs**

Bacteria, molds, yeasts, primary sources of microorganisms in food contamination

**Factors affecting microbial growth in food** **5 hrs**

Intrinsic parameters, extrinsic parameters

**Techniques for determination of microorganisms in food** **10 hrs**

Techniques of detection and enumeration of microorganisms in food, sampling methods (various food industries, dairy, meat market)

**Food handling and spoilage** **15 hrs**

Different types of food handling in industries and market, spoilage of fruits and vegetables, fresh and processed meat and poultry product, egg and egg products, milk and milk products, canned foods, flour cereals and bakery products, fermented foods and beverages, soft drinks, seafoods

**Food preservations** **10 hrs**

Chemical, irradiation, low temperature, high temperature, drying

**Food quality evaluation** **15 hrs**

Quality standard of milk, quality standard of bakeries, quality standard of meat and eggs, quality control of food, Nepal standard, national food regulatory system

**Role of microorganisms in food poisoning** **10 hrs**

Gram positive cocci (*Staphylococcus* spp.), gram positive spore formers (*Bacillus cereus*, *Clostridium* spp.), gram negative bacteria (*Salmonella* spp.), mycotoxin (aflatoxin), seafood toxicants

## Recommended Readings

### Text books


1. Alexander M (1961). Introduction to Soil Microbiology, Academic Press.
2. Atlas RM and Bartha R (1998). Microbial Ecology: Fundamentals and Applications. The Benjamin Cummins Publication Co. Inc.
3. Banwart GJ (1989) Basic Food Microbiology. CBS Publication and Distributions, Delhi.
4. Jay JM (1987). Modern Food Microbiology (3rd Edition). CBS Publications and Distributions, Delhi.


### Reference books


1. Frazier WC and Westhoff DC (1986). Food Microbiology (3rd Edition). Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Rangaswami G and Bagyaraja PT (1993). Agricultural Microbiology (2nd Edition). Prentice Hall of India.
3. Stolp H (1988). Microbial Ecology: Organisms, Habitats, Activities. Cambridge.

# Agriculture and Food Microbiology Practical

## Description of the Course

**Course Title:** Agriculture and Food Microbiology Practical
**Course No:** MB 402 (Major)
**Nature of the Course**: Practical

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

## Course Objectives

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

a) develop practical skills on handling, isolation and identification of soil, water, and food microorganisms.

## Course Contents

**Microorganisms present in soil**: Total viable number of bacteria, fungi, actinomycetes in different kinds of soil
**Buried slide technique for microbial flora of soil:** Different types of microorganisms in soil, identification of microbes by using various techniques
**Azotobacter:** Introduction, morphological structure, culture of *Azotobacter*
**Rhizobium:** Morphological structure, cultural properties, methods of isolation and identification
**Cellulase produced by organisms**: Demonstration of cellulolysis, use of cellulase
**Micro organisms from biofertilizers:** Isolation and identification of organisms responsible for formation of biofertilizers
**Observation of various organisms present in soil:** Demonstration of Winogradsky's column, uses of column in differentiation of microbial ecology
**Differentiation of various organisms from soil samples:** To show the distribution of organisms, their methods of isolation and antibiotic activity
**Cyanobacteria:** Isolation, growth characteristics and identification
**Phosphorus solubilisers:** Methods of culture, identification of solubilisers
**Count of micro-organisms in different foods:** Methods of isolation and counting techniques of bacteria from various foods
**Dairy products; milk, cheese and ice-cream:** Enumeration, culture of organisms, isolation, detection and demonstration of microorganisms
**Tests for milk quality:** Methylene Blue Reduction Time (MBRT) test, Resazurin test, phosphatase test, adulteration tests in milk (starch, soda, sodium hydrooxide, table sugar), alcohol test, acidity test, SNF and fat tests
**Presence of microorganisms in meat and meat products:** Isolation and identification of types of contaminating microorganisms in meat and meat products
**Microorganisms present in fruits:** Culture of microorganisms from fruits (bacteria, yeast and molds), methods of isolation and identification

# Medical and Public Health Microbiology

## Description of the Course

**Course Title:** Medical and Public Health Microbiology
**Course No:** MB 403 (Major)
**Nature of the Course**: Theory

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

## Course Objectives

After completion of the course, the students will be able to:
a) understand basics of epidemiology and health and disease measurements
b) understand public health of infectious diseases
c) understand the immunity process in human body
d) describe biology, pathogenesis and diagnostic methods of bacteria, virus, fungi and parasites

## Course Contents

**Health and disease and epidemiological measurements** **5 hrs**
Definitions of epidemiology, applications of epidemiology, definitions of health and disease, indicators of health and disease, disease frequency measures (mortality, morbidity, incidence, prevalence, incidence density), measures of effect

**Methods of transmission of diseases** **6 hrs**
Epidemic, endemic, pandemic, sporadic, outbreak, investigation of disease outbreaks, mode of transmission of diseases, chain of infection, cases, carriers, hosts

**Management of diseases** **4 hrs**
Disease prevention, control, elimination and eradication

**Drinking water microbiology** **10 hrs**
Types of water, safe drinking water, physico-chemical and microbiological parameters of water quality, biological indicators of water pollution, national and WHO guidelines for drinking water quality standards, principle and procedures of drinking water treatment for large water supply system, methods for monitoring water quality

**Waste management** **10 hrs**
Introduction, solid waste and its types, solid waste management, sewage and industrial effluents, composition and microbiology of sewage, methods for the treatment of waste water

**Microbial air pollution** **6 hrs**
Introduction, methods of enumeration and identification of microorganisms in air (indoor and out door), indicator microorganisms of air pollution, air-borne diseases, air-pollution control

**Historical background of medical microbiology** **2 hrs**
Historical aspects of medical microbiology, major contributors in medical microbiology

**Normal flora of the human body** **5 hrs**
Normal flora of human body (skin, gastrointestinal tract, respiratory tract, genito-urinary tract), opportunistic pathogens

**Immunity process** **30 hrs**

Types of immunity, cells and tissues of immune system, antigens, immunoglobulins and their types, antigen antibody reactions, hypersensitivity

**Safety measures in clinical laboratory** **5 hrs**

Principles of laboratories safety, decontamination and safe disposal of contaminated materials, bio-safety level laboratories, risk and hazard group of microorganisms

**Methods of specimen collection, transportation, processing and culture of clinical samples for detection of pathogens** **8 hrs**

Cerebrospinal fluid, blood, sputum, urine, stool, other body fluids, pus and wound exudates, bacteria culture procedures, possible pathogens in different clinical specimens, maintenance of temperature and transportation of samples, culture of virus in chick embryo and cell lines, cytopathic effects, detection of virus from culture, serological tests for the diagnosis of viruses, samples for fungal infections, types of samples for parasite detection, sample processing and detection methods for blood, intestinal and tissue parasites

**Common pathogenic bacteria** **18 hrs**

Biology, epidemiology of diseases/infections, diagnostic methods, prevention and control of*: Mycobacterium, Staphylococcus, Streptococcus, Escherichia coli, Salmonella, Shigella, Vibrio, Rickettsia, Treponema, Clostridium*

**Common pathogenic viruses** **18 hrs**

Biology, epidemiology of diseases/infections, diagnostic methods and prevention and control of: Herpes viruses, hepatitis viruses, measles virus, influenza virus, HIV, rotavirus, polio virus, rabies virus, Japanese encephalitis virus, dengue virus

**Medically important fungi** **8 hrs**

Introduction, classification, and characteristics of medically important fungi and yeasts

Biology, infections, diagnostic methods, prevention and control of: Dermatophytes, *Aspergillus*, *Histoplasma*, *Candida, Cryptococcus*

**Common pathogenic parasites** **15 hrs**

Biology, epidemiology of diseases/infections, diagnostic methods and prevention and control of: *Entamoeba*, *Giardia*, *Plasmodium* spp., *Wuchereria bancrofti*, *Leishmania* spp., *Taenia*, *Ascaris lumbricoides*, *Ancylostoma duodanale*

## Recommended Readings


1. Park K (2008). Park's Textbook of Social and Preventive Medicine. 18th Edition.
2. Gordis L (2004). Epidemiology, 3rd Edition, Elsevier Saunders.
3. Maier RM, Pepper IL and Gerba CP (2006). Environmental Microbiology. Academic Press, Elsevier Publication.
4. Cheesbrough M (2007). Medical Laboratory Manual for Tropical Countries Vol. 2 ELBS London.
5. Tille P (2014). Bailey & Scott's Diagnostic Microbiology (13th edition). Elsevier.
6. Collee JG, Fraser AG, Marmion BP and Simmons A (1996). Mackie &McCartney Practical Medical Microbiology (14th edition). Churchill Livingstone.
7. Greenwood D, Slack RCB and Peutherer J (2001). Medical Microbiology ELBS, Dunclude Livingstone.
8. Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill, New Delhi.

# Medical and Public Health Microbiology Practical

## Description of the Course

**Course Title:** Medical and Public Health Microbiology Practical **Full Marks**: 50
**Course No:** MB 404 (Major) **Pass**
**Marks**: 20
**Nature of the Course**: Practical **Year**: IV
**Total Lecture Hours:** 180

## Course Objectives

After completion of the course, the students will be able to:
a) conduct analysis of environmental samples.
b) perform field level tests for the diagnosis of diseases.
c) collect, transport, and process the clinical samples for the diagnosis of microbial diseases.

## Course Contents

**To perform bacteriological examination of drinking water**: Most Probable Number (MPN), membrane filter (MF) methods, physico-chemical parameters of water tests, DO, BOD, COD, residual chlorine, ammonia, nitrate/nitrite, sulphate, chloride, iron
**To demonstrate water treatment station:** Field visit to water treatment station and report submission
**To assess air pollution:** Air microbes in indoor and outdoor environments
**To perform rapid diagnosis of viral diseases using test kits**: HIV, hepatitis B, hepatitis C, rotavirus
**To understand the disease reporting system of Nepal:** Visit to District Public/Health Office and report submission
**To demonstrate safety precautions in microbiology laboratories**: Demonstrate various safety measures and precautions to be taken in the laboratories
**To collect and transport various clinical specimens:** Blood, urine, stool, sputum, swabs
**To perform different staining techniques:** Gram's staining, capsule staining, spore staining, Ziehl Neelson, Albert stain, Giemsa stain
**To prepare different culture media and monitoring their quality**: Nutrient agar, blood agar, MacConkey agar, chocolate agar, SS agar, XLD agar, MSA, anaerobic culture medium
**To prepare biochemical media and reagents for identification of bacteria:** MR test, VP test, citrate test, urease test, SIM test, indole test, O/F test, TSI/KIA.
**To differentiate different types of bacteria from biochemical tests:** Carbohydrate utilization test, Nitrate reduction test, interpretation of the result
**To perform enzymatic test of the bacteria:** Perform important enzymatic tests, coagulase test, catalase test, oxidase test, DNase test, Gelatin, Casein and lipid hydrolysis.
**To perform antibiotic susceptibility test of the bacterial isolates**
**Serotyping and molecular typing of medically important bacteria**
**To demonstrate serological tests**: Rapid diagnostic test kits, ELISA, hemagglutination test

**To learn various sample collection techniques for diagnosis of mycotic infections:** Skin scrapping, nails clipping, sputum collection, hair plucking

**To prepare fungal culture media**: Preparation of media; Sabouraud dextrose agar, potato dextrose agar, malt extract agar

**To detect the fungi by direct microscopic methods:** Detection of fungal elements: KOH preparation, iodine preparation, India ink preparation, lacto-phenol cotton blue staining

**To examine the samples for intestinal and tissue parasites**: *Ascaris*, *Entamoeba histolytica*, *Giardia lamblia*, *Plasmodium* spp., *Leishmania* spp.

# Methods in Microbiology

## Description of the Course

**Course Title:** Methods in Microbiology
**Course No:** MB 405 (Applied Microbiology)
**Nature of the Course**: Theory

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

## Course Objectives

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

a) understand the principles, procedures and applications of methods used in the fields of microbiology

## Course Contents

**Safety measures in microbiology laboratory** **10 hrs**
Principles of laboratories safety, biosafety level of laboratories and bio-hazards, risk group of microorganisms, decontamination and safe disposal of contaminated materials, sterilization and sterility techniques

**Methods of specimen collection, transportation and processing of clinical samples for bacteria detection** **20 hrs**
Cerebrospinal fluid, blood and other body fluids, sputum, urine, discharges and pus, stool, culture procedures, test algorithms for diagnosis of bacteria, antibiotic susceptibility tests (Kirby Bauer disc diffusion method, minimum inhibitory concentration determination)

**Method of collection, transportation and processing of clinical samples for virus detection** **20 hrs**
Introduction, types of samples, maintenance of temperature and transportation, identification and interpretation, culture of virus in chick embryo and cell lines, cytopathic effects, detection of virus from culture, serological tests for the diagnosis of viruses

**Sample collection and laboratory diagnosis of mycotic infections** **10 hrs**
Samples for fungal infections, sputum, nasal swab, skin scraping, hair and nails, CSF for fungal meningitis, microscopy, staining, culture

**Method of collections of samples and processing for detection of parasites** **15 hrs**
Introduction, types of samples for parasite detection, sample processing and detection methods for blood, stool and tissue parasites

**Immunological and serological tests** **15 hrs**
Principles, procedures, advantages and applications of precipitation, agglutination, complement fixation, ELISA, radio-immunoassay

**Method of collections of water samples and microbiological analysis** **10 hrs**

Introduction, types of water samples, water sample processing and detection methods, MPN, MF, BOD

**Field level tests for disease diagnosis** **10 hrs**

Principles, procedures and applications of rapid tests for malaria, kala-azar, lymphatic filariasis, dengue, HIV, HBV, HCV, rotavirus, JE, leptospirosis, typhoid

**Molecular tests in microbiology laboratories** **15 hrs**

Samples for molecular diagnostic tests, DNA/RNA extraction, PCR, Real Time PCR, PCR-RFLP, sequencing, western blotting

**Microbiological quality tests of foods** **15 hrs**

Quality test of milk and milk products, egg and egg products, meat and meat products, cereal and cereal products, HACCP, detection methods of carcinogens and toxins in food

**Microbiology laboratory in agriculture** **10 hrs**

Methods for preparation of bio-fertilizers, detection methods of pesticide, herbicide, insecticide, fungicide in soil, isolation and detection of pectinolytic, lignolytic, lipolytic, cellulolytic microorganisms from soil

## Recommended Readings

**Text books**


1. Cheesbrough M (2007). Medical Laboratory Manual for Tropical Countries Vol. 2 ELBS London.
2. Brown AE (2012). Benson's Microbiological Applications. Laboratory Manual in General Microbiology. (12th edition). McGraw-Hill Publisher.
3. Collee JG, Fraser AG, Marmion BP and Simmons A (1996). Mackie &McCartney Practical Medical Microbiology (14th edition). Churchill Livingstone.

# Project Writing and Presentation

## Description of the Course

**Course Title:** Project Writing and Presentation
**Course No:** MB 406 (Major)
**Nature of the Course**: Project work

**Full Marks**: 100
**Pass Marks**: 40
**Year**: IV
**Total Lecture Hours:** 150

## Course Objectives

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

a) carry out laboratory based mini research
b) develop knowledge and skills in writing scientific research report

## Course Contents

Students in group will be assigned relevant research topics related to their study by concerned department/campus. Students will perform laboratory experiments within fourth academic year. The research will be supervised by faculty member(s) of microbiology of concerned department/campus. After completion of laboratory work, the student should write the research report in standard format on the basis of data/findings generated during the laboratory works. The student will submit required number of copies of their research report to concerned department or campus for evaluation. The final evaluation of the project work will be made by a panel of external and internal examiners, head of the department and supervisor(s).

# Bioinstrumentation

## Description of the Course

**Course Title:** Bioinstrumentation
**Course No:** MB 407 (Interdisciplinary subject)
**Nature of the Course**: Theory

**Full Marks**: 50
**Pass Marks**: 17.5
**Year**: IV
**Total Lecture Hours: 75**

## Course Objectives

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

a) understand the working principles and procedures of instruments used in microbiology laboratory

## Course Contents

**Buffers** **2hrs**

Physiological solutions and buffers, importance of buffers in biological researches

**General principle and approaches of biochemical investigations** **8hrs**

Introduction, concept, significance of disruption of cells, extraction buffer, chemical methods, enzymatic digestion, mechanical methods, selection of protein source, methods of solubilization of protein, solubility of protein, chromatographic separations, electrophoresis, ultracentrifugation of protein samples

**Working principle, instrumentation and application of** **10hrs**

Phase contrast, electron microscopy, fluorescence microscopy

**Working principle, instrumentation and applications of** **15 hrs**

Centrifugation techniques, Electrophoretic techniques: Agarose gel, Polyacrylamide gel electrophoresis, Isoelectric focusing, Two- dimensional electrophoresis

**Principles, instrumentation and uses of chromatographic techniques** **20 hrs**

Ion exchange chromatography, Affinity Chromatography, Paper and Thin layer chromatography, Gel Permeation chromatography, Gas Chromatography, High performance Liquid Chromatography (HPLC)

**Principle, instrumentation and application of** **10 hrs**

Lambert Beer's law, X-ray and gamma ray spectroscopy, spectrofluorometry, optical rotation dispersion, electron spin resonance (ESR), Infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectrometry, ultraviolet and visible spectroscopy

**Principle, instrumentation and application of molecular techniques** **10 hrs**

Thermocycler, Probes, Sequencer, Gel documentation system, Microarray

## Recommended Readings

**Text books**


1. Skoog DA, Holler FJ and Nieman TA (2005), Principles of Instrumental Analysis, 5th Edition, Thomson Books/Cole
2. Wilson K and Walker J (Eds) (2005), Principles and Techniques of Biochemistry and Molecular Biology,6thEdition, Cambridge University Press
3. Mendham J, Denny RC, Barnes JD and Thomas M (2008), Vogel's Text Book of Quantitative Chemical Analysis, 6th Edition, Pearson Education .

# B.Sc. FOURTH YEAR

## Quantum Mechanics

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

| | |
|---|---|
| **Course Title:** Quantum Mechanics | **Year:** IV |
| **Course Code:** PHY401 | **Full Marks:** 100 |
| **Nature of Course:** Theory | **Pass Marks:** 35 |

**Course Description:**

This course aims at providing students with basic knowledge and skill in theoretical as well as experimental aspects non-relativistic quantum mechanics.

**Course Objectives:**

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

- to acquire fundamental knowledge of quantum mechanics
- to apply this knowledge for higher studies and research in physics

## QUANTUM MECHANICS [160 hours]

**Course Contents:**

1. **Introductory Wave Mechanics:** 1.1 Inadequacy of classical mechanics 1.2 Historical development of quantum theory 1.3 Davisson-Germer experiment: Result and its interpretation 1.4 de Broglie waves, 1.5 Group and phase velocity: relations and applications, 1.6 Uncertainty principle and its application [15 hours]
2. **Quantum Mechanical Wave Propagation:** 2.1 Equation of wave propagation, 2.2 Time dependent and time independent Schrödinger equation, 2.3 Wave function: information, importance & explanation 2.4 Normalization of wave function, 2.5 Expectation values of dynamical quantities, 2.6 General solution of Schrodinger equation 2.7 Time-independent Schrodinger equation in spherical polar coordinates [20 hours]

3. **Operator Formalism in Quantum Mechanics:** 3.1 Commuting and non-commuting operators, 3.2 Linear Operator, 3.3 Hermitian operator, 3.4 Orthogonal functions and orthogonality, 3.5 Parity operator, 3.6 Projection operator, 3.7 Position and momentum operators 3.8 Angular momentum operators 3.9 Hamiltonian operator 3.10 Commutation relations between position, momentum, angular momentum and Hamiltonian operators: physical interpretation, 3.11 Angular momentum operators in spherical polar coordinates [20 hours]
4. **Postulates of Quantum Mechanics:** 4.1 Introduction 4.2 Statement of the postulates 4.3 Physical interpretation 4.4 Physical implications of the Schrodinger equation: 4.5 superposition principle 4.6 Conservation of probability: equation of continuity 4.7 Probability density and probability current density: their relations with group velocity 4.8 equation of motion for an observable 4.9 Principle of first quantization 4.10 Parity and observable 4.11 Ehrenfest theorem [20 hours]
5. **One Dimensional Quantum Mechanical Problems:** 5.1 Free particle, 5.2 Particle in a box, 5.3 Box normalization 5.4 Free particle in an infinite potential well 5.5 Particle in a finite potential well 5.6 Concept of potential: potential with finite walls, 5.7 Potential step, 5.8 Potential barrier, 5.9 Reflection and transmission coefficient 5.10 interpretation tunneling effect 5.11 Ramsauer Townsend effect, 5.12 Smooth barrier, 5.13 Cold emission of electrons in a metal: scanning tunneling microscope, 5.14 Alpha decay: Geiger Nuttal law, 5.15 Virtual binding [30 hours]
6. **Harmonic Oscillator and Applications:** 6.1 Linear harmonic oscillator, 6.2 Hermite polynomials, 6.3 Oscillator wave function 6.4 Even and odd parity states 6.5 Energy of harmonic oscillator, 6.6 Zero point energy 6.7 Hamiltonian of harmonic oscillator in terms of Creation and annihilation operator, 6.8 eigenvalue and eigenfunction of harmonic oscillator, 6.9 Momentum representation for oscillators, 6.10 Two coupled harmonic oscillators. [20 hours]
7. **Quantum Mechanical Problems and Solutions:** 7.1 Schrödinger equation for spherically symmetric potential 7.2 Angular part of Schrodinger equation: Spherical harmonics 7.3 Shapes of orbitals 7.4 Radial part of Schrodinger equation and its solution for Hydrogen atom, 7.5 Laguerre polynomials solution of Schrödinger equation for hydrogen atom 7.6 Transition probabilities and selection rules. [20 hours]
8. **Central Potential Problems:** 8.1 Two interacting particles, 8.2 Schrodinger equation for two interacting particles in spherical coordinates 8.3 Rigid rotator, 8.4 Free particle radial function, 8.5 Particle in a spherical box, 8.6 Spherical potential well of finite depth, 8.7 General results for two particles bound states. [15 hours]

**Text Books:**

1. *Agrawal, B.K. and Prakash, H*. – **Quantum Mechanics,** Prentice Hall of India, New Delhi (1997)

2. *Powell J. L. and Craseman B.*- **Quantum Mechanics**, Narosa, New Delhi (1994)

**Reference Books:**

1. *Merzbacher, E.* - **Quantum Mechanics,** 2nd ed., John Wiley, New York (1969)

2. *Mathews P. M. and Venkatesan K.* - **A Text Book of Quantum Mechanics***,* Tata McGraw Hill Publishing Co. Ltd, New Delhi (1997)

3. *Prakash S. and Saluja S.*- **Quantum Mechanics,** Kedar Nath Ram Nath Publishing Co. (2002)

4. *Singh S. P., Bagde M. K. and Singh K*.- **Quantum Mechanics***,* S. Chand & Company Ltd. (2002)

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

| | |
|---|---|
| **Course Title:** Physics Laboratory (General) | **Year:** IV |
| **Course Code:** PHY402 | **Full Marks:** 50 |
| **Nature of Course:** Practical | **Pass Marks:** 20 |

**Course Description:**

Physics Laboratory (General) Practical course consists of three sections: (a) General Experiments, (b) Optical Experiments, and (c) Nuclear Experiments. Students have to perform at least 13 experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. 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.

## PHYSICS LAB (General) [180 hours]

1. To determine the wave length of given source of light by Fresnel's Bi-Prism.
2. To study Lloyd's mirror for the determination of wavelength of Hg light.
3. To study the formation of fringe pattern by wedge shape and find the thickness of mica sheet.
4. To study the variation of refractive index with concentration of sugar solutions using a hollow prism.

5. Use the measured dataset of experiment 4 and calculate the standard deviation, standard error and probable error with significant figures. Generate theoretical data and test how well the measured data agrees with the theoretical data in this experiment. Show the trend of measured and theoretical data in a graph and interpret it.
6. To determine the value of Stefan's constant.
7. To determine the ratio of Cp and Cv by Clement and Desorme's apparatus.
8. To determine the ratio of $C_p$ / $C_v$ by using Ruchardt's Method.
9. To study the absorption of X-ray by the materials.
10. To determine the half-life period of a given radioactive substance using a G.M. counter.
11. To study the phenomenon of Back-Scattering using a thin radioactive β-source.
12. To study the absorption of β-particle by material to estimate the end-point energy of the β-particle.
13. To study the phenomenon of hysteresis loss of the material and to determine the hysteresis loss of the material over a cycle.
14. To design and study the parallel LCR circuits for finding the quality factor of the elements.
15. To find the dielectric constant of a material using resonance method.
16. To study the specific heat capacity of the materials using Calorimetric method.
17. To study the temperature dependence of resistance of a given semiconductor.

**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 periods laboratory work twice a week to complete both PHY402 lab works.
2. PHY402 will be examined for the duration of six hours in a session.
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% |

# Nuclear Physics & Solid State Physics

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

**Course Title:** Nuclear Physics and Solid State Physics **Year:** IV
**Course Code:** PHY403 **Full Marks:** 100
**Nature of Course:** Theory **Pass Marks:** 35

**Course description:**

This course aims at providing students with basic knowledge and skill in theoretical as well as experimental aspects of Nuclear Physics and Solid State Physics.

**Course objective:**

- To acquaint student with the theoretical and experimental methods in Nuclear and Solid State Physics.
- To prepare them in developing skill to pursue further study and research in the field of physics.

## NUCLEAR PHYSICS (50%) [80 hours]

**Course Contents:**

1. **Nuclear Forces**: 1.1 Nuclear binding energy and saturation of nuclear forces, 1.2 Charge independence 1.3 Two nucleon system – deuteron problem, 1.4 Ground state of deuteron, 1.5 Magnetic moment, 1.6 Quadrupole moment tensor, 1.7 Interaction: nucleon - nucleon scattering, 1.8 singlet and triplet parameters, 1.9 Charge independence, 1.10 Isospin [12 hours]
2. **Nuclear Reactions**: 2.1 Nuclear transmutation, 2.2 Dscovery of neutrons, 2.3 Characterization and types of nuclear reactions, 2.4 Conservation theorems in

nuclear reactions, 2.5 Q-value, 2.6 Threshold energy, 2.7 Cross-section of nuclear reactions, 2.8 Differential cross section, 2.9 Compound nucleus hypothesis [10 hours]

3. **Nuclear Models**: 3.1 Condition of nuclear stability 3.2 Liquid drop model, nuclear fission 3.3 Semi-empirical mass formula 3.4 Bohr-Wheeler theory, 3.5 Shell model: prediction, 3.6 Energy level scheme and explanations of magic numbers 3.7 Experimental evidences for nuclear magic numbers 3.8 Spin-orbit coupling, 3.9 Spins of nuclei, 3.10 Magnetic moments. [12 hours]
4. **Nuclear Reactors:** 4.1 Nuclear reactor: components, 4.2 Power of a nuclear reactor 4.3 Classification of nuclear reactors: Fission & Fusion, 4.4 Fission production and energy release chain reactions, 4.5 Multiplication factors and critically conditions, 4.6 Uranium reactor 4.7 Moderator 4.8 Controlled thermonuclear reactions 4.9 Proton-proton chain 4.10 Carbon-nitrogen-oxygen cycle [12 hours]

5. **Weak Nuclear Force**: 5.1 Beta decay - energy spectrum, 5.2 Fermi theory: neutrino hypothesis, 5.3 Fermi Curie plot, 5.4 Properties of neutrino 5.5 Types: electron neutrino, muon neutrino and Taon neutrino 5.6 Cross-section of neutrino 5.7 Fermi and Gammow – Teller selection rules, 5.8 Decay rates - non conservation and selection rules, 5.9 Nuclear isometrics, 5.10 Angular correction in successive gamma emissions [12 hours]
6. **Cosmic Rays:** 6.1 Discovery and properties of cosmic rays, 6.2 Primary and secondary cosmic rays, 6.3 Origin of cosmic rays, 6.4 Detection of cosmic rays [4 hours]
7. **Elementary Particles**: 7.1 Introduction 7.2 Classification of elementary particles: leptons and quarks 7.3 Meson theory of nuclear forces, 7.4 Conservation laws: lepton number, baryon number, parity, charge conjugation 7.5 Parity violation: examples and explanation, 7.6 Isospin conservation 7.7 Strangeness conservation 7.8 Hypercharge conservation [10 hours]
8. **Particle Interaction:** 8.1 Quark model: generations and properties 8.2 Baryon and Meson: properties and examples 8.3 Hyperon: examples 8.4 Interaction of quarks and leptons 8.5 Symmetry properties of interactions 8.6 Crossing symmetry 8.7 Standard Model of particle physics: matter sector [8 hours]

## SOLID STATE PHYSICS (50%) [80 hours]

**Course Contents:**

1. **Types and Structure of Crystals**: 1.1 Crystalline types of solid, amorphous and glassy, liquid state, 1.2 Lattice and lattice translational vector, 1.3 symmetry operations and space groups, basis and crystal structure, 1.4 Primitive lattice cell, 1.5 Fundamental types of lattices - two and three dimensional lattices, 1.6 Simple crystal structures- (i) simple, body-centered and face-centered cubic (ii) sodium chloride, (iii) hexagonal close-packed, (v) diamond structures, 1.7 Primitive unit cell,1.8 Wigner-Seitz cell [12 hours]

2. **Crystal Structure from Diffraction:** 2.1 Neutron and X-ray diffraction techniques for studying crystal structure, 2.2 Bragg's law, 2.3 Laue method, 2.4 Brillouin zone: First Brillouin zone of (i) simple cubic, (ii) body centered cubic and (iii) face centered cubic lattices, 2.5 Lattice Planes and Miller indices, 2.6 reciprocal lattice- reciprocal lattice vectors, reciprocal lattice to simple cubic, body centered cubic and face centered cubic lattices; 2.7 Geometrical Structure Factor, 2.8 Atomic Form Factor [12 hours]
3. **Bonding in Crystals:** 3.1 Equilibrium lattice constant, 3.2 Different types of bonding (ionic, covalent, metallic, hydrogen) in crystals and lattice energy, 3.3 Bonding in Crystals of Inert gases [5 hours]
4. **Defects in Crystals:** 4.1 Lattice vacancies, colour-centers, alloy, slip, types of dislocations, 4.2 Burgers vector, 4.3 Dislocation and crystal growth [6 hours]
5. **Lattice Dynamics:** 5.1 Lattice vibration, 5.2 phonon spectrum, 5.3 lattice specific heat – Dulong and Petits relation, Einstein theory, Debye's theory, 5.4 Thermal conductivity – Thermal resistivity of phonon gas, 5.5 Umklapp processes [8 hours]
6. **Free Electron Theory:** 6.1 Free electron theory of metals, 6.2 density of states, 6.3 Fermi energy, 6.4 electron specific heat, relaxation time, mean free path, mobility, thermal conductivity, electrical conductivity, 6.5 Wiedmann-Franz law, 6.6 Hall effect [7 hours]
7. **Band Structure of Crystals:** 7.1 Bloch Functions**,** 7.2 Concept of energy bands in solids, 7.3 Energy bands in one dimension, 7.4 Energy-wave vector curves in three dimensions, 7.5 The tight binding method – Linear combination atomic orbitals, applications to bands from s-levels, 7.6 Valence and conduction band, 7.7 distinction between conductor, insulator and semiconductor on the basis of band theory, 7.8 Fermi surfaces, 7.9 Number of orbitals in a band [12 hours]
8. **Semiconductors**: 8.1 Types of semiconductors (extrinsic and intrinsic) and carrier concentration, 8.2 Impurity conductivity- donor states, acceptor states, 8.3 Thermal ionization of donors and acceptors; Mobility [4 hours]
9. **Superconductivity**: 9.1 General properties of superconductors, 9.2 zero resistivity, 9.3 Critical temperature, Critical magnetic field, 9.4 Meissner effect, 9.5 Type I and type II Superconductors [7 hours]
10. **Dielectric properties**: 10.1 Dielectric constant and polarizability, 10.2 Electronic, ionic and orientational polarizabilities, 10.3 Electric Susceptibility, 10.4 Clausius Mosotti Equation [4 hours]
11. **Magnetism**: 11.1 Dia-, Para-, Ferri-,Antiferro- and Ferromagnetic Materials, 11.2 Classical Langevin Theory of dia – and Paramagnetic Domains, 11.3 Quantum Mechanical Treatment of Paramagnetism, 11.4 Curie's law, 11.5 Weiss's Theory of Ferromagnetism and Ferromagnetic Domains [7 hours]

**Text Books:**

1. *Roy R. R. and Nigam B. P.* - **Nuclear Physics: Theory and Experiment,** New age International (P) Limited, India (1967)

2. *Marmier, P. and Sheldon E.* - **Physics of Nuclei and Particles**, Academic Press New York London (1970)

3. *Kittel C.* – **Introduction to Solid State Physics,** 8th ed., John Wiley & Sons Ltd, India (2005)

4. *Ashkroft N. L. W. and Mermin*- **Solid State Physics**, Holt Rinehart and Winston, New York (1976)

**Reference Books**

1. *Kaplan I.* - **Nuclear Physics**, 2nd ed., Oxford & IBH Publishing Co. Pvt. Ltd (1962)

2. *Srivastava B. N.* - **Basic Nuclear Physics**, 8th ed., Pragati Prakashan, Meerut, India, (1968)

3. *Murugeshan R. and Sivaprasad K.* - **Modern Physics**, S. Chand & Co. Ltd. New Delhi, (2007)

4. *Elliot R. J. & Gibson A. F.* – **An Introduction to Solid state Physics and its Application**, ELBS, Macmilan (1974)

5. *Harrison W. A.* – **Solid State Theory**, Tata McGraw Hill, India (1977)

6. *Dekker A. J.* – **Solid State Physics**, Macmillan, Students Edition (1991)

7. Luth H. and Ibach H. – **Solid State Physics**, Narosa Publishing House, New Delhi (1991)

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

| | |
|---|---|
| **Course Title:** Physics Laboratory (Electronics) | **Year:** IV |
| **Course Code:** PHY404 | **Full Marks:** 100 |
| **Nature of Course:** Practical | **Pass Marks:** 35 |

**Course Description:**

Students have to perform at least 13 Electronics experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. 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.

## PHYSICS LAB (Electronics) [180 hours]

1. Study the low frequency response circuits and calculate their cut-off frequencies.
2. Study the high frequency response circuits and calculate their cut-off frequencies.
3. To construct astable multivibrator using 555 timer and study its performance.
4. To construct monostable multivibrator using 555 timer and study its function.
5. To construct and to study the characteristics of RS flip-flop.
6. To construct and to study the characteristics of J-K flip-flop.
7. To construct a voltage multipliers (doubler) and study its characteristics.
8. To construct a voltage multipliers (tripler) and study its characteristics.
9. To construct and study the working of NOT, AND, OR gates using diodes and transistors.
10. Calculate the power loss in transistors in each case (NOT, AND and OR) wherever it is applicable.

**11.** To study operational amplifier for its input-output waveform and use it as an integrator and differentiator.

**12.** To construct differential amplifier and estimate it's CMRR (Common mode rejection ratio).

**13.** To study the working of half adder.

**14.** To study the working of full adder.

**15.** To construct D/A converter and to study its working.

**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 periods laboratory work twice a week to complete both PHY404 lab works.
2. PHY404 will be examined for the duration of six hours in a session.
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% |

# Material Science

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

| | |
|---|---|
| **Course Title:** Material Science | **Year:** IV |
| **Course Code:** Phy405 | **Full Marks:** 100 |
| **Nature of Course:** Theory/Optional | **Pass Marks:** 35 |

**Course Description:**

This course aims at providing students with basic knowledge and skill in theoretical as well as experimental aspects of Material Science.

**Course Objective:**

- To acquaint student with the theoretical and experimental methods in Material Science.
- To prepare them in developing skill to pursue further study and research in the field of physics.

## MATERIAL SCIENCE [160 hours]

**Course Contents:**

1. **Introduction**: 1.1 Historical perspectives 1.2 Importance of Materials science 1.3 Classification of materials 1.4 Advanced Materials 1.5 Modern Materials need [5 hours]
2. **Synthesis of Materials**: 2.1 Definition of synthesis; historical examples of key synthetic discoveries; future prospects 2.2 Review of thermodynamics and kinetics in synthesis [8 hours]
3. **Atomic Structures and Bonding**: 3.1 Atomic structure; 3.1.1 Fundamental concepts 3.1.2 Electrons in atoms 3.2 bonding forces and energies 3.3 Interatomic bonds 3.4 Molecules [4 hours]
4. **Structure of Crystalline Solids**: 4.1 Crystalline and Non crystalline materials 4.2 Crystallographic directions 4.3 Crystallographic planes 4.4 Single crystals 4.5 Review of Metallic crystal structures – fcc, bcc and hcp structure 4.6 Density computation 4.7 Idea of ceramic crystal structures 4.8 Polymer crystallinity 4.9 Polycrystalline materials 4.10 X-ray diffraction – Determination of Crystal Structures [16 hours]

5. **Imperfections in Solids:** 5.1 Introduction 5.2 Point defects 5.3 Linear defects [8 hours]
6. **Phase diagrams**: 6.1 Phases and phase diagrams – one component system 6.2 Binary phase diagrams; two component systems 6.3 Gibbs phase rule 6.4 examples – Ni-Cu and Fe-C [12 hours]
7. **Mechanical Properties of Metals**: 7.1 Concept of stress and strain 7.2 Elastic deformation 7.3 Plastic deformation 7.4 Hardness [5 hours]
8. **Failure of Metals**: 8.1 Fundamentals of fracture 8.2 Principles of fracture mechanics 8.3 Crack initiation and propagation [5 hours]
9. **Mechanical properties of ceramics and polymers**: 9.1 Stress-strain behavior of ceramics 9.2 Stress-strain behavior of polymers 9.3 Viscoelastic deformation of polymers [8 hours]
10. **Electrical Properties of Materials**: 10.1 Electrical conductivity 10.2 Energy band structures in solid 10.3 Conduction in terms of bands and atomic bonding models 10.4 Electrical characteristics of commercial alloys 10.5 Semiconductors – Temperature dependence of carrier concentration, factors that affect carrier mobility, semiconductor devices 10.6 Dielectric strengths 10.7 Dielectric materials 10.7 Ferroelectricity 10.8 Piezoelectricity [18 hours]
11. **Magnetic Properties of Materials**: 11.1 Diamagnetism and paramagnetism 11.2 Ferromagnetism and antiferromagnetism 11.3 Ferrimagnetism 11.4 Magnetic storage 11.5 Soft and Hard magnetic materials [8 hours]
12. **Thermal Properties of Materials**: 12.1 Heat capacity 12.2 Thermal expansion 12.3 Thermal conductivity 12.4 Thermal stress [7 hours]
13. **Optical Properties of Materials**: 13.1 Electromagnetic radiation 13.2 Interaction of light with solids 13.3 Atomic and electronic interactions 13.4 Luminescence 13.5 Photoconductivity 13.6 Lasers 13.7 Optical fibers in communications [10 hours]
14. **Science of Nanomaterials**: 14.1 Introduction to nanomaterials 14.2 Methods of synthesis of nanoparticles – chemical methods, pulsed laser methods 14.3 Size Dependence of Properties of Materials 14.4 Methods of measuring properties 14.4.1 Particle size determination 14.4.2 Microscopy techniques – Transmission electron microscopy and Scanning microscopy 14.4.3 Spectroscopic Techniques – IR and Raman spectroscopy, Magnetic Resonance 14.5 Carbon nanostructures 14.6 Electrical and mechanical properties of carbon nanotube 14.7 Applications of carbon nanotube 14.8 Quantum wells, wires and dots 14.8.1 Size effects 14.8.2 Conduction electrons and dimensionality 14.8.3 Fermi gas and dimensionality 14.8.4 potential well 14.8.5 Properties dependent on density of states 14.9 Applications – Quantum dot Lasers [30 hours]
15. **Processing of Materials**: 15.1 Introduction 15.2 Fabrication of metals – Forming operations, Casting, Heat treatment of steels 15.3 Processing of Ceramics – Glass forming, Fabrication and processing of clay products 15.4 Processing of Polymers – Forming techniques for plastics, fabrication of fibers and films [10 hours]
16. **Economic, Environmental and Societal Issues in Materials Science**: 16.1 Component design 16.2 materials 16.3 manufacturing techniques 16.4 Recycling

issues 16.5 Essays on social issues, safety issues, economic issues etc.

[6 hours]

**Text Books**


1. *Callister W. D. and Rethwisch D.G.* - **Callister's Material Science and Engineering**, 2nd Edition, Wiley India, New Delhi (2014)

2. *Poole C. P. and Owens F. J.* - **Introduction to Nanotechnology**, Wiley India, New Delhi (2006)


**References Books**


1. *Tiley R. J. D.* - **Understanding solids: The Science of Materials**, John wiley & Sons, England (2004)

2. *Patton W. J.* - **Materials in Industry**, Prentice-Hall of India, New Delhi (1975)

3. *Raghavan V.* - **Materials Science and Engineering**, 4th Edition, Prentice-Hall of India, New Delhi, (2003)

4. *Lindsay S. M.* - **Introduction to Nanoscience**, Oxford University Press, New York (2010)


# Project Work

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

| | | | |
|---|---|---|---|
| **Course Title:** | Project Work | **Year:** | IV |
| **Course Code:** | **PRO406** | **Full Marks:** | 100 |
| **Nature of Course:** | Research Work / Presentation | **Pass Marks:** | 40 |

**Course Description**

This course offers students to learn the research works in science leading to their core subject. Students are required to review literature of his/her field of interest to identify a problem in the project work, that problem should be addressed by the students.

## PROJECT WORK RESEARCH

**Project Guidelines**

1) A student or a group of student can do project work only if a faculty or a subject teacher agrees to supervise his/her project work. It is the responsibility of TU faculties to carry our educational and research activities.

2) The nature of project work can be field work, theoretical work, computational work, observational work and experimental work. Whatever the nature of the work, students should **critically review literature** of the area of interest and identify the problem specifically.

3) Students should prepare a proposal and submit it to the department within three month of the enrollment in the fourth year. The general format of the proposal should like this:
   (a) Background/Introduction
   (b) Literature Review
   (c) Motivation/Objectives
   (d) Methodology
   (e) Expected Result
   (f) References (format should be decided by concerned subject committee)
4) The final VIVA examination should be held within a couple of month of the fourth year final examination. Three names of the external examiner will be proposed by the concerned colleges upon consultation with the department. An external examiner will be appointed by the Dean office, IoST, TU. The internal examiner will be appointed by the concerned department.
5) The format of the project work will be decided by the Central Department Research Committee (CDRC) of particular subject. The general format should be similar to that of the M.Sc. dissertation of respective subject.
6) The evaluation committee consist 4 members - HoD or program coordinator, supervisor, external and internal examiners. A separate evaluation form will be given to all four members of the evaluation committee during the VIVA examination that contains the following:
   (a) Introduction to the subject 10%
   (b) Literature review 10%
   (c) Motivation/Objectives 10%
   (d) Originality and creativity: 10%
   (e) In-depth Research: 10%
   (f) Methods 10%

(g) Figures/plots/tables 10%
(h) Interpretation 10%
(i) Comparison 10%
(j) Presentation: 10%

7) There will be additional fee for the project. Student needs to pay this amount. Remuneration for the supervisor is recommended. It will be decided by the Dean Office, IoST, TU.
8) The eligibility criteria for the students, supervisors, co-supervisors will be decided by the Dean office.

**Note**: *The detail of point (8) is added in the appendix here.*

# Econophysics

**Tribhuvan University**
**Institute of Science and Technology**
**Physics Subject Committee**
**Central Department of Physics**

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|---|---|
| **Course Title:** Econophysics | **Year:** IV |
| **Course Code:** Phy407 | **Full Marks:** 50 |
| **Nature of Course:** Theory / Interdisciplinary | **Pass Marks:** 17.5 |

**Course Description:**

This course aims at providing students with basic knowledge of economics and its connections with physics.

**Course Objectives:**

At the end of this course the student will learn about the interplay between economics and physics: an interdisciplinary area, where physics theories is used to solve problems in economics.

## ECONOPHYSICS [80 hours]

1. **Introduction:** 1.1 Motivation 1.2 Pioneering approaches 1.3 The chaos approach 1.4 The present focus [6 hours]
2. **Efficient market hypothesis:** 2.1 Introduction 2.2 Concepts, paradigms, and variables 2.3 Arbitrage 2.4 Efficient market hypothesis 2.5 Algorithmic complexity theory 2.6 Amount of information in a financial time serie 2.7 Idealized systems in physics and finance [10 hours]
3. **Random walk:** 3.1 Introduction 3.2 One-dimensional discrete case 3.3 The continuous limit 3.4 Central limit theorem 3.5 The speed of convergence 3.6 Berry-Esseen Theorem-1 3.7 Berry-Esseen Theorem-2 3.8 Basin of attraction [16 hours]
4. **Levy stochastic processes and limit theorems:** 4.1 Introduction 4.2 Stable distributions 4.3 Scaling and self-similarity 4.4 Limit theorem for stable distributions 4.5 Power-law distributions 4.6 The St Petersburg paradox 4.7 Power laws in finite systems 4.8 Price change statistics 4.9 Infinitely divisible random processes 4.10 Stable processes 4.11 Poisson process 4.12 Gamma distributed random variables 4.13 Uniformly distributed random variables 4.14 Summary [22 hours]
5. **Scales in financial data:** 5.1 Introduction 5.2 Price scales in financial markets 5.3 Time scales in financial markets 5.4 Summary [6 hours]
6. **Stationary and time correlation:** 6.1 Introduction 6.2 Stationary stochastic processes 6.3 Correlation 6.4 Short-range correlated random processes 6.5 Long-range correlated random processes 6.6 Short-range compared with long-range correlated noise 6.7 Time correlation in financial time series 6.8 Autocorrelation function and spectral density 6.9 Higher-order correlations: The volatility 6.10 Stationary of price changes 6.11 Summary [20 hours]

**Text Book**

2. *Mantegna R. N. and Stanley H. E.* **- An Introduction to Econophysics: Correlations and Complexity in Finance**, First Edition, Cambridge University Press (2000)

**Reference Book**

1. *Sinha S., Chatterjee A., Chakraborti A., Chakrabarti B. K.* - **Econophysics: An Introduction,** Wiley-VCH (2010)

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

Level: B.Sc.
Year: IV
Course Title: Sampling Theory and Design of Experiments (Core Course)
Course Code: STA 401 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:**
To (a) familiarize students with various random sampling techniques and methods of estimation of population parameters. (b) familiarize students with various experimental designs and analysis of experimental data.

**Group A**

**Unit 1: Introduction to Sample Surveys [20]**

1.1 Concepts of population and sample, need for a sample, advantages of sample survey over census
1.2 Basic steps in sampling
1.3 Questionnaire design
1.4 Determinations of sample size
1.5 Sampling and non-sampling errors

**Unit 2: Sampling Methods [45]**

2.1 Techniques of drawing random sample and estimation of population mean population total and variance of the estimators under the sampling plan
2.2 Simple random sampling with and without replacement
2.3 Stratified random sampling
2.4 Cluster sampling (concepts and applications)
2.5 Systematic sampling
2.6 Probability proportional to size (PPS) sampling (with replacement)

**Unit 3: Ratio and regression methods [10]**

3.1 Ratio and regression methods of estimation under simple and stratified random sampling

**Group B**

**Unit 1: Introduction to ANOVA** **[10]**

1.1 Introduction, concept of liner models in ANOVA, statement of Cochran theorem
1.2 Analysis of one-way, two-way classification (1 and m observation per cell) in fixed effect model.

**Unit 2: Fundamental Experimental Designs** **[40]**

2.1 Needs for experiments in scientific inquiries
2.2 Basic terminologies of experimental designs
2.3 Basic principles of experimental designs
2.4 Completely Randomized Design (CRD): Statistical analysis of CRD, Expectation of sum of squares, ANOVA table, Advantages and disadvantages
2.5 Randomized Block Design (RBD): Statistical analysis of RBD for one observation per experimental unit, Expectation of sum of squares, ANOVA table, Efficiency of RBD relative to CRD, Estimations of missing value (one observation only), Advantages and disadvantages
2.6 Latin Square Design (LSD): Statistical analysis of m x m LSD for one observation per experimental unit, Expectation of sum of squares, ANOVA table, Estimation of missing value in LSD (one observation only), Efficiency of LSD relative to RBD, Advantage and disadvantages
2.7 Greco-LSD and its analysis
2.8 Analysis of covariance for one way layout with one concomitant variable for CRD

**Unit 3: Factorial Designs** **[25]**

3.1 Concepts of factorial experiments: Basic terminologies and principles, $2^2$, $2^3$, $3^2$ designs, Yates method of computing factorial effect totals
3.2 Confounding in $2^3$ factorial design

**Note: Separate answer sheet is required for group A and group B in examination**

**References:**


1. Montgomery, D.C,*(2012). Design and Analysis of Experiments,* John Wiley and Sons.
2. Mukhopadhyay,P. *Theory and Methods of Survey Sampling,* Prentice-Hall, Latest Edition.
3. Kapoor, V.K. and Gupta, S., *Applied Statistics*,S. Chand, Latest Edition.
4. Kempthrone,O., *Design and Analysis of Experiments,* John Wiley and Sons , Latest Edition.
5. Cochran W. G., *Sampling Techniques,* John Wiley and Sons, Latest Edition.

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

Level: B.Sc.
Year: IV
Course Title: Four Year B.Sc. (Core Course I Practical)
Course Code: STA 402 Full Marks: 50
Nature of the Course: Practical Pass Marks: 20
Total Number of Periods: 180

**Course objectives:**

**Pre-requisites:** Sound knowledge in the topics of Sampling Theory and Design of Experiments

**Objectives:**

- To apply knowledge of sampling theory in sample survey data
- To be able to understand, develop and analyze experimental designs

| S. No. | Title of practical problems | No. of problems |
|---|---|---|
| 1 | Simple random sampling (with sample size estimation) | 3 |
| 2 | Stratified random sampling (with different allocation schemes) | 3 |
| 3 | Systematic sampling | 2 |
| 4 | PPS sampling | 2 |
| 5 | Ratio and regression method of estimation | 2 |
| 6 | Analysis of variance (one way and two way) | 2 |
| 7 | Completely randomized design (CRD) | 2 |
| 8 | Randomized block design | 2 |
| 9 | Latin square design | 1 |
| 10 | Analysis of covariance | 1 |
| 11 | Factorial designs ($2^2$, $2^3$, $3^2$ designs) | 3 |
| 12 | Confounding in factorial designs | 2 |
| | **Total number of experiments** | **25** |

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

Level: B.Sc.
Year: IV
Course Title: Statistical Modeling (Core Course II)
Course Code: STA 403 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:**

To impart knowledge on statistical modeling through regression methods incorporating simple and multiple regression models, curvilinear models and models with categorical independent variables.

**UNIT1 Linear regression model [41]**

1.1 Dependent (response) and independent (explanatory) variables, linearity in variables and parameters, population and sample regression functions, cross-sectional and time series models

1.2 Simple linear regression models: Model specification, assumptions, ordinary least squares (OLS) and maximum likelihood (MLE) methods, derivation of parameter estimates and their interpretations, fitted regression model and its graphical representation, variance and standard error of estimates, properties of OLS estimators and Gauss-Markov theorem, prediction, interval estimation of regression parameters and mean response, hypothesis testing of regression coefficients, test of significance approach, use of *p* value

1.3 Model adequacy tests: Overall goodness of fit test by coefficient of determination ($R^2$) and analysis of variance, probability and quantile plots (P-P and Q-Q plots) for assessing normality, lack of fit and pure error, lack of fit mean square, detection and consequences of outliers, raw and standardized residuals, use of standardized residuals to assess violation of assumptions, residual plots in detecting the suitability of the fitted model, autocorrelation and Durbin-Watson test

1.4 Regression through origin: model specification, least square estimation, test of significance and confidence interval for parameter coefficient, $R^2$ in no intercept model.

Problems and examples

**UNIT 2 Multiple linear regression model [41]**

2.1 Definition, model specification, assumptions, three variable linear regression model, derivation of OLS and maximum likelihood estimates, partial regression coefficients and their interpretations, variance and standard errors of estimates, properties of OLS estimates, testing the overall significance of the regression model, testing significance of regression coefficients, use of *p* values, interval estimation of parameters and mean response, standardized regression coefficient

2.2 Model adequacy tests: Overall goodness of fit test by multiple coefficient of determination ($R^2$), difference between unadjusted and adjusted $R^{i2}$, relation between unadjusted and adjusted $R^{i2}$, analysis of variance, probability and quantile plots (P-P and Q-Q plots) for assessing normality, lack of fit and pure error, lack of fit mean square, detection and consequences of outliers, raw and standardized residuals, use of standardized residuals to assess violation of assumptions, residual plots in detecting the suitability of the fitted model, autocorrelation and Durbin-Watson test, concept of multicollinearity, its consequences in regression analysis, Variance inflation factors and its use in detection of multicollinearity.

Problems and examples

**UNIT 3 Curvilinear regression models [42]**

3.1 Functional forms of regression models and curvilinear relationships between variables, linearity in transformed model, log-linear model and measurement of elasticity, measurement of relative changes, semi-log models: Log-Lin and Lin-Log regression models and measurement of growth rate, absolute and relative changes, reciprocal model, logistic growth model, polynomial regression model (up to three variables), compound and S curve models

3.2 Cobb-Douglas production function and its application in econometric analysis, estimation of parameters in curvilinear models and model adequacy tests in linearized functions of the curvilinear models

Problems and examples

**UNIT 4 Regression on categorical variables [26]**

4.1 Nature of categorical (qualitative) or dummy variables and their impacts on regression models, examples of use of such variables in modeling

4.2 Regression with categorical independent variables: linear models with quantitative and qualitative independent variables, use of dummy variables in regression models, regression on one quantitative variable and one categorical variable with two classes, regression on one quantitative variable and one categorical variable with more than two classes, regression on one quantitative and two qualitative variables, use of dummy variables for measuring interaction effect, measuring seasonal effects using dummy variables

Problems and examples

**References:**


1. Drapper, N. R. and Smith, H. (1998). *Applied Regression Analysis*, Third edition, Wiley, New York.
2. Gujarati, D. N. (1995). *Basic Econometrics*, Third Edition, McGraw-Hill, Inc., New Delhi.
3. Maddala, G.S (2002). *Econometrics*, Third Edition, John Wiley and Sons, Singapore.
4. Montgomery, D. C., Perk, E. A. and Vining, G. G. (2003). *Introduction to Linear Regression Analysis*, Third edition, John Wiley and Sons, Inc., Singapore.

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

Level: B.Sc.
Year: IV
Course Title: Statistical Modeling (Core Course II Practical)
Course Code: STA 404 — Full Marks: 50
Nature of the Course: Practical — Pass Marks: 20
Total Number of Periods: 180

**Course objectives:**

**Pre-requisites:** Sound knowledge in the topics of Statistical Modeling

**Objective:**

- To apply the theoretical knowledge of statistical modeling into practice through development of regression models based upon real data and supported by standard model adequacy tests

| S. No. | Title of the problems | No. of problems |
|---|---|---|
| 1 | Simple linear regression with model adequacy tests (using cross-sectional and time series data) | 4 |
| 2 | Simple linear regression through origin | 2 |
| 3 | Multiple linear regression with model adequacy tests (using cross-sectional and time series data) | 4 |
| 4 | Log-linear model (double log) | 2 |
| 5 | Log-Lin and Lin-Log models | 2 |
| 6 | Reciprocal model | 1 |
| 7 | Logistic growth model | 2 |
| 8 | Polynomial models (two and three degree polynomials) | 2 |
| 9 | Cobb-Douglas production function | 2 |
| 10 | Regression with categorical independent variables | |

| | | |
|---|---|---|
| | (Regression on one quantitative variable and one categorical variable with two and more than two classes and regression on one quantitative and two qualitative variables) | 4 |
| | **Total number of problems** | **25** |

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

Level: B.Sc.
Year: IV
Course Title: Demography and Official Statistics
(Applied Science: Leading to Core Course)
Course Code: STA 405 Full Marks: 100
Nature of the Course: Theory Pass Marks: 35
Total Number of Periods: 150

**Course objectives:**

1. To impart substantial knowledge to the students on demography, demographic measures, population models and to compute different demographic measures
2. To make students aware of official statistics, Statistical System, Survey and census, Agriculture statistics, Industrial statistics, Trade statistics, Price statistics, etc

## Group A: Demography

### Unit 1: Introduction to Demography [30]

1.1 Age-Sex Composition**:** Evaluation of age and sex data, Errors in age reporting, Whipple's index, UN's age –sex accuracy index, Population pyramid and age dependency ratio, Adjustment or smoothing of age distributing (Method of simple parabola)

1.2 Measurement of Mortality and life Tables: Crude death rate and age-specific death rate, Standardized death rates (direct and indirect methods), Comparative mortality index, Complete life table its functions and relation between its various functions, Abridged life table and construction by Reed-Merrell and Greville's methods

1.3 Measurement of Fertility: Crude birth rate, general fertility rate, age-specific birth rate, total fertility rate and child-woman ratio, standardized birth rate (directed and indirect) and UN's age-sex adjusted birth rate, Replacement index

### Unit 2 Population Growth Models: [20]

2.1 Compound interest model, Simple exponential model, Polynomial model up to third degree, Logistic models, Use these models in population projection, Population projection by component method

2.2 Time series model
2.3 Factors affecting the population growth
2.4 Booms and Dooms theory
2.5 Malthus Theory
2.6 Demographic Transition Theory
2.7 Ultimate and optimum population

**Unit 3 Population Models:** **[25]**

3.1 Survival probability model, Age structure model, Estimation of birth death rates from these models
3.2 Establishment of the relationship $c(x) = be^{-rx}l(x)$
3.3 Construction of life table from age structure model
3.4 Estimation of birth and death rates from life table
3.5 Stable population model: Lotka's fundamental stable population model
3.6 Stationary population as a special case of stable population
3.7 Estimation of Population growth by using Lolka's method, r- method, Vig's method and K- method (with derivation)

## Group B: Official Statistics

**Unit 4**

4.1 Basic introduction to official statistics **[3]**

- Importance of official statistics
- United Nations Fundamental principles of official statistics
- Concept of evidence based policy
- Opportunities and challenges of official statistics
- Open data access

4.2 Statistical System of Nepal **[3]**

- Concept of Statistical System
- Legal framework
- Role of CBS and other institutions
- Statistical plans and policies
- Relationship between Statistical System of Nepal and International Statistical System
- Major sources of statistics: Admin data, scientific statistical operations

4.3 Survey and census systems **[5]**

- Importance of statistical surveys
- Concept of survey design and sample design
- Households surveys, enterprise/establishments surveys, etc.
- Importance of census

- Concept of census design
- Type of censuses
- Survey and Census practice in Nepal
- Costing of survey and census

**Unit 5**

5.1 Agriculture and rural development statistics **[3]**

- Concept and scope of agriculture, forestry and fishing and rural development statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.2 Social, gender and population statistics **[3]**

- Concept and scope of social statistics (health, education, welfare, social security, etc)
- Concept and scope of gender statistics
- Concept and scope of population statistics
- Concept and scope of vital statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.3 Industrial statistics **[3]**

- Concept and scope of industrial statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.4 Trade statistics **[3]**

- Concept and scope of trade statistics
- International Trade in goods and services
- Distributive trade
- Major indicators-Nepal Specific
- Sources and data gaps

5.5 Price statistics **[6]**

- Concept and scope of price statistics
- Economic background of price statistics
- Measures of inflation
- Consumer Price Index
- Producers Price Index
- Other indices
- Major indices -Nepal specific
- Sources and data gaps

5.6 Economic statistics **[10]**

- Concept and scope of economic statistics
- Introduction to the System of National Accounts (SNA)
- Ranking National Account, Revisiting National Account
- Concept on Supply and use tables, IO tables
- Concept and scope of Balance of Payment (BOP)
- Introduction to BOP and international investment statistics
- Introduction to government finance statistics, financial statistics
- Major micro economic indicators-Nepal Specific
- Sources and data gaps

5.7 Labor statistics **[4]**

- Concept and scope of labor statistics
- Measuring employment, unemployment, underemployment, decent work etc.
- Major labor force indicators - Nepal specific
- International Conference of Labor Statisticians (ICLS) resolution
- Sources and data gaps

5.8 Environment statistics **[4]**

- Concept and scope of environment statistics
- UN Framework of development of Environment Statistics
- Major indicators-Nepal specific
- Sources and data gaps

5.9 Tourism statistics **[3]**

- Concept and scope of the tourism statistics
- Major indicators- Nepal specific
- Sources and data gaps

5.10. Other thematic statistics **[6]**

- Crime statistics, water statistics, energy statistics, construction, transport statistics, service statistics etc.
- Major indicators-Nepal specific
- Sources and data gaps

**Unit 6**

6.1 Statistical infrastructure **[6]**

- Master sample frame
- Statistical registers (Population registers, business registers etc.)
- Statistical classifications: International and national economic, social and other classifications, Reference and related classifications

- Information technology and statistical management
- Concept of Management Information System (MIS): Nepal specific MISs i.e. HMIS, EMIS etc
- Basic concept on Metadata

6.2 Questionnaire design **[4]**

- Principles on questionnaire design
- Types of questionnaires
- Practical issues

6.3 Development initiatives **[5]**

- National plans: Vision and strategic objectives of the current national plan
- Basic introduction to International development agenda i.e. PRS, Sustainable Development, MDGs, SDGs
- Goals, targets and indicators of development initiatives

6.4 Monitoring and Evaluation **[4]**

- Logical framework
- Concept of monitoring and evaluation
- Types of monitoring and evaluation
- Role of statistical system in monitoring and evaluation
- Basic statistical methods for impact evaluation
- Practical issues

**Note: Separate answer sheet is required for group A and group B in examination**

**References:**


1. Biswas, S. (1988). *Stochastic Processes in Demography and Applications*, Wiley-Eastern, India.
2. Pathak, K.B. and Ran F. (1988). *Techniques of Demographic Analysis*, Himalayan Publishing House
3. Singh, M.L. (1995). *Some Measures of Demography*, Kathmandu.
4. Singh, M.L. Sayami, S.B. (1997). *An Introduction to Mathematical Demography*, Kathamndu.
5. *Nepal ko Antarik Tathyanka Pranali*, CBS publication, Kathmandu.
6. *Slattery Martin* (1986). Official Statistics, Taristrek.
7. Giovanini, E : *Understanding Economic Statistics*, OECD Publication.
8. *Fundamental Principles of official statistics* www.unece.org/stats/archive/docs.fp.e.html
9. *Economic and development statistics* www.un.org/esa/progareas/stats.html

10. *World health statistics*. www.who.int/whosis/who stat/2008/en/index.html

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

Level: B.Sc.
Year: IV
Course Title: Spatial and Survey Technology (Interdisciplinary Subject)
Course Code: SST 407 Full Marks: 50
Nature of the Course: Theory Pass Marks: 17.5
Total Number of Periods: 75

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**Course objectives:**

After completion of this course, students will be

i) familiar with the principles behind survey Technology, Remote Sensing and Geographical Information System and

ii) acquainted with practical knowledge for conducing survey and able to use appropriate tools for their research work.

**Requirements**

- Topographic, Thematic, Air photo and Satellite Image for visual interpretation of geo-spatial data system.

Computer lab with GIS software and statistical software installed.

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**1. Introduction to Survey [12]**

- Definition and Needs; scope and fields of survey, types of survey, levels of survey
- Survey proposal, survey design, survey team, qualities of survey designer, training for survey, public relation for survey
- Preparation of field work: general safety belongings for survey, use of location and reference point, field note book and administrative reports; letter of identification
- Problem of identification in survey, advantages and disadvantages of surveys

**2. Designing Survey Instruments [15]**

- Definition, designing questionnaire, types of questions and responses, wording of questions, sequencing, routing, branching and funneling questions, structured vs. semi- structured instruments
- Questionnaires for i) longitudinal and cross sectional surveys ii) cohort study iii) trend study and iv) panel study
- Designing web-based questionnaires
- Examples of widely used questionnaires
- Examples of good and bad practices

**Use of Secondary Data** **[8]**

- Secondary data sources, administrative data and their sources, problems related to administrative data handling, other quantitative resources; data searching methods: data archiving, data mining
- Secondary data structure, data management, data splitting, variable selection
- Data quality issues, methods of data quality assurance

**3. Remote Sensing and Image Data** **[12]**

- Introduction to remote sensing (RS): definitions, principles of RS, physical basis of RS
- Satellites , sensors and their characteristics: satellites, types of satellite orbits, sensors, types of sensors, imaging sensors
- Resolution in remote sensing: spatial resolution, Spectral resolution, radiometric resolution and temporal resolution
- Satellite missions

**4. Geographical Information System and Spatial Methods** **[16]**

- Introduction to GIS: definition of GIS, GIS fields and objects, physical components of GIS, functionality of GIS, Applications of GIS
- GIS data sources, GIS data types, GIS data models
- GIS data processing: defining projection and coordinate system; entering editing and linking spatial and attribute data, GIS map projections, GIS data creation
- Methods of analyzing and interpreting spatial data, spatial relationships, overlay and neighbourhood operations

**5. Statistical Analysis of Spatial and Survey Data (using software)** **[12]**

- Construction of graphs and chart and tables and proper descriptive statistics
- Selection of appropriate inferential methods
- Making practice on spatial relationship, buffering and overlay
- Modern approaches of spatial and survey data analysis

**References:**


1. Aronoff. S. (1989). *Geographic information systems: A management perspective*. Ottawa: WDL Publications.
2. ASA (1997). *Survey research methods section information.* American Statistical Association website: http.//www. stat.ncsu.edu/info/srms/srms.html
3. Birkin, M., Clarke G., Clarke M. & Wilson (1996). An intelligent GIS: Location decisions & strategic planning. *Geoinformation International*. Cambridge, UK.
4. Dedy, R. A. (Ed.) (2000). *Principles of geographic information system.* Enscheda: the International Institute of Aerospace Survey and Earth Sciences.
5. De Vaus, D. (2001). *Research design in social research*. Thousand Oaks, CA: Sage.
6. Khatiwada, R. P., & Mandal, U. K. (2016). *Spatial and survey technology.* Kathmandu: KEC Publication
7. Khatiwada, R. P., Pradhan, B. L. & Poudel, N. (2015). *Research methodology*. Kathmandu, Nepal: KEC publications
8. Sabins, F. F. (1996). *Remote sensing: Principles and interpretation*. New York: WH Freeman.
9. Statistics Canada, (2010). *Survey methods and practices*. Canada: Ministry of Industry.

# Zoology

**Tribhuvan University**
**Institute of Science and Technology**
**Four Years B. Sc. Zoology Course of Study**

**Course Title: Entomology and Parasitology** **Full Marks : 100**
**Course No. : Zool.401** **Pass Marks : 35**
**Nature of Course : Theory** **Year : IV**
**Instruction Lectures: 150**

**Objectives of the Course:**

At the end of course students will be able to:

- Understand value of virus, bacteria, protozoan and helminth parasites and insects.
- Explain and demonstrate general anatomy of insects and host-parasite relationship.
- Epidemiology of diseases caused by parasites/environment and concept of pharmacology.
- Identify some common pests and parasites of agriculture and understand their control measures.
- Create understanding of economic and commercial insects, vectors and vector-borne diseases.

## Group A: Entomology (75lec.)

### General Entomology

**Diversity and Importance of Insects**: Introduction, Insect diversity, Importance of insects, Naming and classification of insects. **(7 lec.)**

**Insect Morphology**: General body plan, Head, Head appendages: antennae and mouthparts. Thorax, Thoracic appendages: legs and wings. Abdomen, Abdominal appendages: external genitalia and other appendages. **(11 lec.)**

**Insect Anatomy and Physiology:** Digestive system. Circulatory system. Excretory system and nitrogenous excretion. Nervous & chemical integration. Sense organs. Respiratory system. Reproductive system. **(20 lec.)**

### Applied Entomology

**Pest Management :** Pest damage. Economic decision levels for pest populations. Methods of pest control (legislative, physical, cultural, biological control, crop plant resistance to pest attack and chemical control). Classification of pesticides. Pesticide formulations. Effects of pesticides.

Pesticide use in Nepal. Safe use of pesticides. Integrated Pest Management. Descriptions, biology and control of selected crop pests *(Quadraspidiotus pernicisus, Aphis gossypii, Leptocorisa acuta, Phthorimaea operculella, Spodoptera litura, Sitophylus zeamais).* **(21 lec.)**

**Industrial Entomology: Apiculture:** Society organization of honey bee. Honey bee species. Morphology and life cycle of honey bee. Bee keeping. Prospects of beekeeping in Nepal. **Sericulture:** Introduction. Life cycle of silk moth. Strains of silkworm. Rearing of silkworms. Cocoons. Mulberry cultivation. Composition & uses of silk. Prospects of sericulture in Nepal. **Lac culture**: Introduction. Life cycle of the lac insect. Strains of lac. Host plants for lac insects. Lac cultivation. Composition and uses of lac.

**Yarsa Gumba** (Parasitic fungus & Ghost moth caterpillar): Introduction, economic importance & conservation. **(15 lec.)**

## Group B: Parasitology (75 lec.)

**General Parasitology:** Introduction, scope and historical landmarks. Host parasite inter-relationship. Types of host and parasites. Properties of parasites. **(5 lec.)**

**Epidemiology:** Uses, tools and measurement (mortality, morbidity, incidence and prevalence). Dynamics of disease transmission. **(7lec.)**

**Bacteriology and Virology: Bacteria-** Molecular characteristics. Entry and colonization in human host. Bacterial toxin and human diseases. Modes of transmission, pathogenicity and control measures bacterial diseases (Tetanus, Syphilis and Leprosy). **Virus-** Molecular characteristics. Modes of transmission, pathogenicity and control measures of viral diseases (Hepatitis, Dengue, Avian influenza, Ebola and Swine flu). **(13 lec.)**

**Protozoology and Helminthology:** Epidemiology of Protozoan diseases (Malaria, Leishmaniasis, Giardiasis, Amoebiasis) and helminthic diseases (Fasciolopsis, Echinococcosis, Schistosomiasis, Ancylostomiasis, Enterobiasis and Filariasis). Parasitic nematodes in citrus plants. Agricultural practices in phytonematode control. **(10 lec.)**

**Zoonotic Diseases:** Epidemiology of viral (Japanese encephalitis), bacterial (Brucellosis), protozoan (Thellariasis) and helminthic (Trichinelliosis). **(7 lec.)**

**Vector and Vector Borne Diseases:** Diseases transmitted by sandflies, mosquitoes, ticks and mites. Control of vector and vector borne diseases. **(7 lec.)**

**Environmental Health:** Problems, planning and management in Nepal. Excreta disposal and public health importance. Food, milk and water borne diseases. Occupational diseases due to biological agents (Anthrax and Hydatidosis). **(7 lec.)**

**Immunology:** Immunity. Immunizing agents. Types of vaccines. Cold chain. Current immunization practices. **(8 lec.)**

**Pharmacology:** Nomenclature of drugs. Routes of drug administration. Pharmacokinetics and pharmacodynamics. Antibiotics, its classification and application in medical sciences. Anthelmintic and antiprotozoan medicines. **(11 lec.)**

**Suggested Readings:**

**Entomology (latest editions)**


Aruga, H. Principles of Sericulture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Chapman, R.F. The Insects: Structure and Function. 4th edition.Cambridge University Press.

Delong, J. Borror and Delong, Dwight M. An Introduction to the Study of Insects.

Fenemore, P.G. and Prakash, A. Applied Entomology. New Age International Publishers.

Gillot, C. Entomology. Plenum Press, New York.

Gullan P.J & Cramston P.S., The insects: An outline of Entomology, Wiley Publishers

Hill, D.S. 1993. Agricultural Insect Pests of the Tropics and their Control. Special edition for sale in Asia only. Cambridge University Press, Cambridge.

Metcalf, R.L. and Luckmann, W.H. Introduction to Insect Pest Management.. John Wiley & Sons, New York

Metcalf, R.L. and Flint, W.P. Useful and Destructive Insects, their Habitats and Control. McGraw- Hill, New York.

Pedigo, L.P. Entomology and Pest Management. Prentice Hall of India Private Limited, New Delhi.

Richards, O.W. and Davies, R.G. IMMS' General Textbook of Entomology. vol. 1. BI Publications Pvt. Ltd., New Delhi.

Snodgrass, R.E. Principles of Insect Morphology. CBS Publishers & Distributors.

Verma LR (eds) Honeybees in mountain agriculture, Oxford & IBH publishing Co. Pvt. Ltd. New Delhi, India


**Parasitology (latest editions)**


Arora, D.R. and Arora B. Medical Parasitology.CBS Publishers and Distributors, New Delhi.

Arora, D.R. Text book of Microbiology .CBS Publishers and Distributor, New Delhi.

Belding, D.L. Text book of Parasitology. Mereditch, New York.

Chatterji, K.D. Parasitology (Protozoology and Helminthology). Medical Publishers, Calcutta, India.

Chandler, A.C. and Read, C.P. Introduction to Parasitology. John,Wiley and Sons, inc.

Mathur, J.S. Preventive and Social Medicine, A comprehensive Text book with special focus on Nepal. CBS Publication and Distributor, New Delhi.

Park, K. Text book of Preventive and Social Medicine. Banarsidas Bhanot Publishers Jabalpur, India.

Parija, S.C. Review of Parasitic Zoonoses. A.I.T.B.S. Publishers and Distributors, Delhi.

Tripathi, K.D. Essentials of Medical Pharmacology. Jaypee Brothers, Medical Publishers P. Ltd., New Delhi.

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**Course Title: Entomology and Parasitology** **Full Marks:50**
**Course No. : Zool.402** **Pass Marks:20**
**Nature of Course : Practical** **Year : IV**
**Objective of the Course:** For better understanding of the topics of Zool.401.

**Entomology**

1. Study of museum specimens/permanent slides of pest species and vectors covering important orders.
2. Identification of collected insects up to orders using keys to orders, identification of major crop pest species and their wet and dry preservation (liquid preservatives, insect pinning, labeling and storing).
3. Preparation of permanent slides: Antennae (3-5 types), Wings (3-5 types), Mouth parts (2-3 types) and Whole mount of fleas, lice, apterygotes, thrips, aphids, ticks and mites (2-5 types).
4. Dissection of common insects such as honey bees (sting), grasshoppers (nervous system).
5. Survey of varieties of synthetic chemical pesticides available in the market and write note on i) trade name, common name and chemical name composition, ii) Nature of action and target species iii) Note whether recommended to use in Nepal, and iv) note their formulations with their characteristics nature.
6. Study different kinds of sprayers and their parts with respective functions in operation.
7. Study of caste system of honey bees and different instars of silkworm.

**Parasitology**

1. Study of museum specimens of helminthes and permanent slides of bacteria, protozoans, platyhelminthes and nematodes.
2. Collection, preservation/slide preparation and identification of parasites.
3. Examination of faecal samples for identification of intestinal parasites and eggs.
4. Preparation of thick and thin blood smears on a slide.
5. Preparation and study of protozoan culture.
6. Microphotography of parasites. Identification of photos of different stages of parasites.
7. Principle and use of *in vitro* diagnostic tools: Immunochromatographic Test (ICT) / Rapid

Diagnostic Test (RDT) for different human diseases (malaria, filariasis, dengue etc).

**Practical note book preparation as regular study.**

**Report writing:** Survey of any locality regarding any topic of Zool. 401 and write a report of about 5 -10 pages. Conduct **seminar** on the report and submit the final report accommodating suggestions made in the seminar.

Examples:

- Study of damage patterns of stored grains, field crops and vegetables caused by the insects and nematodes.
- Visit to the hospitals for the survey (general survey, status or case report) of any studied disease, immunization programs, etc. or visit of farmer plots, apiculture / sericulture/ fish/ poultry /animal husbandry in local area.

Prepare market survey report on pesticide use on vegetables or fruit trees.

## Tribhuvan University
## Institute of Science and Technology
## Four Years B. Sc. Zoology Course of Study

**Course Title: Ecology and Fish & Fisheries** **Full Marks: 100**
**Course No. : Zool.403** **Pass Marks: 35**
**Nature of Course: Theory** **Year: IV**
**Instruction Lectures: 150**

**Objectives of the Course:**

At the end of course students will be able to:

- Understand the basic concepts and principles of ecology.
- Understand major environmental problems and issues.
- Understand the challenges, principles and practices of biodiversity conservation.
- Know basic taxonomy and status of indigenous fishes of Nepal.
- Understand the significance of limnological parameters, nutrition, fish disease and seed production in aquaculture.
- Gain knowledge on the importance of post-harvest and marketing of fishes.

### Group A: Ecology and Conservation Biology (75 hrs.)

**Ecology**

**Introduction and Ecological factors:** Scope and development of ecological thoughts. Habitat and ecological niche. Ecological factors - Liebig's law of the minimum, Shelford's law of tolerance, Effects of ecological factors on the distribution and abundance of organisms. **(6 hrs.)**

**Ecosystem:** Concept. Structure- Biotic and abiotic components, and ecological process. Ecosystem energetic - primary productivity, secondary productivity, energy flow, food chain and food web. Biogeochemical cycles - Gaseous cycle (C, N, $O_2$) and sedimentary cycles (S, P). Disturbances and dynamics of ecosystem. **(12 hrs.)**

**Population Ecology:** Concept. Characteristics- natality, mortality, immigration, emigration, density, fecundity. Structures - age and sex distribution, life table and survivorship curve. Dynamics- Population growth and regulation, density dependent and density independent regulation. **(8 hrs.)**

**Community Ecology:** Concept and characters of community. Community structure – physical and biological structures. Species interaction and their effects – Positive (mutualism, cooperation and commensalism) and negative interactions (predation, competition, parasitism). Succession/ecosystem development- Process, and concept of climax, changes in ecosystem attributes, succession and animal life. **(10 hrs.)**

**Pollution and Environment:** Process of ozone depletion, acid rain, and eutrophication. Concept of Reducing Emission from Deforestation and Degradation (REDD) and Clean Development Mechanism (CDM). Climate change and its impacts. Biological Invasion- Characteristics of invasive species, process and impacts of biological invasion. **(8 hrs.)**

**Natural Resources:** Concepts of renewable and non- renewable natural resources. Management approach- Ecosystem and/or watershed approach. **(4 hrs.)**

**Conservation Biology**

**Biodiversity:** Levels and hierarchy. Values and uses. Threats: primary threats, concept of threatened species (IUCN Red List Categories). **(7 hrs.)**

**Biodiversity Sampling/surveys:** Concept and purpose. Biodiversity assessment and monitoring. Biodiversity indices. Sampling terrestrial vegetation - Quadrat or sample plots, belt transects and line intercept. Sampling animal populations - Trapping and collection of soil organism and insects, estimating abundance (Census, Capture- recapture, removal, line transects). Sampling indices of animal abundance. Sampling habitat - Introduction and use of map, remote sensing and GIS. **(11 hrs.)**

**Biodiversity Conservation:** History of conservation - Global and National. National Policy and International conventions. Conservation approaches: In-situ conservation - Concept, Protected Areas (IUCN categories), Biosphere Reserves, Protected Areas Management in Nepal, Ramsar sites of Nepal, Ex-situ conservation - Concept, gene bank, Zoo garden, botanical gardens, captive breeding. Landscape level conservation. **(9 hrs.)**

## Group B. Fish and Fisheries (75 hrs.)

**Fish Systematics:** Principles of fish taxonomy. Fish identification techniques. Classification of fishes with reference to Nepal. **(4 hrs.)**

Fish Biology: Digestive, Respiratory, Blood vascular system, Excretory system, Nervous system and Reproduction of typical fresh water fish. (10 hrs.)

**Fresh Water Ecology:** River systems and their zonations, Ecological validity of the river zontion.. Lakes and types, origin and ecological application. **(5 hrs.)**

**Limnological Parameters**: Physicochemical parameters-turbidity, temperature, pH, dissolved oxygen, dissolved $CO_2$, alkalinity, hardness, ammonia, phosphorus, BOD, COD etc. Biological parameters– phytoplankton, zooplanktons, nekton and zoo benthos etc. **(7 hrs.)**

**Environment Impact Assessment:** Concept, importance and application of EIA with reference to Nepal. **(3 hrs.)**

**Fisheries**

**Capture and Culture Fisheries: Capture fishery-** Introduction, warm water and cold water fishery in Nepal. Status of inland water resources and inland capture fishery. Fish exploitation, threats and management of capture fishery. **Culture fishery -** Introduction, principles and scope of culture fishery, Different systems of fish culture, status of fish culture and aquaculture. **(6 hrs.)**

**Pond preparation-** Pond engineering, criteria for selection of fish species for culture, characteristics of cultivable species, common cultivable fishes of Nepal, pre stocking and post stocking management. **(6 hrs.)**

**Fish Breeding and Management:** Maturation and spawning. Role of gonadotropin in fish breeding. Induced breeding of indigenous major carps. Management and rearing of hatchling, fry, fingerling and broodstock. (**7 hrs.)**

**Nutrition:** Importance of different biomolecular compounds in fish feed. Nutritional requirement of fishes in different stages of life on the basis of feeding habits.
Artificial diet- Introduction, formulation. Supplementary feeding and pellet feeding. Nutrient deficient diseases in fishes. (**9 hrs.)**

**Fish Pathology:** Introduction, morphology, life cycle, symptoms, prophylaxis and therapy of important infectious diseases of fish: Bacterial (tail and fin rot), Fungal (Saprolegniasis and Epizootic Ulcerative Syndrome), Protozoan (Ichthyophthiriasis) and Metazoan (Argulosis). Importance of management of fish diseases in fish culture. (**9 hrs.)**

**Post Harvest Technology, Fish Marketing and Extension:** Post harvest technology- Introduction, Principles and importance of fish preservation. Traditional and advanced methods of fish preservation.

**Fish Marketing-** Introduction, fish transportation, status of present fish marketing in Nepal.

**Extension**- Cooperatives and their importance in fish production and marketing. **(9 hrs.)**

**Suggested Readings (Fish and Fisheries):**


Amlacher, E., 1970. Textbook of Fish Diseases. Translated from German by D.A. Conroy and R.L. Herman. Jersey City, N.J., T.F.H. Publications Inc., 302 p.

Gupta, S.K and Gupta, P.C. 2014. General and Applied Ichthyology (Fish and Fisheries) Pub. S. Chand & Company Pvt. Ltd. New Delhi, India.

Jhingran, V.G. 1991. Fish and Fisheries of India. 3rd ed. Hindustan Publishing Corporation New Delhi, 727 p.

Jhingran, V.G. & Pullin, R.S.V. 1985. A Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM Studies and Reviews 11, 191 pp. Asian Development Bank, Manila, Philippines and International Center for Living Aquatic Resources Management, Metro Manila, Philippines.

Khanna, S.S. 2006. An Introduction to Fishes. Silver Line Publications, New Delhi. Revised and Up-graded Edition.

Pillay, T.V.R. 1990. Aquaculture Principles and Practices (English) Pillay, T.V.R., / Oxford (UK), Fishing News Books, 575 p.

Parihar, R.P. 2009. Fish Biology and Indian Fisheries. Central Publishing House, Allahabad.

Santhanam, N. Sukumaran and Natrajan, P. 1987. Fresh Water Aquaculture. Oxford and IBH Publishing Co. Pvt. Ltd.

Shrestha, J. 1981. Fishes of Nepal. Curriculum Development Centre, Tribhuvan University, Kathmandu, Nepal.

Shrestha, J. 1994. Fishes, Fishing Implements and Methods of Nepal. ISBN 974-7315-55-6, Crafts Press Bangkok.

Shrestha, T.K. 2008. Ichthyology of Nepal – A Study of Fishes of the Himalayan Waters. Published by Himalayan Ecosphere, Kathmandu, Nepal.


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**Course Title: Ecology and Fish &Fisheries** **Full Marks: 50**
**Course No. : Zool.404** **Pass Marks: 20**
**Nature of Course: Practical** **Year: IV**

**Objective of the Course:** For better understanding of the topics of Zool.403.

**Ecology**

1. Tools and techniques: Principle and applications of Sechi disc, Altimeter, Soil thermometer, Min-Max thermometer, Maps, GPS, etc.

2. Determination of minimum number and size of quadrat.
3. Determination of water holding capacity and percolation rate of soil.
4. Determination of physico-chemical properties of water ($O_2$, $CO_2$, chlorides, alkalinity, etc).
5. Determination of density/frequency/abundance of the vegetation by quadrat method.
6. Biodiversity assessment
7. Estimation of population density of animals from aquatic and terrestrial habitat.
8. Determination of primary productivity of aquatic and terrestrial ecosystem.

**Fish & Fisheries**

1. Identification of fishes: Taxonomic study to identify the important locally available freshwater fishes of Nepal.
2. Study of accessory respiratory organs in locally available fishes (Clarias, Channa, Anabas, Heteropneustes fossilis etc.)
3. Identifying disease and pathogen of fishes: Collection of diseased fishes and preparation of permanent slides for disease identification (Name of the disease, symptom and causative agent/ pathogen and identifying characters of the pathogen).
4. Study of water quality parameters and planktons.
5. Determination of GSI ( Gastro-somatic index).
6. To determine and analyze the stomach contents of a given fish.

**Practical note book preparation as regular study.**

**Report writing:** Survey of any locality regarding any topic of Zool. 403and writing a report of about 5-10 pages. Conduct **seminar** on the report and submit the final report accommodating suggestions made in the seminar.

**Examples:**

- Visit to riverine system, lakes/ ponds or any water bodies and fish markets for fish collection, preservation in 4% formalin and interview with fishermen communities. Prepare report on fish diversity, abundance of dominant fish species, use of local fishing gears and status of fishermen communities.
- Field visit to any freshwater fish farm (warm and cold water). Prepare report on aquaculture technology on different constituents of fish farms like hatchery system, nursery and rearing of fishes, artificial fish feed.
- Prepare market survey report to show market status/trend on any one: whole sale/retail fish market/edible fish market/fish seed market/fish feed market/processed fish product market etc.
- Fish diseases
- Hydropower dam

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**Suggested Readings:**

Krebs, C.J. Ecology: An Experimental Analysis of Distribution and Abundance of Animal Population. Addision-Wesley Educational Publishers.

Smith, R.L. Ecology and Field Biology. Harper Collins College Publisher.

Trivedi, R.K., Goel, P.K. and Trishal, C.L. 1998. Practical Methods in Ecology and Environmental Science. Environmental Publication, Karad (India).

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**Tribhuvan University**
**Institute of Science and Technology**
**Four Years B. Sc. Zoology Course of Study**

**Course Title: Applied Biology** **Full Marks: 100**
**Course No. : Zool.405** **Pass Marks: 35**
**Nature of Course: Theory** **Year: IV**
**Instruction Lectures: 150**
**Objectives of the Course:**

At the end of course students will be able to understand:

- The relationship between economic growth, environment and human well-being
- The value of partnership between the above ground species (huminity) and the below-ground species (earthworms) and the valuable services provided by the bees and worms.
- The basic concepts and risk factors of toxicology.
- The application of scientific principles in the processing of material by biological agents to provide goods and services.
- The contribution of the natural capital stocks to human welfare both directly and indirectly.

**Introduction:** Definition, scope, areas of applied biology. Role of biology in human welfare. **(2 lec.)**

**Biofertilizer & Green Energy:** General concept of biofertilizer, green energy and biofuels (ethanol, biodiesel, green diesel and biogas). Vermicompost Technology: Introduction to vermicompost/vermiculture, The compost worms and rearing. Methods and Products: Vermicomposting Systems. Organic wastes and Environmental management. Value and Economics of vermicomposting. **(12 lec.)**

**Bee Keeping:** Honey bees and human beings. Colony and its organization. Products of the hive and bees. Bee keeping equipments. Bee keeping process and management. Rearing queens and breeding bees. Bee training for pollination. Managing maladies. Scope of bee keeping in Nepal. **(15 lec.)**

**Fermentation Technology:** Introduction. Fermentation equipments. Modes of fermenter operation. Preparation of media for bioprocesses. Preservation and maintenance of industrial microorganisms. Scale up and scale down of fermentation processes. Downstream processing. Fermented products and their manufacture: Fermented dairy products (cheeses, yogurt), cereal products (breads and related products), soya products, fermented vegetables, vitamins, alcohols, and antibiotics. Indigenous fermentation technology of food and beverages of Nepal (gundruk, sinki, wine, mahi and chhurpi). **(25 lec.)**

**Biopesticides:** Introduction. Mechanism of biocontrol (Antagonism)-(amensalism, competition, parasitism and predation). Microbial pesticides (bacterial, viral and myco pesticides).Use of Insects as biocontrol agents. Botanical pesticides. Biologically active chemical components from plants (Azadirachtins, Nicotine-sulphate, Limonene, Ryania, Rotenone, Sabadilla, Pyrithrin). Indigenous knowledge of pest management in Nepal. (**15 lec.)**

**Toxicology**: Introduction (definition and scope, dose response relationships, sources of toxic compounds, movements of toxicants in the environment). Classes of toxicants (exposure classes-air, water and soil pollutants, occupational toxicants; use classes-metals, pesticides, food additives and contaminants, toxins, solvents, therapeutic drugs, cosmetics).Toxicant processing in vivo (absorption and distribution). Elimination of toxicants. Toxic action (acute toxicity, chemical carcinogenesis, teratogenesis, organ toxicity). Applied toxicology (toxicity testing, forensic and clinical toxicity, prevention of toxicity). Environmental toxicology (bioaccumulation, transport and fate in the environment, environmental risk assessment, bio-remediation). (**40 lec.)**

**Biochemical and Molecular Techniques and their Applications:** Centrifugation. Spectrophotometry. Electrophoresis. Chromatography. Detection of nucleic acids and proteins. **( 25 lec.)**

**Geo-informatics and Applications:** Introduction and application of Geographic Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS). **(8 lec.)**

**Ecosystem Services:** Introduction. Valuation of ecosystem services. (**8 lec.)**

**Suggested Readings:**


Beekeeping Basics. 2004. The Pennsylvania State University, College of Agricultural Sciences Cooperative Extension, Code # AGRS-93.

Costanza, R., d'Arge R., de Groot R., Farber S., Grasso M., Hannon B., Naeem S., Limburg K., Paruelo J., O'Neill R.V., Raskin R., Sutton P., van den Belt M. The Value of the World's Ecosystem Services and Natural Capital, NATURE, VOL 387.

David Cramp. A Practical Manual of Beekeeping. Spring Hill.

Dubey, R.C. A Text Book of Biotechnology. S.Chand and Company PVT.LTD, New Delhi.

Dubey, N.K. (Ed). Natural Products in Plant Pest Management. CABI.

Edwards, C.A. and Lofty, J.R..1977. Biology of Earthworms. Chapman and Hall Ltd., London.

Edwards, C.A. Arancon, N.Q., Sherman R.L. (Eds.). Vermiculture Technology: Earthworms, Organic Wastes and Environmental Management. CRC Press. Tayloer and Francis group.

Glenn, M. Manual of On-Farm Vermicomposting and Vermiculture. Organic Agriculture Centre of Canada.

Henry C. (Ed.). Fermentation and Biochemical Engineering Hand-book. 2nd Ed.Vogel Consultant

Scotch Plains, New Jersey and Celeste L. Todaro, Noyes Pub., New Jersey, US.
Hodgson, E. (Ed.) 2004. A Textbook of Modern Toxicology. Third Ed. John Wiley & Sons, Inc.
Hui, Y.H.(Ed). Handbook of Food Products Manufacturing. John Wiley & Sons, Inc.
Jabde, P.V. 2005. Text Book of Applied Zoology. Discovery Publishing House.
Kevin, A and Lee, K.E. 1989. Earthworm for Gardeners and Fisherman. CSIRO, Australia, Division of Soils.
Lee, K.E. 1985. Earthworms: Their Ecology and Relationship with Soils and Land Use. Academic Press, Sydney.
McNeil, B. and Harvey, L. M. (eds.). Practical Fermentation Technology. John Wiley & Sons, Inc.
Prakash, A. and Rao, J. Botanical Pesticides in Agriculture. CRC Press.
Prescott, M. Harley, J. P. and Klein D.A. 2002. Microbiology. Fifth Edition. The McGraw−Hill, Companies.
Robert Costanza, Ralph d'Arge, Rudolf de Groot, Stephen Farberk, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Suttonkk& Marjan van den Belt. The Value of the World's Ecosystem Services and Natural Capital, NATURE, VOL 387.
Thomas, M. Lillesand, Ralph W. Kiefer. Remote Sensing and Image Interpretation. John Wiley and Sons, Inc.
Valuing Ecosystem Services: Toward Better Environmental Decision-Making. The National Academies Press, Washington, D.C. ISBN: 0-309-54586-2, 2004.
Wilson, K. and Walker, J. (Eds). Principles and Technology of Biochemistry and Molecular Biology.

**Tribhuvan University**
**Institute of Science and Technology**
**Four Years B. Sc. Zoology Course of Study**

**Course Title: Project Work** **Full Marks : 100**
**Course No. : B. Sc. Zool.406** **Pass Marks: 40**
**Nature of Course: Research Work / Presentation** **Year: IV**

**Objective of the Course:**

This course offers students to strengthen the knowledge in research based academic activities related with Zoology.

**All the matter should be as per the instruction of the IoST Dean's Office.**

**Project Guidelines**

1) A student can do project work only if a faculty or a subject teacher agrees to supervise his/her project work. It is the responsibility of TU faculties to carry out educational and research activities.

2) The nature of project work can be field work, observational work and experimental work. Whatever the nature of the work, students should **critically review literature** of the area of interest and identify the problem specifically.

3) Students should prepare a proposal and submit it to the department within first two months of the fourth year or as time allocated by the concerned department head. The general format of the proposal should be as follows:

(g) Background/Introduction/Rationale
(h) Literature Review
(i) Aims & Objectives
(j) Materials and Methods
(k) Expected Results
(l) Time Frame
(m) References (format as M.Sc. dissertation of respective subject)

4) The student must complete a dissertation work and should submit it within the academic session of the fourth year.

5) The thesis format of the project should be same as the format of M.Sc. dissertation of respective subject. The format decided by the Central Department Research Committee (CDRC).

6) The final VIVA examination should be held within a couple of month of the fourth year final examination.

7) Students will have to present their work and defend it in an open viva-voce.

**Tribhuvan University**
**Institute of Science and Technology**
**Four Years B. Sc. Zoology Course of Study**

**Course Title: Ethnobiology & Biodiversity Conservation** **Full Marks: 50**
**(Interdisciplinery course)**
**Course No. : Zool. 407** **Pass Marks: 17.5**
**Nature of Course: Theory** **Year: IV**
**Instruction Lectures: 75**

**Objectives of the Course:** At the end of the course, the students will be able to understand:

- What is ethnobiology?
- Significance of indigenous knowledge systems in preserving biological, cultural and linguistic diversity in the world.

- Basic code of ethics as well as the field cum laboratory methods in ethnobiology.
- Ethnobiology as a potential contributor to rural development.
- Principles and applications of ethnobiology in human welfare.
- Untold reality of treating various diseases by the use of medicinal animals and plants

based on indigenous knowledge system.

- Comparative advantage of collective property rights against personal property right.

**Course Content**

**Basics of Ethnobiology:** Definition, history, evolution, civilization and ethnobiology. Concept, scope and prospective of ethnobiology. **(5 lec.)**

**Multi-disciplinary and Basic Sub-disciplinary Relationship of Ethnobiology (7 lec.)**

**Medico-ethnobiology:** Medico-ethnozoology; Medico-ethnobotany; Food, health and medicine in Ethnobiology; Ethnopharmacology and the marketing of traditional knowledge. **(5 lec.)**

**Knowledge Systems in Ethnobiology:** Indigenous knowledge system and International knowledge system. **(3 lec.)**

**Classification of Nature Across Cultures:** Ethnobiological Classification: Folk taxonomy and nomenclature, the recognition, classification, and naming of plants and animals in traditional societies. **(3 lec.)**

**Status and Field of Ethnobiology:** Status of ethnobiology in the world: European continent, American continent, Asian continent, African continent and Oceania. Field of ethnobiology. Status of ethnobiology with special reference to Nepal**.** **(7 lec.)**

**Code of Ethics, Ethnobiological Field Trips and Collections:** Code of ethics in ethnobiology. Ethnobiological guidelines for field visits, research, collections, databases and publications. **(7 lec.)**

**Principles of Ethnobiology (6 lec.)**

**Applications of Ethnobiology (5 lec.)**

**Research Design and Field cum Laboratory Methods in Ethnobiology:** Research design. Field cum laboratory methods in ethnobiology. **(5 lec.)**

**Ethnobiology Research and Education:** Ethnobiology research and development, ethnobiology education, indigenous peoples' concerns and priorities. **(5 lec.)**

**Intellectual Property Rights in Ethnobiology:** Intellectual property law. Patents, trademarks and copyright. Personal property rights vs. collective property rights. **(5 lec.)**

**Conventional and Molecular Ethnobiology**: Concept of conventional ethnobiology and molecular ethnobiology. Difference between conventional and molecular ethnobiology. Importance of conventional and molecular ethnobiology related to medico-research on animals, plants, human and microbes. **(4 lec.)**

**Ethnobiology and Biodiversity Conservation:** Ethnobiology and ethnography: A case study of Raute tribe in Nepal. Ethnobiology and biological, cultural and linguistic diversity. Ethnobiology and biodiversity conservation; The role of ethnic groups in biodiversity conservation initiatives; Indigenous peoples and nature conservation. **(7 lec.)**

**Future Directions and Careers in Ethnobiology** **(1 lec.)**

Reference Books:

Indigenous and Tribal Peoples Convention, 1989 (ILO-convention 169)

Jain, S.K. (1996): Ethnobiology in Human Welfare. Proceedings of IV International Congress of Ethnobiology held at Lucknow, India, during 17-21 November, 1994. Deep Publications, A-3/27A, D.D.A. Flats, Paschim Vihar, New Delhi-110063, India.

Martin, G.J. (1996): Ethnobotany: A Methods Manual. A 'People and Plants' Conservation Manual. Chapman & Hall, London, Weinheim, New York, Tokyo, Melbourne, Madras.

Singh, N.B. (1997): The Endangered Raute Tribe: Ethnobiology and Biodiversity. GLoRECA "ETHNOBIOLOGY", Kathmandu, Nepal.

United Nations Convention on Biological Diversity, June 5, 1992

WTO and the TRIPS Agreement, 1995

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# Computational Course

**Course Title: Computational Course** **Lecture hours: 80**
**Course Code: COM 408** **Full marks: 50**
**Nature of Course: Theory / Lab** **Pass marks**: **17.5**

**Objectives**

The main objective of this course is to provide students knowledge of fundamental concepts of computers and information technology.

**Unit 1: Introduction to Computer** **10 hrs.**
Definition and Characteristics of Computer; Evolution and Generations of Computers in Brief; Classification of Computers (Super, Mainframe, Mini and Microcomputer; Analog, Digital and Hybrid Computer); Basic Computer Organization (Input, Output, and Memory/Storage Unit; Central Processing Unit); Computer Software (Definition of Software, System Software and Application Software)

**Unit 2: Operating System** **5 hrs.**
What is an Operating System? Functions of Operating System (Process Management, Memory Management, File Management, Device Management, Security Management); Examples of operating systems: UNIX, LINUX & Windows.

**Unit 3: Data Communications and Computer Networks** **5 hrs.**
Basic Elements of a Communication System; Data Transmission Modes; Data Transmission Speed; Data Transmission Media; What is Computer Network? Network Types; Network Topologies; Communication Protocol; Wireless Networking

**Unit 4: The Internet** **5 hrs.**
Definition; Internet Services (Electronic Mail, File Transfer, Telnet, Usenet News, and WWW); Uses of the Internet; Internet Address

**Unit 5: Data Representation** **9 hrs.**
Number system (Binary, Octal, Decimal, and Hexadecimal); Conversion from One Number System to Another; Binary Arithmetic (Addition and Subtraction); Logic gates

**Unit 6: Database Management System** **6 hrs.**
What is Database? What is Database Management System? Advantages of using Database Approach; Database applications; Introduction to Database Models; Introduction to data warehousing, Data mining, and Data Mart; Computational Nano Science; Space Data; Computational Biology

**Unit 7: Multimedia** **4 hrs.**

What is Multimedia? What is Multimedia Computer System? Multimedia Components (Text, Graphics, Animation, Audio, and Video) Multimedia Applications

**Unit 8: Computer Security** **8 hrs.**

Introduction; Security threat and security attack; Malicious software; Hacking; Cryptography (symmetric key and public key); Introduction to Firewall; Users identification and Authentication; Security awareness; Security policy; Antivirus and Antispyware.

**Unit 9: Geographical Information System & Remote Sensing** **8 hrs.**

Definition of GIS and Remote Sensing; Components of GIS; Map Projections: Spatial and Non-spatial Data; Data Model and Input, Data Analysis and Output; Remote Sensing Applications: Agriculture, Forestry, Land Use / Land Cover Mapping, Water Resources, Snow and Glacier, Wetland Management

**Unit 10: Laboratory Work** **20 hrs**

After completing this course, students should have practical knowledge of operating systems, word processors, spreadsheets, presentation package, and internet and its services.

**Note:** *Evaluation of students will be done through* ***final written examination****. However, during the classes teachers are required to use computer interface through multimedia. Students should practice it in the computer.*

**References:**


1. Sinha P. K. and Sinha P. (2011). Computer Fundamentals. JBA, India.
2. Goel A. (2010). Computer Fundamentals. Pearson Education, India.
3. Campbell J.B. (2008). Introduction to Remote Sensing, Fourth Edition. Guilford Press.
4. Huisman O. de By R. A., Principles of Geographic Information Systems: An Introductory textbook, International Institute for Geo-Information Science and Earth Observation, The Netherlands (2001)