

TEXT BOOK

Courses of Study

Bachelor
Second Year



Institute of Science and Technology

TEXT BOOK

Tribhuvan University, Kirtipur,
Kathmandu, Nepal

First Published 2048

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1st Edition 3000 Copies

Price: Rs.

Printed by:
Bidya Dhari Printing Press
Patan Industries Area
Phone: 524795
526762

CONTENT

<u>Subject</u>	<u>Full Marks</u>	<u>Page</u>
Physics	150	1
Chemistry	150	10
Mathematics	100	16
Botany	150	19
Zoology	150	25
Geology	150	30
Microbiology	150	39
Statistics	150	47
Meteorology	150	52
Optional English	100	60

PHYSICS

Paper II

Full Marks: 100

Group A

Optics, Atomic Physics:

1. Monochromatic aberrations of images - Spherical, Astigmatism, Coma, Curvature of the field and distortion, Elimination of spherical, coma, astigmatism, curvature of the field and distortion.

2. Interference :- Wave velocity and group velocity, super position of two waves, Interference of several waves, Interference in space nodal and antinodal planes, coherent sources, conditions for interference, Interference fringes from a double source, Intensity distribution.

Interference of two beam of light by division of wave front & division of amplitude, Biprism, Bi-mirrors, Lloyd's Mirror, Interference in thin films, Newton's ring, Newton's fringes and Haidinger's fringes, Michelson's interferometer and its uses, Fabry Perot's interferometer.

3. Diffraction :- Fraunhofer diffraction, Single slit, Double slit, Plane grating, Concave grating, Resolving power of the instruments, Fresnel's diffraction, Half period zones Circular aperture, Zone plate, Cornu spiral straight edge.

4. Polarization:- Brewster's law, Malus law, Double refraction, Hugen's principle, Nicol's prism, Quarter and half wave plate, Elliptically and circularly polarised light optical activity, Laurent's half shade polarimeter.
5. Absorption and Scattering:- General and selective absorption, Molecular scattering.
6. Dispersion:- Normal and Anomalous scattering.

Group B

Electronics

1. **Semi-Conductor Physics**
Germanium and silicon atoms, Germanium and silicon crystals.
Conduction in pure germanium and silicon atoms, Concept of holes.
Extrinsic semi conductor
2. **P-N Junction Diode**
The P-N junction; Rectifying properties of a p-n junction,
I-V Characteristics of a semi conductor diode.
3. **Large Signal-Diode approximations**
The ideal diode,
The second approximation of a real diode,
The third approximation of a real diode,
Using the diode approximation approximating the reverse current; D.C. power supply,
Zener diodes,
The second approximation of a zenner diode.
4. **Small signal diode approximation,**
Superposition theorems, Superposition in electric circuits, A-C resistance of a diode, Formula for the A-C resistance of a diode; Application of the superposition, Theorem of diode circuits, Diode capacitance in the reverse region.
5. **The Junction Transistor**
Terminology and schematic symbols,
Biasing the transistor,
The ideal transistor,
I-V characteristics of a common

transistor,
Using superposition to analyse common base circuits,
A complicated A-C equivalent circuit,
A complicated A-C equivalent circuit,
Formula for common base analysis,
(notation for voltages and currents)
I-V characteristics of the common-emitter transistor,
The beta of a transistor,
The Ideal common-emitter transistor,
Base bias of a transistor,
Emitter bias of a transistor,
Analysis of common-emitter transistor circuits,
Voltage gain of an emitter-biased stage,
Effects of source resistance,
Basic idea of the common collector connection,
Derivation of common collector formula,
The Darlington pair,

6. Large Signal Operation
D-C load line interpretation of an A-C signal
The A-C load line; obtaining maximum unclipped signal
7. Temperature Effects and Bias Arrangements
Thermal runaway; Stabilization, stability factor,
Stability factors of various biasing arrangements,
8. A-C operation and equivalent circuits
Analysis of CE circuits
9. Cascading the stages
RC coupling; Inductive coupling;
Transformer coupling.

10. Brief account of radio transmission and reception,
A simple radio receiver circuit (straight set)
11. Feedback
Positive feedback and negative feedback;
Current feedback; Voltage feedback;
Oscillation, Barkhausen's condition, A simple transistor oscillator,
12. Digital Electronics
Simple AND or OR gates, Symbolic representation, Elementary boolean algebra, Binary system of numbers, Conversion of decimal and binary numbers, Simple rules of binary addition and subtraction.

Group C

Modern Physics

1. Atomic spectra
Elliptical orbits for Hydrogen Energy level diagram for hydrogen, The correspondence principle, optical spectral series, Orbital angular momentum, Total angular momentum, vector model, Magnetic moment of an orbital electron, Magnetic moment due to spin, Magnetic quantum numbers, Pauli's exclusion principle of spectral motion, Spectrum of sodium.
2. X-Rays.
Origin and properties, Absorption and emission spectra, Diffraction of X-rays by crystal, Measurement of X-ray wave length using X-ray detector.
3. Properties of Stable Nuclei
Rutherford's experiment for existence of nucleus,
Constitution of nuclei,
Isotopes, isobars and isotones,
Masses of nuclei and nucleons,
Aston and Bainbridge mass spectrographs
Binding energy, Mass defect and binding energy per nucleon.
4. Detectors
Semiconductors counters
G.M. counters
Photographic emulsions
5. Accelerators
Van de Graaff generator
Cyclotron
Linear accelerators

6. Radioactivity
 - Disintegration constant,
 - Curie,
 - Alphadecay,
 - Natural series,
 - Energy and range of alpha-particles,
 - Geiger-Nuttal Law,
 - Beta decay,
 - Neutrino hypothesis,
 - Beta particles spectra,
 - Interaction of Gamma-rays; photo-electric effect,
 - Compton scattering and pair creation.

7. Nuclear Reaction
 - Discovery of neutrons and positrons,
 - Excited states and unstable nuclei
 - Compound nucleus,
 - Resonances,
 - Coulomb barrier,
 - Types of reaction

Paper II

Full Mark: 50

Practical

A. Electronics

1. Response characteristics of series and parallel resonant circuits.
2. Q of coils and capacitances,
3. Net work analysis, Thevein Norton's maximum power transfer theorem
4. A.C. bridges- measurement of L,C,R, and frequency.
5. Transistor amplification
6. Characteristics of junction transistor
7. Direct measurement of h-parameters
8. Diode rectification
9. Ripple currents of different filter circuits
10. Use of C. R. O. to measure voltage, time and frequency
11. R-C transients.

B. Modern Physics

1. Measurement of electronic charge - Millikan method.
2. Measurement of e/m - Thomson method
3. Study of thermionic emission and space charge
4. a) Verification of Richardson's equation
b) e/m of electron.
5. Characteristics of photocell
6. Characteristics of G.M. Counter
7. Half life of a radioactive source
8. Absorption of r-rays.

Textbooks:

1. Optics - O.P. Khandewal
2. Introduction to Atomic and Nuclear Physics - Henry Semat, Chapman & Hall, Ltd., London, 1971.
3. Transistor Circuit - APPROXIMATIONS, - A.P. Malvino, Tata McGraw Hill Publishing co., New Delhi, 1985.

Reference Books:

1. Text book of optics - A.K. Ghatak, Tata McGraw Hill, New Delhi, 1971.
2. Fundamental of Optics - Jenkin's & White, TMH, 1957, New York.
3. Optics and Atomic Physics - Satya Prakash, Ratna Prakashan Mandir, Agra, 1988.
4. Concepts of Nuclear Physics - Bernard L. Cohen, TMH Publishing Company Ltd., New Delhi, 1978.
5. Modern Physics - R. Murugesan, S. Chand and Company Ltd. New Delhi, 1986.
6. Modern Physics - J. B. Rajam, S. Chand & Company Ltd., New Delhi, 1986.
7. Principles of Electronics - V.K. Mehta, S. Chand & Company (Pvt) Ltd., New Delhi, 1988.

CHEMISTRY

Paper II

Full Marks: 100

Section A. Physical

Thermodynamics:

First law of thermodynamics, enthalpy, heat capacity, Joule-Thompson effect, reversible process, reversibility and maximum work, Second law of thermodynamics, Carnot cycle, entropy, and free energy, Thermochemical terms and equations, Hess's law of constant heat summation, Kirchoff's equation.

Colloids:

Colloidal State of matter, lyophilic and lyophobic colloids, preparation and purification of colloids, brief discussion of the kinetic, optical and electrical properties of colloids.

Catalysis:

Criteria of Catalysis, theories of catalysis, poisons and promoters.

Electrochemistry:

Failure of Arrhenius's theory in the case of strong electrolytes qualitative treatment of the theory of strong electrolytes, Debye-Huckel-Onsagar equation), activity and activity coefficient, e.m.f. of cells. Origin of e.m.f. standard electrode potential, Nernst equation, half-cells, reference electrodes, conductometric titrations, Potentiometric titrations.

Spectrophotometry:

Beer-Lambert Law, discription of simple spectrophotometer, simple applications.

Orbital Pictures of Molecules:

Atomic orbitals, molecular orbitals, hybrid orbitals, hybridization, molecular orbital pictures of methane, ethylene, acetylene, benzene.

Electronic Effects:

Inductive effect, electrometric effect, mesomerism, resonance, hyper-conjugation.

Physico-Chemical Methods Concerning Reaction Mechanism:

Kinetic methods and non-kinetic methods (isolation and trapping of the intermediate, tracer technique, etc.)

Energetic of Reaction:

Progress of reaction, energy changes, energy of activation, transition state, free energy, activated complex, relationship between enthalpy of activation, entropy of activation and free energy of activation.

Free Radical Substitution:

Halogenation, mechanism of halogenation, relative reactivity of alkane halogenation, case of abstraction of hydrogen atom, stability of free radical, ease of formation of free radicals, orientation and reactivity, reactivity and selectivity.

Elimination:

E_1 and E_2 reactions, dehydrohalogenation of alkyl halides and its mechanism, orientation and reactivity, dehydration of alcohols and its

mechanism, carbonium ion theory, stability of carbonium ion, ease of formulation of carbonium ion.

Electrophilic and Free Radical Addition:

Addition of hydrogen halide, Markownikoff's rule, Addition of hydrogen bromide and peroxide effect, electrophilic addition, mechanism, orientation, reactivity, mechanism of addition of halogen, free radical addition, mechanism of the peroxide initiated addition of HBr.

Nucleophilic Aliphatic Substitution:

S_N1 , S_N2 reactions mechanism, kinetics, reactivity, and stereochemistry.

Resonance and Aromatic Character:

Resonance theory, orbital picture of benzene, Kekule $(4n+2)$ rule, mechanism of nitration, sulphonation, halogenation, Friedel Craft's alkylation.

Nucleophilic Addition of Carbonyl Compounds:

Nucleophilic addition, reduction, addition of Grignard's reagent, reduction with metal hydrides, addition of cyanide, bisulphite derivative of ammonia, alcohol, Cannizaro's reaction.

Nucleophilic Aromatic Substitution:

Low reactivity of aryl and vinyl halides, structure of aryl and vinyl halides, effect of halogen on electrophilic aromatic substitution, nucleophilic aromatic substitution by molecular displacement and its mechanism, reactivity in nucleophilic aromatic substitution, elimination-addition mechanism for nucleophilic aromatic substitution.

Stereochemistry:

Stereoisomerism, optical activity, enantiomerism, tetrahedral carbon, dissymmetry, asymmetric carbon atom, enantiomers, racemic modification, configuration, R and S configuration, sequence rule.

Carbohydrates:

Osazone formation and epimers, Kiliani and Fischer synthesis, Ruff degradation, absolute configuration, cyclic structure of D (+) glucose and formation of glucosides, configuration about C₁, methylation, determination of ring size conformation.

Heterocyclic Compounds:

Structures of Pyrrole, furan, and thiophene, sources of pyrrole, furan, and thiophene, electrophilic substitution in pyrrole, furan, and thiophene, structure of pyridine, electrophilic and nucleophilic substitution in pyridine, basicity of pyridine, quinoline.

Aminoacids and Proteins:

Aminoacids as dipolar ions, isoelectric point, properties, geometry of peptide linkages.

Cyclic Aliphatic Hydrocarbons:

Nomenclature, preparation, reactions, Baeyer's strain theory, conformation of cycloalkane, equatorial and axial bonds in cyclo-hexane.

Reactions Involving Carbonion:

Nucleophilic acyl substitution, alkaline and acid hydrolysis on esters, trans-esterification, acidity-of-hydrogen, reactions involving carbanions, base promotes halogenation of ketone, stereo chemistry of carbanions enolization, aldol condensation, dehydration of

aldol product. Perkin condensation, Wittig reaction.

Dicarboxylic Acids:

Effects of heat, malonic acid synthesis.

Keto Acids:

Claisen rearrangement, acetoacetic ester synthesis of ketone and acid, decarboxylation of keto acids, keto-enol tautomerism.

Hydroxy Acids:

Reformatsky reaction, stereochemistry of hydroxy acids.

Unsaturated Carbonyl Compounds:

Michael addition, Diels Alder reaction.

Practical Paper II

Full Marks : 50

Detection of N.S. and halogens in organic compounds. Identification of functional groups, Preparations of organic compounds involving acetylation and hydrolysis, Preparation of Phenolphthalein. Determination of melting point of organic compounds.

Some inorganic preparations (at least 3 compounds).

Gravimetric analysis of iron, Gravimetric estimation of sulphate in K_2SO_4

Preparation of buffer solution and determination of pH by indicator method.

Recommended Books:

1. Essentials of Physical Chemistry, B. S. Bahl.
2. Organic Chemistry, Morrison and Boyd.

MATHEMATICS

Paper III

Full Marks: 100

Vectors and Differential Equation, and Mechanics/
Optimisation and Linear Programming.

Paper III will contain three sections A, B and C. There will be 12 questions 3 from each of the sections A and B, and 6 from section C. Candidates may answer any SEVEN questions, selecting atleast one from each sections A and B, and three from section C. Each question will carry 14 marks and the remaining 2 marks will be allotted according to th following scheme:

2 marks for students securing marks 66 and above.
1 mark for students securing marks between 33-66.

Section A : Vectors

1. Products of three and more vectors
2. Vector differentiation, gradient divergence and curl
3. Theorems of Gauss, Stokes and Green.

Section B: Differential Equations

4. Exact equations
5. Differential equations of second order
6. Simultaneous linear differential equations with constant coefficients and total differential equations.

Section C: Mechanics OR Optimisation & Linear Programming.

Mechanics: (Statics and Dynamics)

1. Coplanar forces
2. Catenary (inelastic)
3. Centre of gravity
4. Motion in a straight line (S.H.M., inverse laws)
5. Motion in a plane (radial and transverse velocities and accelerations, tangential and normal velocities and accelerations)
6. Motion under central forces and constrained motion (cycloid).

OR Optimisation and Linear Programming

1. Problems of Optimisation, maximization and minimization with several variables.
2. Maximization and minimization subject to constraints and Lagrange's multipliers.
3. Linear programming and transport problems
4. Duality problems
5. Game Theory
6. Difference Equations.

Recommended books: (Recent edition)

Paper III:

1. R.S. Verma: Textbook on Statics, Pothisala Pub. Allahabad.
2. M. Ray: A Textbook on Dynamics, S. Chand & Co. Delhi.
3. Lalji Prasad: A Textbook of Vector Analysis.
4. B.L. Vaidya: Undergraduate Vector Analysis.- Ratna Pustak Bhandar, Kathmandu.
5. T.N. Vaidya: Undergraduate Dynamics.- Ratna Pustak Bhandar, Kathmandu, 1990.

6. D. Murray: Differential Equations.
7. P.K. Gupta and Man Mohan: Linear Programming and Game Theory, S.C. & Co.
8. S.I. Gass: Linear Programming.
9. G. Hadley: Linear Programming.
10. R.K. Gupta: Linear Programming, Krishna Prakashan Mandir.
11. P.K. Gupta, Man Mohan and Kanti Swarup: Operation Research.
12. G.D. Pant: Calculus for Economics.
13. T. Yamani: Mathematics for Economics.
14. A.C. Chiang: Fundamental Methods of Mathematical Economics.

BOTANY

Paper II

Full Marks: 100

Ecology

General introduction, factors-biotic and abiotic, soil erosion, afforestation, deforestation, biogeochemical cycles (H_2O , P, C, both sedimentary and gaseous). Communities and succession, major ecosystems, trophic levels, Food chain, Principles of nature conservation, Pollution air and water.

Physiology

Water relations: Osmotic pressure, Turgor pressure, Diffusion pressure deficit, Transpiration, factors affecting transpiration, ascent of sap. Mineral nutrition:- Role of major and minor mineral elements. Photosynthesis: General mechanism, factors affecting photosynthesis, concept of C_3 and C_4 Plants. Translocation of Photosynthesis.

Respiration: General mechanism of aerobic and anaerobic respiration. Role of respiration in physiological processes,

Protein and Fat Synthesis; General account.
Enzymes: General account.

Growth and Development: General account of plant hormones and inhibitors, Physiology of seed germination and dormancy, Photoperiodism and vernalization, Photomorphogenesis.

Morphogenesis: Basic principles, polarity, symmetry and differentiation.

Taxonomy and Economic Botany

- (A) A brief history of the classification of angiosperms, principles of classification of Bentham and Hooker and Engler and Prantle.
- (B) Systematic study, economic importance and affinities of the following families:-
Ranunculaceae, Magnoliaceae, Caryophyllaceae, Rutaceae, Umbelliferae, Scrophulariaceae, Verbenaceae, Labiatae, Polygonaceae, Euphorbiaceae, Musaceae, Graminae.
- (C) Source & economic importance of the following plant products: morphine, camphor, tea, serpentine, belladonna, cotton and jute.

Embryology

Micro and megasporogenesis, Typical types of male and female gametophyte, endosperms, embryogenesis of a typical dicot and monocot plant.

Anatomy

General types of plant tissues. Their distribution and significance in different plant organs, Concept of mechanical tissues, Ecological anatomy, Anomalous secondary growth.

Practical Paper II

Full Marks: 50

1. To study soil types and the water-holding capacity of soil.
2. To study the vegetation of a given locality by quadrat method.
3. To demonstrate the different stages of plant succession in a pond.
4. To perform experiments on osmosis, DPD, and transpiration.
5. To perform experiments to study the effects of the different factors on photosynthesis.
6. To perform experiments of aerobic and anaerobic respiration.
7. To perform simple experiments on the effects of enzymes.
8. Semi-technical description of angiospermic plants belonging to the families mentioned in the theory paper.
9. Demonstration and description of plant products of economic importance.
10. To prepare permanent slides of stem showing anomalous structure.
11. To demonstrate the methods of preparation of herbarium.

Recommended Books:

1. Dube, H.C., A Textbook of Fungi, Bacteria and Viruses.
2. Alexopoulos, C.J., Introductory Mycology.
3. Pandey, B.P., Economic Botany, S. Chand & Co. Ltd., New Delhi.
4. Pandey, S.N. & P.S. Tribedi, A Textbook of Botany, Vol. I Vikas Publishing House Pvt. Ltd, New Delhi, 1982.
5. Smith G.M., Cryptogamic Botany, Vo.. I. & II, McGraw Hill Book Company, Inc., N.Y.
6. Brij Gopal & N. Bhardwaj, Elements of Ecology, Vikas Pub. House Pvt Ltd., New Delhi.
7. Odum, E.P., Fundamental of Ecology.
8. Mishra, K.C., D.N. Rao, R.S. Ambast, K.L. Mukherjee, R.S. Dwivedi & P.V. Ananth Krishnan, Ecology Study of Ecosystem, A.H. Wheeler & Co., Allahabad, 1970.
9. Lawrence, G.H.M., Taxonomy of Vascular Plants, Oxford & IBH Publishing Company, New Delhi.
10. Noggle, G.R. & G.F. Fritz, Introductory Plant Physiology, Prentice Hall of India Pvt. Ltd., New Delhi.
11. Sporne, K.R., The Morphology of Gymnosperms.
12. Sporne, K.R., The Morphology of Gymnosperms, B.I. Publishing, Delhi.

13. Stanton, J.D.A., Forests of Nepal, John Murray London.
14. Sinnot, E.W., L.C. Dunn and Dobzhansky; Principle of Genetics, McGraw Hill Book Company, Inc., N.Y.
15. Swanson, C.P., T.Merz & W.J. Young; Cytogenetics, Prentice Hall of India Pvt. Ltd., New Delhi.
16. Garbeer, E.D.; Cytogenetics: An Introduction; McGraw Hill Book Company, N.Y.
17. Sinha, V. & S. Sinha : Cytogenetics, Plant Breeding and Evolution, Vikas Publishing House Pvt. Ltd.
18. Singleton, W.R.: Elementary Genetics, New Delhi: Affiliated East West Press Pvt. Ltd.
19. Pandey, B.P., Plant Anatomy, S.Chand & Company Ltd. New Delhi.
20. Esau, K.; Plant Anatomy, John Willey & Sons Inc., N.Y.
21. Vasistha, P.C., A Textbook of Plant Anatomy, S. Nagin & Co., Delhi.
22. Dube, H.C., A Textbook of Fungi, Bacteria and Virus, Vikas Publishing House Pvt. Ltd. New Delhi.
23. Gupta R.K., Textbook of Systematic Botany, Atma Ram & Sons, Delhi.
24. Arnold, C.A., An Introduction to Paleobotany, McGraw Hill Book Co., N.Y.

25. Parihar, N.S., An Introduction to Embryophyta: Vol. I Bryophyta, Vol. II Pteridophyta, Central Book Depot, Allahabad.
26. Devlin, R.M., Plant Physiology, Affiliated East West Press Pvt. Ltd. New Delhi.
27. Meyer, B.S., D.B. Anderson, R.H. Bohring and D.G. Frakamme: Introduction to Plant Physiology, Van Nastrand N.Y.
28. Bhojwani, S.S. and S.P. Bhanthnagar: The Embryology of Angiosperms, Vikas Pub. HUse Pvt. Ltd., New Delhi.
29. Gangulee, H.C. and A.K. Kar: College Botany Vol. I and II, New Central Book Agency, Calcutta.

ZOOLOGY

Paper II (125 Periods)

Full Marks: 100

1. General characters and classification of Protochordates, Pisces, Amphibia, Reptilia, Aves and Mammalia (Upto orders) 12 Periods.
2. Characteristics and affinities of Herdmania, Balanoglossus and Branchiostoma. (10 Periods)
3. Organ systems of Scoliodon, Uromastix and clumba (Pigeon).
4. Poisonous and non-poisonous snakes. (2 Periods).
Nature of poison and biting mechanism (2 periods).
5. Structure and function of Endocrine glands (Pituitary, Thyroids, Pancreas and Adrenals) of mammals. (6 periods).
6. Development of Branchiostoma (Amphioxus) upto the formation of coelom Development of Chick upto the formation of extra embryonic membrane. Different types of placenta in mammals (9 periods).

Mammalian Physiology

7. Physiology of respiration, Respiratory mechanism, Respiratory pigments and their role, CO_2 transport, Physiology of circulation, Blood pressure, Origin and conduction of heart beat. Excretion and Osmoregulation. (20 periods).

Ecology:

Ecosystems- Grassland, Pond and Forest.

**Adaptation-aquatic, terrestrial & aerial.
(6 periods).**

**Population and communities, succession. (3
periods).**

**Pollution - Air, Water and Noise. (3
periods).**

**Zoogeography- Palearctic, Ethiopian,
Oriental, Australian, Neartic, Neotropic
regions, Pheasants of Nepal. (6 periods)**

Biostatistics: (10 periods).

Data Collection

**Census, Random sampling, Systematic
sampling,**

Replication, Design of experiment,

Measuring central tendency, Mean, Mode,

**Median, Arithmetic, Geometric and Harmonic
mean. Measuring Variability**

**Variance: Standard deviation, Standard
error. Frequency distribution,**

**Significance Test: Chi-square, Students t-
test, Oneway analysis of variance.**

Practical Paper II

Full Marks: 50

- Major Dissections (to expose) (15)
- (a) Afferent arteries of Scoliodon
 - (b) Efferent art-eries of ,,
 - (c) Cranial nerves of ,,
 - (d) Internal ears of ,,
 - (e) General anatomy, Alimentary canal, Urinogenital and Blood Vascular Systems of Uromastix or Hemidactylus.
 - (f) Air sacs of Pigeon
 - (g) Flight Muscles of Pigeon
 - (h) Arterial System of Pigeon
 - (i) Venous system of Pigeon
 - (j) Permanent slide preparation of the following:- (8)
 - (a) Placoid scales of Scoliodon
 - (b) Pecten of Pigeon
 - (c) Other locally available material.
 - (k) Identify and Comment upon - (12)
 - (a) Museum specimens
 - (b) Histological slides
 - (c) Embryological slides of chicks.
 - (d) Bones of vertebrates (Frog, Rabbit, Pigeon and Representative of Reptile)
 - (l) Lower Chordate - Balanoglossus, Herdmania.

Branchiostoma (Amphioxus); T.S. of Balanoglossus and Branchiostoma or other available specimens.

- (m) Cyclostomata - Petromyzon or other available specimen.
- (n) Pisces - Scoliodon, Torpedo, Sting-ray, Pristis, Chimaera, Amia, Labeo, Clarius, Anguilla, Syngnathus, Hippocampus, Anabas, Exocoetus, Echeneis, Tetradon, Mastacembalus or other available specimens.
- (o) Ichthyophis, Ambystoma, Salamander, Newt, Triton, Necturus, Rana, Bufo, Hyla or other available specimens.
- (p) Reptilia - Hemidactylus, Calotes, Varanus, Horned-toad, Draco, Chamaeleon, Turtoise, Turtle, Cobra, Viper or other available specimen.
- (q) Aves - Psittacula, Corvus, Anser, Lophophorus, King-fisher, woodpecker or other available specimens. Embryological slides of chicks.
- (r) Mammalia - Rat, Squirrel, Manis, Panda, or other available specimens.
- (s) Embryology - Slides of chick embryo.
- (t) Comparative Study of Bones - (Limbs, Girdles, Skulls and vertebrae of Amphibia, Reptilia, Aves and Mammalian) species.

4. Viva Voce (10)

5. Practical Record (5)

N.B. Museum specimens representing various classes of Phylum Chordata should be given for the general survey of animals as far as possible.

Recommended Books:

1. Parker and Haswell, A text book of Zoology, Vol II
2. Prasad, S.N.: Vertebrate Zoology.
3. Jordan and Verma: Chordate Zoology and Animal Physiology
4. Sembha Sivish and Chelliappa: Physiology and Ecology.

Reference Books:

1. Herdmania - S.M. Das
2. Thillayampalam - Scoliodon.
3. T.C. Majpuria - Introduction to Chordates.
4. M. Jollie - Chordate Morphology.
5. Odum, E.P. - Fundamentals of Ecology.
6. T.K. Shrestha - Wild life of Nepal.
7. J. Shrestha - Fishes of Nepal.
8. M.L. Singh - Statistics for Intermediate (Certificate Level)

GEOLOGY

Theory	Lectrs. P/W	Marks
Paper II Petrology	2	
Historical Geology, Paleontology and Geology of Nepal	2	
		100
Economic Geology and Engineering Geology	2	
Practical:	Practs. Class/w	Marks
Paper II (Related to theory paper II)	2	40
Field Report:	Weeks	Marks
	4	20
GRAND TOTAL:		300

A. PETROLOGY

Definition and scope of the subject. Three-fold classification of rocks.

Igneous Petrology: Introduction, Field observations of igneous rocks. Mode of occurrence. Types of intrusion. Types of extrusion. Methods of emplacement of igneous rocks. Study of the experiments with molten silicates-unary, binary and ternary systems. Phase relations and textures. Crystallization of magma. Classification of igneous rocks. Evolution of magmas. Interior of the Earth. Formation of the magmas and rift zones. Igneous rocks at continental margins. Continental igneous rocks. Petrographic description of the following rocks: Granite, pegmatite, aplite, syenite, monzonite, granodiorite, diorite, gabbro, rhyolite, dacite, trachyte, latite, andesite, basalt, phonolite, ultramafic rocks, pyroclastic rocks, spillites, carbonatite.

Sedimentary petrology: Introduction, the occurrence of sedimentary rocks, depositional basins, formation of sediments. Chemical and mechanical weathering. Sedimentary facies, diagenesis and lithification. Sedimentary structure and textures. Classification of sedimentary rocks. Mud rocks, sandstones, and conglomerates. Diagenesis of sandstones. Limestones and dolomites, evaporites, bedded cherts, bedded phosphate rocks, bedded iron deposits.

Metamorphic petrology: Introduction, occurrence, recognition, textures and structures of metamorphic rocks, field observation of metamorphic rocks. Regional metamorphism, contact metamorphism, burial metamorphism, cataclastic metamorphism. Isogrades, facies concepts, phase rule, controls and processes of metamorphism. Metamorphic differentiation, metamorphic reactions, upper limit of metamorphism, mineral changes during metamorphism, mineral variation and metamorphic facies. Mineral variation related to initial rock composition, time-temperature and deformational relationship. Determination of temperature and pressure. Metamorphic rocks and global tectonics.

B. HISTORICAL GEOLOGY, PALEONTOLOGY AND GEOLOGY OF NEPAL.

HISTORICAL GEOLOGY: Definition, scope, aim and method of study; stratigraphic classification and correlation, standard stratigraphic scale and geological time-scale, geochronology, international code of stratigraphic nomenclature. Correlation of lithostratigraphic, biostratigraphic, and chronostratigraphic units. Principles of paleogeography and paleotectonics, Earth's crustal structures and tectonic cycles. Life and paleogeography during Archean, Proterozoic, Paleozoic, Mesozoic and Cainozoic (Cenozoic) eras.

PALEONTOLOGY: Definition and scope of paleontology. Fossilization and application of study of fossils. Brief concept of species ecosystem and nomenclature of species. Adaptation and functional morphology.

Morphology, geological distribution, evolutionary trends, classification of the following invertebrate groups:

Protozoa (Foraminifera), Brachiopoda, Mollusca (Bivalvia, Gastropoda and Cephalopoda), Graptoloidea, Coelenterata (Anthozoa), Bryozoa, Echinoderma (Echinnoidea, Crinoidea), Arthropoda (Trilobita).

Fossil Plants, Elementary vertebrate paleontology. Fossil man. Origin and evolution of life through ages. Theory of organic evolution.

GEOLOGY OF NEPAL: Physiographic subdivisions of Nepal in relation to the Himalayan arc. Geological division of Nepal. Geology of the Siwaliks (Churia), Lesser Himalaya, Higher Himalaya, Tethys Himalaya of Nepal and geology of the Kathmandu Valley area.

C. ECONOMIC GEOLOGY AND ENGINEERING GEOLOGY

ECONOMIC GEOLOGY: Introduction, historical background, distribution, Morphology and disposition of ore bodies. Classification of ore deposits, physical characteristics, optical properties and structure of ore minerals.

Ore forming processes magmatic, contact metamorphic, pneumatolitic to hydrothermal, sedimentary. Residual enrichment and mechanical concentration. Supergene enrichment, metamorphism. Chemical composition, important physical properties, mode of occurrence, utilization, distribution in Nepal and adjacent areas, and occurrence of the important ore

minerals of the following metals, nonmetals, and fuels:

Lead, Zinc, copper, iron, gold, magnesite, limestone, precious stones, coal and petroleum.

ENGINEERING GEOLOGY: Definition and scope of engineering geology, its relation with other geological sciences and civil engineering. Engineering properties of soil: grain size distribution, Atterberg limits, specific gravity, unit weight, porosity, absorption. Engineering properties of rocks: specific gravity, porosity, compressive strength, shear strength, modulus of elasticity, modulus of compression. Engineering Geological studies for dam, reservoir, irrigation canal, road, bridge and tunnel.

Naturally occurring construction materials. Landslides: causes, factors contributing to landslides, control of landslides.

PETROLOGY: Study of the following rock types in hand specimens and under microscope.

Granite, syenite, diorite, gabbro, norite, anorthosite, peridotite, dunite, pegmatite, aplite, dolerite, pyroxenite, charnokite, basalt, andesite, rhyolite, breccia, conglomerate, greywacke, argillite, sandstone, clay, shale, marl, limestone, dolomite, bauxite, slate, phyllite, schist, amphibolite, gneiss, marble. Serpentinites.

PALEONTOLOGY: Description of systematics and geological age of the followings:

Invertebrate fossils:

Foraminifera - Nummulites, Assilina, Discocyclina, Alveolina, Fusulina, Orbitolina.

Brachiopoda - Lingula, Productus, Paraspirifer, Crytospirifer Rhynchonella, Terebratula, Atrypa, Syringothyris, Aulocothyris, Tetractinella.

Bivalvia Nucula, Alcyonia, Pecten, Ostrea, Exogyra, Gryphaea, Unio, Cardita, Nuculana, Posidonia, Limastrata, Hoernesia.

Gastropoda - Bellerophon, Turritella, Cerithium, Cypraea, Murex, Coures, Physa, Viviparus, Potamides, Plevrotoma Selys.

Cephalopoda - Orthoceras, Nautilus, Goniatites, Ceratites, Phylloceras, Perisphinctes, Baculites, Turritites, Belemnites, Cardioleras Sp., Cordatum, Arcestes Sp., Tornoceras, Trigonellia, Ceratites Nodosus, Macrocephalites.

Graptoloidea - Monograptus, Tetragraptus,
Dendrographes, Antennomea.

Anthozoa - Calceola, Zaphrentis, Montlivaltia,
Favosites, Lithostrotion, Dictyonocera,
Thecosmilia, Sandalina.

Echinoidea - Micraster, Schizaster, Clypeaster,
Conolus, Cidaris, Hemicideris, Peatremites
Godoni, Encrinus, Liliiformis.

Trilobita - Paradoxites, Olenus, Calymene,

Agnostes.

Bryozoa Fenestella, Polypera, Protoretipora.

Plant fossils - Glossopteris, Gangamopteris,
Schizoneura, Vertebratia, Thinnfeldia,
Sphenopteris, Cladophlebis, Btilophyllum,
Otozamites.

HISTORICAL GEOLOGY: Preparation of columnar
sections with available data and their
interpretation. Study of geological history from
geological maps and cross-sections. Preparation
of paleogeographic maps.

ECONOMIC GEOLOGY: Study of the following economic
minerals in hand specimen: Lepidolite, halite,
native copper, chalcocite, covellite, chalcopyrite,
malachite, azurite, bauxite, laterite, rutile,
limonite, goethite, siderite, pyrite, galena,
columbite, tantalite, orpiment, stibnite,
cassiterite, sulphur, brunite, psilomelane,
rhodonite, rhodochrosite, graphite, peats,
lignite, Bituminous coal, anthracite, crude
petroleum.

Principles of reflecting microscopy and study of polished section of common ore minerals.

ENGINEERING GEOLOGY: Exercise in areial photo, topographic, and geological map interpretation. granulometric analysis. Introduction to the use of stereographic projection in engineering geology.

Text books:

1. Ehlers and Blatt : Petrology, Igneous, sedimentary and Metamorphic, CBS.
2. Woods : Invertebrate Paleontology, CBS.
3. Ravindra Kumar: Principles of stratigraphy, and Historical Geology, Tata McGraw Hill
4. J. Stocklin, Geology of Nepal and its regional framework, Journal of Geology, 1981.
5. Smirnon (ed) : Studies of Mineral Deposits, Ginzburg, Grignier, Yakovler, Mir Publishers, Moscow.
6. Singh Prabin : Engineering and general geology, BDK.

Reference Books:

1. Moorhouse : Study of rocks in thin section, CBS.
2. Maslov: Basic Engineering Geology and Soil Mechanics, Mir Publishers, Moscow.

3. Jensen & Bateman: Economic Geology.
4. Evans: An Introduction to ore geology, ELBS.
5. Raup & Stanley: Principles of Paleontology,
CBS.
6. C.K. Sharma: Geology of Nepal Himalaya and
adjacent countries.

MICROBIOLOGY

Paper II

Full Marks: 100

Environmental, Food and Industrial Microbiology

Objectives:

1. To acquaint the student with those organisms that occur in the environment and that are transported to the environment of their activities and their effect on the environment.
2. To acquaint the student with the principles of food microbiology, the organisms used in processing and producing food, the organisms involved in food spoilage and food borne diseases as well as methods of their control.
3. To acquaint the student with the microbial processing methods and products commonly used in industry and agriculture.

Subject Outline:

Theory:

1. Environmental Microbiology,

a. Soil Microbiology:

The soil system

- i) Physical factors in soil that affect microorganisms.
- ii) Chemical factors.

- iii) Soil organisms and their activities
- iv) Decomposition of organic materials.
- v) Symbiotic and nonsymbiotic nitrogen fixation
- vi) Biofertilizer.

b. Air Microbiology:

- i) Microbes as air pollutants.

c. Aquatic Microbiology:

The aquatic system.

- i) Physical factors.
- ii) Chemical factors,
- iii) Aquatic microorganisms and their functions.

d. Water Quality Basis:

- i) Biological indicators of pollution.
- ii) Sewage and sewage treatment.
- iii) Water treatment.

e. Biogeochemical Cycles and Microorganisms Involved

- i) Carbon
- ii) Nitrogen
- iii) Sulphur
- iv) Phosphorus & others

f. Microbial Degradation of Pesticides and Herbicides:

- i) Types of degradation
- ii) Factors affecting degradation.

g. Microbial Ecology:

- i) Ruminants
- ii) Chemostats and Turbidostats.

2. Food Microbiology:

- a. Organisms found in various foods.
- b. Role and significance of microorganisms in food.
- c. Factors that affect microbial growth; intrinsic and extrinsic parameters.
- d. Determination of microorganisms in food, methods and technique.
- e. Food handling
- f. Food spoilage:
 - i) Fruits and vegetables
 - ii) Fresh and cured meats and poultry
 - iii) Eggs
 - iv) Dairy products
 - v) Canned foods
 - vi) Flour, cereals and bakery products
 - vii) Fermented foods and soft drinks
- g. Food Preservations
 - i) Chemical
 - ii) Irradiation
 - iii) Low temperatures
 - iv) High temperatures
 - v) Drying
 - vi) Osmosis
- h. Microbiological indexes of food; sanitary; quality standards of milk, bread, meat and eggs.
 - i) food poisoning
 - ii) Gram positive cocci-Staphylococcus sps.
 - iii) Gram positive sporeformer-Clostridium sps.

- iv) Gram negative bacteria-Salmonella sps.

3. Industrial and Analytical Microbiology.

a. Industrial Microbiology

- i) Introduction
- ii) Role of microbes in production vitamins.
- iii) Antibiotics.
- iv) Steroids.
- v) Alcohols.

4. Analytical Microbiology:

- i) Introduction
- ii) Methodology
- iii) Agar-diffusion
- iv) Titrometric methods
- v) Turbidity
- vi) Sterility test

5. Microbial Deterioration in wood and paper industries.

6. Industrial control of microorganisms.

Practical and its part: Environment, food and industrial microbiology.

1. Enumeration of different kinds of microorganisms, total viable no. of Bacteria, fungi and actinomycetes in different kinds of soil and rhizosphere.
2. Bacterial counts by the direct microscopic methods-in nutrient agar medium
3. Counting of MPN of Algae, and Protozoa in a given sample of water.
4. Isolation and identification of Azotobacter
5. The buried slide techniques of studying the soil microflora.
6. Isolation and identification of Rhizobium.
7. Measurement of nitrogen fixation by microzeldahal method.
8. Collection and multiplication of algae.
9. Liberation of Ammonia from organic matter (or production of NH_3 from Humus etc.) by living soil bacteria.
10. Isolation of cellulose decomposers.
11. Isolation of phosphorus solubilisers.

12. Isolation of microorganisms from composts (enumeration and identification of organism).
13. Nodulation test of the Rhizobium.
14. Winogradsky column.
15. Direct count of microorganisms of water.
16. Biochemical oxygen demand (Measurement of residual; oxygen).
17. Bacteriological examination of water (qualitative test).
18. Microbiological examination of dairy product (e.g., cheese or ice-cream).
19. Breed count of milk.
20. Reductase test, Methylene blue MRBT and resazurine test.
21. Bacteriological examination of meat and poultry.
22. Macroscopical and Microscopical study of yeast.
23. Study of yeast in pure culture
 - a) Morphological
 - b) Sporulation
 - c) Conjugation
 - d) Budding
 - e) Pseudomycelial forms.
24. Production of ethyl alcohol from molasses of fruits, utilizing the yeast.

25. Isolation of antibiotic producing strains from the given soil samples.
26. Antibacterial spectrum analysis of the isolated strains against.
 - a) E. Coli
 - b) Staphyl occoccus aureus
 - c) Salmonella typhi by the following methods:
 - i) Streak
 - ii) Strip and Radial methods
27. Study of antibacterial spectrum of 50% alcohol extract of Allium sativum against.
 - a) Staphylococcus aureus
 - b) E Coli
 - c) Salmonella sps
 - d) Paratyphoid
 - e) Saccharomyces Cerevisiae (yeast) by following methods:
 - i) Agar dilution methods
 - ii) Agar diffusion methods
28. Sterility test
Test for sterility of the given parenteral injection.
 - a) Direct inoculation method
 - b) Filtration method
29. Microbiological Essay:
Determination of the potency of pencillin in the given sample.

Recommended Books (Latest Edition)

1. Frobiser, Sommerneyer and Furest
Microbiology in health & diseases.
2. Davis : Microbiology

3. Cruickshank - Medical microbiology
4. Dey & Dey - Medical bacteriology and Aids -
Pub. Allied agency.
5. Stainer - The Microbial World, Prentice Hall
6. Topley and Wilson - Principle of Bacteriology,
Virology and immunology, Volume 1,2,3 and 4
7. J.D. Brock & Brock - The Biology of
Microorganisms.
8. Martin Alexander - Soil Microbiology
9. James M. Jay - Modern Food Microbiology, CBS,
Publishers & distributors.
10. W.C. Frazier & D.C. Westhoff - Food
Microbiology. Tata McGraw Hill.
11. Betty C. Habbs - Food Poisoning and Food
hygiene, Edward Arnold.
12. Miller and Litsky - Industrial Microbiology,
McGraw Hill.
13. Reinheimer - Aquatic Microbiology.
14. Kavanagh - Analytical Microbiology, Vol I &
II
15. Smith - Microbiology and Pathology - Mosby.

STATISTICS

Paper II:

Full Marks: 100

Applied Statistics

No. of Lectures

- 2.1 **Sample Survey:** (4)
Sample surveyes and censuses. Advantage of sample surveyes, Principles steps in sample surveyes, Sampling and nonsampling errors, Simple random sampling, Methods of drawing simple random samples (SRS), Frequency test of randomness. Sampling with and without replacement. Mean and variance of SRS. Estimation, determination of sample size.
- 2.2 **Stratified Sampling:** (10)
Objectives of stratification, Mean and variance of staratified sample mean. Proportional and optimum allocations. Relative precision of stratified sample with respect to simple random sample.
- 2.3 **Analysis of Variance:** (6)
Concept and assumptions, one way and two way classification with one observation per cell, Critical difference methods.
- 2.4 **Design of Experiments:** (20)
Basic Principles of experimental design; Completly Randomised Block Design (CRBD) Random Block Design (RBD) and Latin Square Design (LSD), Standardised LSD. Techniques of missing plots for RBD and LSD for single missing observation. Advantage and disadvantages of CRBD, RBD and LSD. Comparisions of efficiencies of designs.

Factorial Expt.: 2^2 and 2^3 design.
Advantage of factorial experiments over ordinary designs. Estimations of mean effects and interactions (Yates methods).

2.5 Analysis of Time Series: (10)

Components of time series. Estimation of trend: freehand, Semi-average, Moving average and least square methods, Measurement of seasonal variation and short term fluctuation. Ratio to moving average, Ratio to trend, Simple Average Method and Link Relative Methods.

2.6.1 Non-Parametric Methods: (12)

Distinction on between parametric and non-parametric tests (NPT), Advantages and disadvantages of NPT, Binomial, Kolmogorov-smirnov and Run tests.

Two Sample Cases: Sign test, Wilcoxon signed rank test and Mann-whitney U-test.

or

2.6.2 Index Numbers:

Definition and concept of Index number. Principle steps in construction of an Index number, types of Index number, Simple and weighted Index number, various methods of computing Index number, (Paasche, Marshal Edgeworth, Dorbisch Laspeyre, Bowley and Fisher's Index number). Texts of Index number (Time and Factor reversal tests). Fixed and chain base Index numbers. Conversions of Index number from fixed to chain and vice versa. Deflating by Index number. Cost of living indices - Concepts and constructions.

- 2.7 **Official Statistics:** (10)
Scope and coverage of different censuses related to Agriculture, Industry and Population. Methods used in these censuses (with reference to Nepal).

Demographic Surveys of Nepal:

Different demographic sample surveys of Nepal with special references to their objectives, methods and important results.

- 2.8 **a. Demography:** (15)
Introduction, Sources of demographic data, Age-sex composition. Evaluation of Age and Sex data and Errors in reporting, Whipple's Index, U.N.'s Age-Sex accuracy Index. Population pyramid and Age dependency ratio.

b. Vital Statistics:

Definition and computation of crude and standardised birth and death rates. Concepts and computation of Age specific birth and death rates. General and total fertility rates. Replacement indices: Gross and Net reproduction rates.

c. Life Table:

Simple life table, its usages and construction. Relationship between various columns of a life table.

d. Population Models:

Population models - Simple, Exponential and Logistic models, Uses of these models in population projections.

Paper III Practical Paper:

It consists of two parts, each consisting of 50 marks. I part will be dealt in 1st year and II part will be dealt in 2nd year.

Tentative exercises to be completed for practical paper in second year from different topics of study are as follows:

Part II

S.No.	Subject Area (Section No.)	Tentative No. of Problems
1	2.1	7
2	2.2	7
3	2.3	8
4	2.4	7
5	2.5	5
6	2.61	6
	or	
7	2.62	6
8	2.8	10
	Total	50

Course Arrangements

Theory Paper II	F.M.: 100
Practical Paper Part II	F.M.: 50

	Total: 150 Marks

Recommended Readings:

1. Gupta, S.C. and Kapoor, V.K. (1977), Fundamental of Mathematical Statistics, S. Chand and Co.
2. Kapoor, J.N. and Saxena, H.C. (1963), Mathematical Statistics, S. Chand and Co.
3. Gupta, S.C. and Kapoor, V.K. (1984), Fundamental of Applied Statistics, Sultan Chand and Sons, New Delhi.
4. Goon, A.M. Gupta, M.K. and Das Gupta, B. (1976), Fundamentals of Statistics, Vol. II World Press, India.
5. Cochran, W.G. (1963), Sampling Techniques, Asia Publishing Co., India.
6. Singh, M.L. (1984), Official Statistics (Mimeographed Notes), Tribhuvan University, Nepal.
7. Ranjit, J.G. (1982), Design and Analysis of Experiments (Mimeographed Notes), T.C. Campus, Nepal.
8. Central Bureau of Statistics (1977), Analysis of Population Statistics of Nepal, Nepal.
9. Central Bureau of Statistics (1987), Population Monograph of Nepal, Nepal.
10. Shrestha, H.B. (1988), Elementary Statistical Methods, Orient Longman Ltd., Calcutta.
11. Singh, M.L. and Syami, S. An Introduction to Mathematical Demography (1990), J.M. Singh D.M. Mmandhar Publication, Kathmandu.

METEOROLOGY

Paper - II

Full Marks: 100

Group A - Climatology and Agriculture Meteorology.

Group B - Hydrology and Hydrometry

The students are required to answer any five questions selecting at least two from each group.

Group A

Climatology and Agriculture Meteorology

1. The atmosphere - The scope of climatology, Nature of the atmosphere, Origin of the atmosphere Composition of the atmosphere.
2. The fundamental physics of radiation - Nature of radiation, Black body radiation - Radiative transfer (General), solar radiation and insolation, Daily solar radiation incident on a horizontal surface at the top of the atmosphere, terrestrial radiation, Radiation in the free atmosphere. Disposition of solar radiation, depletion of solar radiation, radiation flux and cooling in the atmosphere, radiation charts, heat balance of the earth, Characteristics of Sun.
3. Atmospheric moisture - water vapour, physical states of water, cloud classification and formation, cloud observation, Fog precipitation - causes, forms and types, distribution precipitation regionally, seasonal variation of rainfall.

4. Air masses, their structure and modification - source regions of air masses, characteristics of air masses processes determining air-mass characteristics, ocean heat exchange and evaporation, the nature of vertical fluxes, summary of air masses modification.
5. Climatic classification - Approaches to climatic classification, Koppen's classification, The Thornthwaite's classification. Description of climatic - type. Seven types of climate. The dry climate. The warm temperate rainy climate, The snow forest climate, Polar climate.
6. Climate vegetation and soils - climatic factors in plant growth, climate as a factor in soil formation, soil erosion.
7. Applied climatology - climate and affairs of man, potential application of climatology, Existing applications of climatology.
8. Micro-climatology - Distribution of the meteorological elements in the microclimatic regions.

Agriculture Meteorology

1. Definition of Topoclimatology, meaning, scope and significance of microclimatology, definition and importance of agrometeorology, phytoclimate, improving the climate.

General effects of radiation on plant growth, basic process of photosynthesis,

saturation light intensity, and the efficiency of light utilization. Photosynthesis in relation to temperature, photosynthesis in relation to CO₂ concentration, Respiration and net photosynthesis, other factors affecting the rate of net photosynthesis.

3. Leaf transmissibility, leaf arrangement, radiation and light distribution within the canopy, photoperiodism, cardinal temperatures, Van Hoff's law, thermoperiodicity, leaf temperature.
4. Significance of soil temperature, thermal properties of soil, physical laws governing the change of soil temperature. Frost prevention of frost, soil temperature and crop yield, methods of modifying soil temperature.
5. Evaporation, evapotranspiration meteorological factors determining potential evapotranspiration, actual evapotranspiration. The effect plant height on the rate of evapotranspiration. Lysimeters, the energy budget equation, Bowen's Ratio.
6. Significance of soil moisture in agriculture, measurement of soil moisture, effect of precipitation on agriculture products.

Group B

Hydrology and Hydrometry:

Hydrology:

1. Introduction: Definition;, subdivisions of hydrology and its scope, history of hydrology in Nepal.
2. Hydrologic cycle and Run off cycle: Qualitative and quantitative aspects of hydrologic cycle, definition and sources of run off, the run off cycle, factors affecting run off.
3. Lakes: Origin, classification, hydrological and morphological characteristics of lakes, water balance, wind, ice and temperature effects.
4. The river basin: Descriptive study, drainage, divide drainage area, drainage pattern, stream order basin shape, drainage density.
5. Precipitation: Precipitation measurements, gauge location recording and non recording gauges: adjustment of data: double mass curve analysis, Computation of average precipitation, arithmetic mean polygan, isohyetal methods.
6. Stream flow: Classification of streams, site selection and gauging stations; general principles for design of network: general requirements, optimum network.
7. Infiltration: Definitions, factors affecting infiltration, relationship

between infiltration capacity and duration of rain fall.

8. Ground Water: Occurrence, sub surface water, sources and classification of ground water, ground water movement. Darcy's law, coefficient of permeability, ground water flow rates, permeability formulae, laboratory measurement of permeability tracing ground water movement.
9. Water quality: Parameters in water analysis, analysis of some major ions, units, water quality requirements for domestic, agricultural and industrial purposes.

Hydrometry:

1. Introduction: Definition and scope of hydrometry, history of hydrometry.
2. State discharge relationship control, non-unique relationship presentation and use, extrapolation, selection of hydrometric site; (net works): site conditions, network design.
3. Measurement of stage: Manual gauges, recording gauges, crest gauges.
4. Measurement of discharge: River stage, recorders, current meters: area velocity method, tracer method, weirs and flumes method, accuracies and errors, general stage measurements, discharge measurement, stage discharge relationship.

5. Sediment Sampling: Measurement of suspended sediment and bed load and laboratory procedures.
6. Snow cover: water equivalent, depth and extent of snow cover, ground survey, radioisotopes, snowgauges, natural gamma radiation.
7. Hydrograph analysis: Components of hydrograph unit hydrograph, shape of the hydrograph, separation of hydrographic components.

Practical Paper II

Full Marks: 50

1. Introduction to the meteorological observation (Metar, Speci)
2. To study the elements of upper air message (Pilot balloon and Radiosonde observations)
3. Plotting of the upper air message
4. Analysis of upper air charts
5. Pseudo adiabatic diagram analysis
6. Data extraction technique from pilot balloon observations
7. Preparation of route forecast
8. Preparation of area forecast.
9. Hydrological practicals.
10. Field work; Routine field works, manpower hazards field report, Inspection reports, gaugehouse, cable structures.

References:

1. General Climatology: Howard J. Critchfield.
2. Climate and Agriculture - Jen Hun Chang
3. Applied Hydrology - Ray K. Linsley, Max A Kohler and Joseph L.H. Paulhus,
4. Engineering Hydrology - J. Nemec, Tata McgRaw Hill.
5. Agriculture Physics - C.W. Rose
6. Introduction to Climatology, Trewartha.

OPTIONAL ENGLISH

Full Marks: 100

Course Structure

The course is divided into four areas: varieties, grammar, translation paraphrase, and extensive reading.

1. Varieties of English

Prescribed Texts:

- (a) Hawkins, William F. and Ronald Mackin, ed. English Studies Series 3, OUP, 1966.

The following lessons:

- (i) Can Life Exist on the Planets?
- Sir James Jeans
- (ii) Evolution and Natural Selection
- Sir W.C. Dampier
- (iii) Chance or Probability
- J. Bronowski
- (iv) Marconi and the Invention of Radio.
- Norman Wymer
- (v) Banting and the Discovery of Insulin. - Patrick Pringle
- (vi) Splitting the Atom
- Egon Larsen

- (b) Kaushik, R.K. and S.C. Bhatia, ed. Essays, Short Stories and One Act Plays, OUP, 1975.

The following lessons only:

- (i) Grief - Anton Chekov
- (ii) The Doll's House
- Katherine Mansfield
- (iii) How Much Land Does a Man Need?
- Leo Tolstoy

(iv) A Marriage Proposal - Anton Chekov

(v) The Boy Comes Home - A.A. Milne

(vi) The Monkey's Paw - W.W. Jacobs

2. Grammar

Prescribed Text:

Leech, Geoffery and Jan Svartvik, *A Communicative Grammar of English*, London: Longman, 1975.

The following parts:

1. Part one: Varieties of English
2. Part Two: Intonation
3. Part three: Grammar in Use

3. Translation/Paraphrase

Any book(s) containing wide varieties of translation and paraphrasing materials (Paraphrasing for non-Nepali students only. Translation from Nepali to English for all Nepali students).

4. Extensive Reading

Prescribed Text:

Golding, William, *Lord of the Flies*, London: Faber and Faber, 1954. (for non-detailed study).

Evaluation Scheme

Reading and writing	50 %
Grammar	30 %
Translation	20 %

TEXT BOOK