

# Courses of Study

## Bachelor

### First Year



Institute of Science & Technology

2048/1991

Curriculum Development Centre

Tribhuvan University, Kirtipur

Kathmandu, Nepal

**First Published 1991**

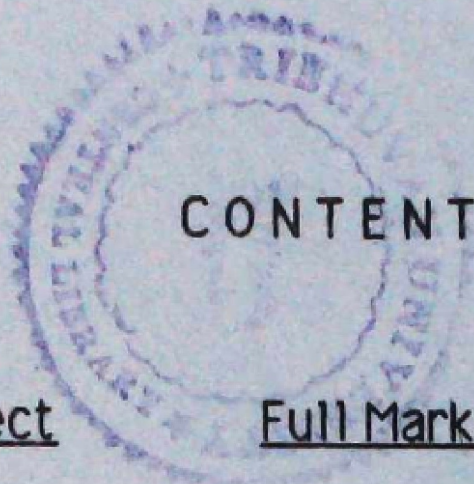
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**Price :**

**Printed by :**

**Tribhuvan University Press, Kirtipur,  
Kathmandu, NEPAL**



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**PHYSICS****Paper****Full Marks: 100****Section A****Mechanics**

1. Frames of Reference: Inertial frames and Galilean transformation.
2. Work and energy: Conservative force and potential energy, Electric potential, Electric volt, Gravitational potential and escape velocity, Gravitational potential due to a spherical shell and a solid sphere.
3. Conservation of linear momentum, Rocket, Collision of particles, Angular momentum and torque, Central forces and reduced mass.
4. Equations of motion for a rigid body, Angular momentum vector, Moment of inertia, Theorems of perpendicular and parallel axes, Moment of inertia of solid - rectangular, circular lamina, solid sphere and spherical shell, Effect of torque on rotating rigid bodies, Kinetic energy of rotation.
5. Oscillator in a potential well, Harmonic oscillator, Equation and energy, Simple, Compound & torsional pendulum, Helmholtz resonator, Damping force; Damped harmonic, Quality factor, Critical damping.
6. Bending of a bar, Modulus of rigidity, Tension of cylinder, Interrelation between elastic moduli, Poisson's ratio, and its determinations, Coefficient of viscosity, Flow through a capillary tube, Limitations of Poiseuille's formula.

7. Relativity: Ether as a medium for light waves, Michelson - Morley experiment, Lorentz transformation, Relativity of time and length, Addition of velocities, Mass-energy relation.

### **Waves**

1. One dimensional waves, wave equation and propagation constant, Transverse waves in strings, Wave velocity, Energy and its rate of flow, Velocity of longitudinal waves in rods and in fluids, linear bounded medium.
2. Stationary waves, Modes-vibration, Accoustic impedance, Reflection at junction of two linear media.

## **Section B**

### **Thermodynamics and Statistical Physics**

#### **Thermodynamics:**

1. Fundamental concepts, Internal and external energy, States of a molecule, Properties of bulk matter, Nature of thermal energy; Equilibrium, Thermodynamic variables of a system, Scope of thermodynamics.
2. **First Law of Thermodynamics:**  
Temperature, Zeroth law of thermodynamics, Scale of temperature, Fixed points, International temperature scale, Constant volume hydrogen gas thermometer, Absolute scale of temperature, Platinum resistance thermometer, Callendar & Griffiths bridge, Thermocouple thermometer, Kelvin scale of temperature, Equation of state, Work, work done in volume expansion, Indicator diagram for a gas, First law of thermodynamics,

First law and internal energy, Two specific heats, Joule's law and perfect gas, Difference of two specific heats of a perfect gas, Quasi-static Processes, Isothermal, Isobaric, Isochoric cycle and adiabatic processes, Adiabatic process in a perfect gas, Clement-Desormes method for  $C_p/C_v$ .

### 3. Kinetic Theory and Real Gases

Introduction, Perfect gas, RMS speed of molecules, specific heat of a monatomic and diatomic perfect gases, Distribution of speeds among the molecules, Van der Waals equation of state, Joule-Thomson expansion of a real gas, Nature of Van der Waals forces, Joule-Thomson expansion, Distinction between Joule expansion, Joule-Thomson expansion and adiabatic expansion of a gas, Change of temperature in Joule-Thomson expansion.

### 4. Second Law of Thermodynamics

Introduction, Insufficiency of the first law of thermodynamics, Heat engine, Efficiency of a heat engine, Carnot engine, Energy transformation in a Carnot cycle, Reversible and irreversible processes and cycles, Carnot's theorem and the second law of thermodynamics, Entropy, Entropy-temperature diagram, Principle of increase of entropy, comments on the second law, Thermodynamic scale of temperature, Identity of perfect gas scale and Kelvin scale.

### 5. Thermodynamical Relationships

Single valued functions of state, Intensive and extensive parameters, Maxwell's Thermodynamical relationships, Useful manipulations with partial derivatives, P - V - T surfaces for ideal gas, Co and H<sub>2</sub>O. Triple point & critical point, Clausius-Clapeyron latent heat equation, the Joule-Thomson effect and regenerative cooling.

## 6. **Black-body Radiation**

Black body, Energy density and energy flux of radiation, Radiations inside a hollow enclosure, Kirchhoff's law, Stefan-Boltzmann law, Pressure of radiation, Wien's displacement law (only introduction) and its application, Planck oscillator and Planck's formula (without derivation), Solar constant & temperature of the sun, Angstrom's pyrheliometer.

## **Statistical Physics**

### 1. **Background of the Statistical Method**

Introduction, Distribution of particles in a box, Calculation of probability distribution with increasing equilibrium and fluctuations, Terms used in statistical mechanics, Ensemble and average properties, Constraints, Energywise distribution.

### 2. **General Theorems in Statistical Mechanics**

Phase space representation, Phase space into cells, Methodology of statistical mechanics, The  $\Omega(E)$  function, Two systems in thermal contact, entropy and probability, The Boltzmann canonical distribution, Equipartition of energy.

### 3 **Statistics of Molecules in a Gas**

Introduction, Distribution for  $N$  molecules in volume  $V$ , Relations between energy, temperature and entropy, Distribution of speed, velocity, energy in molecules of a gas, Maxwellian velocity distribution and its discussion, Maxwellian speed distribution and its discussion, Interpretation of temperature.

### 4. **Bose-Einstein and Fermi-Dirac Statistics**

Introduction, Fermi-Dirac distribution, Bose-Einstein distribution and Maxwell-Boltzmann distribution. The three statistics and their

formulae, Distribution function in the three statistics and their discussion.

### 5. **Transport Phenomena in Gases.**

Introduction, Molecular collisions, Collision, Diameter, Mean free path, Mean free time, Collision Cross-section, Thermal conduction, Isothermal surfaces, Thermal resistance, Periodic heat wave & thermometric conductivity, Thermal conductivity of bad conductors (Lees & Charlton Lab. method).

## **Section C**

### **Vector**

1. Review of scalar and vector, Product of two or more vectors, Differentiation and integration of a vector, Gradient of a scalar, Vector differential operator, Divergence of a vector, Laplace's operator, Curl of a vector, Physical interpretation of gradient, divergence and curl.

2. Charges and fields: Gauss's theorem and its different applications.

### 3. **Electric Potential and Field**

Electric potential and line integral, Gradient of an electric potential field, Conductor in an electric field, Electrical image, Divergence theorem of Gauss, Poisson's equation, Laplace's equations, and uniqueness theorem, Stoke's theorem.

### 4. **Electric Field in Matter**

Dielectrics, Pot. & field due to a short dipole, Atomic and molecular dipole. Induced dipole moments.

### 5. **Electric Currents**

Electric current and current density, Stationary current, R-C circuits, charging and discharging of a capacitor through a resistor, Measurement

of high resistance by leakage.

### 6. **Magnetic Field**

Ampere's theorem, Biot & Savart's law, Field on the axis of a circular coil and application, Force due to magnetic field on current and charge, Line integral of a magnetic field, curl & divergence of magnetic field.

### 7. **Electromagnetic Induction**

Conducting rod moving through a magnetic field, closed circuit field, Maxwell equation & electromagnetic waves in free space, Ballistic galvanometer - Fluxmeter, Inductance - mutual inductance-circuit containing L-R, R-C, Magnetic vector potential.

### 8. **Magnetic Properties of Matter**

Magnetic poles & dipoles, Magnetic field with matter, magnetic susceptibility.

Classical theory of magnetism-dia, Para & ferromagnetism.

Atomic theory of magnetism, Hysteresis.

### 9. **A.C. Circuits**

Natural oscillation, LCR circuit & quality factor of the circuit, L-R-resonant circuit, (series & parallel) - sharpness of resonance-measurement of powers, energy, Choke coil, Complex number representation of A.C., Admittance & Impedance, A.C. bridges (a) De Sauty bridge (b) Anderson's bridge (c) Owen's bridge, Transformers, A.C. Mains, Transmission Line.

**Practical 1**

Full Marks 50

The students are required to complete 16 experiments (choosing at least 4 experiments from each group) in the 1st year and they are required to complete 12 experiments (choosing at least 3 experiments from each group in the 2nd year).

**A. Mechanics**

1. Fly wheel: Determination of moment of inertia.
2. Compound pendulum: Determination of  $g$ , and ratio of gyration.
3. Bending of beams: Determination of Young's modulus of elasticity.
4. Determination of surface tension of water by capillary tube method.
5. Viscosity (Poiseuille's method): Determination of coefficient of viscosity by Poiseuille's method.

**B. Heat**

1. Platinum resistance thermometer: Measurement of high temperature.
2. Stefan's law of radiation: Measurement of Stefan's constant.
3. Callender Barne's experiment-steady flow: Determinant of  $J$ .
5. Characteristics of thermocouple.

**C. Light**

1. Measurement of wavelength by:
  - a) Newton's ring
  - b) Bi-prism
  - c) Michelson's interferometer

## d) Grating

2. Refractive index by prism spectrometer
3. Analysis of polarised light by Babinet's compensator
4. Specific rotation by polarimeter.

**Electricity and Magnetism**

1. Ballistic galvanometer: sensitivity
2. Low resistance: Carey-Foster bridge
3. High resistance: Leakage method
4. Calibration of ammeter and voltmeter
5. Absolute capacity: Ballistic galvanometer
6. Power factor factor
7. Susceptibility of liquids
8. Search coil - magnetic flux density
9. Helmholtz coil - magnetic flux density
10. Time constant - charging and discharging method
11. Earth inductor: Angle of DIP.

**Textbooks**

1. Mechanics - J.K. Ghose, Shivalal Agrawal & Company, Agra, 1968.
2. Thermodynamics and Statistical Physics - D.P. Khandelwal & S. Lokanathan
3. Electricity and Electronics - J.K. Ghose, Shivalal Agrawal and Company, Agra, 1968.

**References**

1. A textbook of Mechanics - D.N. Bhargava and G.S. Sharma. - Ratan Prakashan Mandir, Agra, 1974.
2. Elements of Mechanics - Gupta, Prakash and Agrawal, Pragati Prakashan, Meerut, 1982.

3. Relativity, Mechanics and Statistical Physics - D.S. Mann and P.K. Mukherjee, Wiley Eastern Limited, New Delhi, 1982.
4. An Introduction to Thermodynamics, the Kinetic Theory - F.W. Sears, Addison - Wesley Co, 1975.
5. A Textbook on Heat - J.B. Rajam, S. Chand & Company Ltd. New Delhi, 1983.
6. Electricity and Magnetism - D.N. Vasudev, S. Chand & Co., Delhi, 1968.

**CHEMISTRY****Paper I****Full Marks: 100****Section A. Physical****Atomic Structure**

Bohr's theory and hydrogen spectra, Sommerfield model, quantum numbers, concept of s, p, and d orbital, and quantum designation of electrons. Hund's rule, Pauli exclusion principle, Heisenberg's uncertainty principle, Schroedinger's wave equation (qualitative idea only).

**Radioactivity**

Radioactive radiations, radioactive disintegration, isotopes, their separation and uses, half life determination, detection and measurement of radioactivity (elementary concept), nuclear fission and fusion, stellar energy.

**Kinetic Theory**

Kinetic equation and derivation of gas laws, deviations from ideal behaviour and Van-Der-Wall's equation, critical phenomena, liquification of gases, distribution of molecular velocities.

**Chemical Equilibrium**

Law of mass action and its applications to homogeneous equilibrium, relation between  $K_p$  and  $K_c$ , criteria of chemical equilibrium, effect of temperature, pressure and components on chemical equilibrium, Le-chatelier's principle and its applications.

## **Laws of Dilute Solutions**

Raoult's law and determination of vapour pressure lowering, laws of elevation of boiling point and depression of freezing point and determination of molecular weight, abnormalities in solution due to association and dissociation.

## **Osmotic Pressure**

Osmotic pressure, laws of osmotic pressure, determination of osmotic pressure.

## **Electrochemistry**

Specific conductance equivalent and molecular conductance, variation of conductance with dilution, transport number, Kohlrauchs's law, Ostwald's dilution law, common ion effect, solubility product principle, pH and buffer.

## **Chemical Kinetics**

Order and molecularity, rate equations for first, second and third order reactions, determination of order of reaction, activation energy and activated complexes.

## **Section B: Inorganic**

### **Chemical Periodicity**

Variation of the following properties in the periodic table: valency, electronegativity, ionization potential, atomic and ionic radii.

### **Atomic Properties**

Ionization potential, electron affinity, electronegativity, atomic and ionic radii.

### **Elementary Idea of Quantum Mechanical Theories of Valency:**

## **Ionic Compound**

Structures of ionic solids, ionic compounds of type AX (ZnS, NaCl, CsCl), ionic compounds of type AX<sub>2</sub>(CaF<sub>2</sub>, TiO<sub>2</sub>) layer structures, Stoichiometric and nonstoichiometric defects.

## **Principles of Qualitative and Quantitative Analysis**

Solubility product, principle, commonion effect, Reactions underlying group separation, principles of gravimetric and volumetric analysis.

## **Co-ordination Complexes:**

Werner's theory, nomenclature, isomerism, valence bond theory, Crystal field theory (Elementary concept).

## **Group Discussions**

Group study of Gr. IA & B.

Chemistry of Ag, Li.

Group Study of II A & B, Group III B (B, Al), IVB (C, Si, Sn, Pb), VB (N, P, As, Sb, Bi), VI B (S, Se, Te), VII B (F, Cl, Br, I), VII A (Fe, Co, Ni), Zero group (He, Ne, Ar, Kr, Xe).

## **Chemistry of following Elements and Compounds**

Chemistry of Be, Al, B, Si, Sn.

Fixation of nitrogen, nitrogen, potassium & phosphorus fertilizers, hydrazine, hydroxylamine, hydrozoic acid, oxides, and oxyacids of Phosphorus, Hydrogen Peroxide, Ozone, Peracids of sulphur.

Sodium thiosulphate.

Chemistry of Fluorine, Oxides & Oxyacids of Cl<sub>2</sub>, Br<sub>2</sub>, and I<sub>2</sub>.

Chemistry of Ti, V, Mn, Cr & Ni.

Chemistry of Argon

Types of bonds, ionic bonds, covalent bonds, coordinate bonds, metallic bonds, hydrogen bonds, double and triple bonds, hybridization of sigma and pi bonds, molecular orbital methods, LCAO method, united atom method.

**Practical Paper I****Full Marks: 50**

Systematic qualitative analysis of the mixtures of inorganic salt containing not more than 4 radical (two cations and two anions). Volumetric analysis involving acidimetry and alkalimetry. Volumetric analysis involving redox titrations (permanganometry) and estimation of iron in Mohr's salt. Volumetric estimation of Ca in  $\text{CaCO}_3$ . Iodometric and precipitation titrations (argentrimetry).

**Recommended Books**

1. Modern Inorganic Chemistry : R.C. Agrawal.
2. Concept of Inorganic Chemistry : J.D. Lee
3. Modern Inorganic Chemistry : Satya Prakash
4. Advanced Inorganic Chemistry: Cotton and Wilkinson.
5. Inorganic Chemistry : T. Moellor
6. Essentials of Physical Chemistry: B.S. Bahl.

## MATHEMATICS

The syllabus demands understanding of basic mathematical concepts and their applications, together with an ability to show this by clear expressions and careful reasoning. In the examination, skills in algebraic manipulations and numerical accuracy in calculation will be expected.

The present courses of study is a blend of the 'modern' and 'traditional' approaches to the subject and retains the important feature of freedom of reasonable choice at every stage. Different campuses may prepare candidates for one or more options. Particular attention is also paid to the interests of the following groups of students:

- (a) those taking Mathematics at Master Level and
- (b) those not taking Mathematics at Master Level.

Pre-requisite: Proficiency Certificate Level Mathematics.

In the examination, there will be three hour papers, two papers in the first year (Part I) and one paper in the second year (Part II); and each will be of 100 marks. Each paper may contain questions on any part of the syllabus. The papers are as follows:

Paper : I

Full Marks: 100

### Calculus and Analytical Geometry

Paper I will contain four sections A,B,C, and D. There will be 12 questions, 4 from section A, 2 from B, 2 from section C and 4 from section D. The candidates may answer any SEVEN questions

selecting **at least** 1 from each sections B and C and 2 from each sections A and D. Each question will carry 14 marks and the remaining 2 marks will be allotted according to the following scheme:

2 Marks for students securing marks between 66 and above.

1 Mark for students securing marks between 33-65.

The breakdown of paper I into various sections together with the number (H) of lecture-hours per week, the number (Q) of questions to each sections and the minimum number (A) of questions to be answered in each section, is given below:

Section	Topic	(H)	(Q)	(A)	(+)
A	Differential Calculus	2	4	2	1
B	Integral Calculus	1	2	1	To be chosen from any section
C	Differential Equation	1	2	1	
D	Analytical Geometry	<u>2</u>	<u>4</u>	<u>2</u>	—
Total		6	12	6	+ 1 = 7

### Courses

#### Paper I: Calculus and Analytical Geometry

##### Section A: Differential Calculus (4 questions)

1. Successive differentiation and expansions of functions.
2. Partial differentiation, Euler's theorem, indeterminate forms.
3. Tangents and normals, curvatures.
4. Maxima and minima of functions of one variable, asymptotes and curve tracing.

**Section B: Integral Calculus (2 questions)**

1. Definite and indefinite integrals, reduction formulae, uses of Beta and Gamma functions.
2. Rectification, quadrature, volume and surface areas of solids of revolution.

**Section C: Differential Equations (2 questions)**

1. First order (first and higher degree) ordinary differential equations.
2. Linear differential equations with constant coefficients and homogeneous linear differential equations.

**Section D: Analytical Geometry (4 questions)**

1. Ellipse and hyperbola, Polar Equation of a conic, section, General Equation of Second Degree representing conic Section.
2. Straight Lines
3. Sphere and Cones
4. Central Conicoids.

**Paper II**

Full Marks 100

**Algebra and Analysis**

Paper II will contain two sections A and B. There will be 12 questions, 6 from section A and 6 from section B. The candidates may answer any SEVEN questions selecting **at least** three from each section. Each question will carry 14 marks and the remaining 2 marks will be allotted according to the scheme mentioned in Paper I.

The breakdown of Paper II into various sections together with the number (H) of lecture-hours per week, the number (A) of questions to be asked in each section and the minimum number (A) of questions to be answered in each section, is given below:

Sections	Topics	Particulars	(H)	(Q)	(A)	(+)
A	Algebra	Linear Algebra	4	2	2	One question to be chosen from any section
		Group & Rings	$1\frac{1}{2} + 1\frac{1}{2}$	1	1	
B	Analysis	First four topics	4	2	2	section
		Last two topics	2	1	1	
Total			6	12	6 + 1 = 7	

### Paper II: Algebra and Analysis

#### Section A: Algebra (6 questions)

1. Matrices and Determinants
2. Groups
3. Rings
4. Vectors in Euclidean n-space
5. Vector spaces and subspaces
6. Linear Transformations, Eigenvalues and Eigenvector.

#### Section B: Analysis (6 questions)

1. Real Number System and Elements of Set Theory
2. Metric Sets and Limits
3. Numerical Sequences and Series
4. Continuity Uniform Continuity
5. Differentiation
6. Integration.

## Recommended Books

### Paper I

1. B.C. Das and B.N. Mukherjee: Differential Calculus, U.N. Dhur & Sons, Calcutta, 1981.
2. B.C. Das and B.N. Mukherjee: Integral Calculus, U.N. Dhur & Sons, Calcutta, 1981.
3. S.L. Loney: Coordinate Geometry, Macmillan and Co., Calcutta, 1988.
4. G.T. Bell: An Elementary Treatise on Coordinate Geometry, Macmillan & Co., Calcutta, 1987.
5. M.R. Joshi: An Analytical Geometry, Sukunda Pustak Bhawan, 1990.
6. T.N. Vaidya: An Elementary Treatise on Differential Equations, T. Vaidya, Kathmandu, 1990.

### Part I Paper II

1. R.M. Shrestha, S. Bajracharya: Elementary Linear Algebra, Sukunda Pustak Bhawan, Kathmandu, 1990.
2. G.D. Pant: Algebra, A. Pant, Kathmandu, 1987.
3. A.H. Smith, W.A. Albrecht: Fundamental Concept of Analysis, Prentices Hall of India, New Delhi, 1987.
4. Linear Algebra: Serge Lang, Addison & Wesley PC.
5. Topics in Algebra: I.N. Herstein, Vikash Publishing House.

N.B. : Details courses should be consulted.

**BOTANY**

There shall be one theory paper of three hours duration carrying 100 marks and one practical paper of six hours duration carrying 50 marks in each academic year.

Every student is required to pass separately in each of theory and practical paper.

**Paper I****Full Marks: 100****Algae**

- A. General account of the classification, characteristics and economic importance of algae.
- B. Structure and life cycle of the following types:  
**Oscillatoria, Chlamydomonas, Volvox,  
 Oedogonium, Vaucheria, Chara, Fucus, and  
 Batrachospermum.**

**Fungi**

- A. General account of the classification, characteristics and economic importance of fungi.
2. Structure and life cycle of the following types:  
**Albugo, Saprolegnia, Eurotium, Peziza, Puccinia,  
 Agaricus and Alternaria.**
- C Structure and reproduction of bacteria; structure, chemical composition reproduction and economic importance of viruses; structure, types and economic importance of lichens.

**Bryophyta**

General account of the classification, characteristics, development of sex organs,

life cycle and evolution of the sporophyte with reference to the following types  
**Riccia, Marchantia, Peltia, Anthoceros** and **Polytrichum** .

### **Pteridophyta**

General account of the classification, characteristics, stelar system, development of sex organs and life cycle with reference to the following types:

**Lycopodium, Selaginella, Equisetum** and **Marsilea**

### **Gymnosperms**

A. General account of the classification, characteristics, distribution and economic importance of gymnosperms.

B. Structure and life cycle of the following types:

**Cycas, Pinus.**

### **Paleobotany**

Introduction, types of fossil formation, general survey of different geological eras and periods with their dominant vegetation.

### **Cytology and Genetics**

1. History of cytology and genetics, structure of cell and cell organelles.
2. Mitosis and meiosis.
3. Morphology, chemistry and duplication of chromosomes.
4. Process and significance of crossing-over, chiasma formation and linkage (complete and incomplete).

5. Elementary ideas of chromosomal abberation, polyploidy and mutation.
6. Sex-chromosome and sex linked inheritance.
7. Mendel's laws of inheritance, expression and interaction of genes.

### Evolution

1. Origin of life
2. Theories and evidences of Evolution.

### Practical Paper I

Full Marks: 50

1. Study of the habit, structure of vegetative and reproductive parts of the following types:  
**Oscillatoria, Chlamydomonas, Volvox, Oedogonium,, Vauchèria, Chara, Fucus and Batrachospermum.**
2. Study of the habit, structure of vegetative and reproductive parts of the following types:  
**Albugo, Saprolegnia, Eurotium, Peziza, Puccinia, Agaricus and Alternaria.**
3. Gram positive and gram negative staining of bacteria.
4. Study of structures of a typical lichen.
5. Study of the habit, external and internal structure of vegetative and reproductive parts of **Riccia, Marchantia, Peltia, Anthoceros and Polytrichum .**
6. Study of the habit, external and internal structures of vegetative and reproductive parts of **Lycopodium, Selaginella, Equisetum and Marsilea.**

7. Study of the habit, external and internal structures of vegetative and reproductive parts of **Cycas** and **Pinus**
8. a) Preparation of  
 i) Pre-treating agents ii) Fixatives, iii) Stains
- b) To study the different Stages of mitosis and meiosis and count the chromosome numbers.

### Recommended books

Dube, H.C. : A Textbook of Fungi, Bacteria and Viruses.

Alexopoulos, C.J.: Introductory Mycology.

Pandey, B.P. : Economic Botany, S. Chand & Co. Ltd., New Delhi.

Pandey, S.N. & P.S. Tribedi: A Textbook of Botany, Vol. I, Vikas Publishing House Pvt. Ltd., New Delhi.

Pandey, S.N., S.P. Mishra & P.S. Trivedi: Textbook of Botany, Vikas Pub. House Pvt. Ltd., New Delhi, 1982.

Smith G.M. : Cryptogamic Botany, Vol. I. & II, McGraw, Hill Book Company, Inc., N.Y.

Brij Gopal & N. Bhardwaj: Elements of Ecology, Vikas Pub. House Pvt Ltd., New Delhi.

Odum, E.P. : Fundamental of Ecology.

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.

Lawrence, G.H.M.: Taxonomy of Vascular Plants, Oxford & IBH Pub. Co., New Delhi.

Noggle, G.R. & G.F. Fritz: Introductory Plant Physiology, Prentice Hall of India Pvt. Ltd., New Delhi .

Gangulee, H.C. and A.K. Kar: College Botany Vol. I and Vol. II, New Central Book Agency, Calcutta.

Sporne, K.R. The Morphology of Gymnosperms.

Sporne, K.R. : The Morphology of Gymnosperms B.I. Pub, Delhi.

Stanton, J.D.A.: Forests of Nepal, John Murray London.

Sinnot, E.W., L.C. Dunn and Dobzhansky; Principle of Genetics, McGraw Hill Book Company, Inc., N.Y.

Swanson, C.P., T. Merz & W.J. Young. Cytogenetics. Prentice Hall of India Pvt. Ltd., New Delhi.

Garbeer, E.D.: Cytogenetics: An Introduction, McGraw Hill Book Company, N.Y.

Sinha, V & S. Sinha : Cytogenetics, Plant Breeding and Evolution, Vikas Pub. House Pvt. Ltd., New Delhi.

Singleton, W.R. : Elementary Genetics, New Delhi: Affiliated East West Press Pvt. Ltd.

Pandey, B.P. Plant Anatomy, S. Chand & Company Ltd. New Delhi.

Esau, K. : Plant Anatomy, John Willey & Sons Inc. N.Y.

Vasistha, P.C. : A Textbook of Plant Anatomy S. Nagin & Co., Delhi.

Dube, H.C.: A Textbook of Fungi, Bacteria and Virus, Vikas Pub. House Pvt. Ltd. New Delhi.

Gupta R.K. : Textbook of Systematic Botany, Atma Ram & Sons, Delhi.

Arnold, C.A. : An Introduction to Paleobotany, McGraw Hill Book Co., N.Y.

Parihar, N.S. : An Introduction to Embryophyta. Vol. I Bryophytes, Vol. II Pteriodophytes, Central Book Depot, Allahabad.

Devlin, R.M. : Plant Physiology, Affiliated East West Press Pvt. Ltd. New Delhi.

Meyer, B.S., D.B. Anderson, R.H. Bohning and D.G. Frakamme: Introduction to Plant Physiology. Van Nastrand N.Y.

Bhojwani, S.S. and S.P. Bhanthnagar: The Embryology of Angiosperms, Vikas Pub. House Pvt. Ltd., New Delhi.

## ZOOLOGY

There shall be two theory papers each of three hours duration carrying 100 marks and two practical papers each carrying 50 marks of six hours duration.

Also includes the courses of Proficiency Certificate Level (I.Sc.). Students have to pass separately in theory and practical papers.

**Paper I: (125) Periods:-****Full Marks 100**

1. Classification of Protozoa, Porifera, Coelenterata, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca and Echinodermata (upto orders, 18 periods).
2. Structure (External features), Reproduction and life-history of Vorticella, Obelia, Fasciola, Ascaris, Hirudo and Musca . (18 periods).
3. Canal system of Sycon, Organ systems of Palaemon, Mouth-parts of insects, Organ systems of Pila, External features of Asterias. (32 periods).
4. Evidences of Organic Evolution. (2 periods).
5. Mendel's laws of heredity, Action and interaction of genes, Sex determination, Sex-linked characters and inheritances. (8 periods).
6. Organisation of an animal cell. Structure and functions of cell membrane, Mitochondria, Golgi complex, Lysosome, Ribosome, Endoplasmic reticulum, Nucleus, Nucleolus, Cilia and Flagella. Structure, types and functions of chromosomes, Cell respiration (Glycolysis and Citric-acid cycle). Cell-excretion (Ornithine cycle). (18 periods).

7. Protective behaviour - Colouration and Mimicry. Animal relationship in relation to Predation, Parasitism, Mutualism & Commensalism. (6 periods).
8. Structure, life cycle and economic importance of Giardia, Taenia, and Wuchereria. Life-history, nature of damage, and control of Leptocorisa chinensis (in paddy), Sitophilus oryzae (stored grain). (15 periods).
9. Biological Principles and Management of Sericulture and Pisciculture. (6 periods).

**Practical Paper: I****Full Marks: 50**

1. Major Dissection of the following animals:- (15)

- (a) Alimentary canal of Leech.
- (b) Nephridial and Reproductive Systems of Leech.
- (c) Nervous System of Palaemon (Prawn).
- (d) Nervous System of Pila.
- (e) Appendages of Prawn.

2. Permanent Slide Preparation of the following:- (8)

- (a) Jaw of Leech.
- (b) Radula of Pila.
- (c) Statocysts of Prawn.
- (d) Mouth Parts of Houeybee, Housefly, Butterfly, and Mosquito.

3. Identification and comments upon the spots:- (12)

(a) Museum specimens representing various classes of different Phyla belonging to Invertebrate.

(i) Permanent slides representing histology of various cells, tissues and organs of invertebrate organisms.

(ii) Permanent slides of larval forms or whole mount preparation of various invertebrate organisms.

A. Protozoa - Amoeba, Paramecium, Euglena, Vorticella, Monocystis, Plasmodium, Giardia or other available materials of Protozoa.

B. Porifera - Sycon, Euspongia, Hornysponge, gemmules and spicules of sponges or other available material of Porifera.

C. Coelenterata - Hydra, Obelia, Medusa of Obelia, Pennaria, Sertularia, Plumularia, Companularia, Physalia, Porpita, Veella, Aurelia, Metridium, Tubipora, Gorgonia, Pennatula, Adamsia or other available specimens.

D. Platyhelminthes - Fasciola hepatica, Taenia solium, Planaria; (Miracidium, Sporocysts, Redia, Cercaria) larvae of Fasciola hepatica. Mature proglottid, T.S. of mature proglottid of Taenia sp. and Cysticercus larva or other available specimens.

E. Nematelminthes - Ascaris ♂ and ♀ Wuchereria bancrofti and T.S. of ♂ and ♀ Ascaris (mature) or other available specimens.

- F. Annelida - Pheretima (Earthworm), Hirudo (Leech), Nereis, Heteronereis, Aphrodite, Glycera, Chaetopterus, Arenicola, Amphitrite, Sipunculus.  
T.S. of body through crop and its diverticula of Leech or other available specimens.
- G. Arthropoda - Prawn, Daphnia, Cypris, Cyclops, Lepus, Lepisma, Balanus, Squilla, Hermitcrab, Crab, Scorpion, Limulus, Spider, Julus, Scolopendra, Grass-hopper, Honeybee, Moth, Butterfly, cricket, Gryllotalpa, Praying mantis, Stick insect, Dragonfly, Belostoma, Nepa, Beetle, Leptocorisa, sp., Sitophilus oryzae or other available specimens.
- H. Mollusca - Pila, Unio, Mytilus, Pecten, Teredo, Aplysia, Cypraea, Dentalium, Chiton, Nautilus, Sepia, Loligo, Octopus or other available specimens.
- I. Echinodermata - Starfish, Thyone, Antedon, Cucumaria, Echinarachinus (Sand dollar), Seaurchin, Clypeaster or other available specimens.

4. Viva-Voce (10)

5. Practical Record (5)

N.B.: Museum specimens representing various classes of different phyla should be given for general survey of animals as far as possible.

#### Recommended Textbooks (Latest editions).

1. Textbook of Zoology - Parker and Hasswell, Vol. I.
2. Invertebrate Zoology - S.N. Prasad
3. Physiology & Ecology - Sembha Siviah Rao & Chelliappa

**Reference**

1. Invertebrate - Kotpal Series
2. Invertebrate Zoology - T.C. Majpuria
3. Pheretima - K.N. Bahl
4. Hirudinaria - M.L. Bhatia
5. Cell Biology - De. Robrtis
6. Cell Biology - S.S. Khanna
7. Principles of Genetics - Sinnot, Dunn & Dobzhansky
8. Genetics - Verma and Agrawal
9. Organic Evolution - Lull
10. Organic Evolution - Kormonday
11. A Guide to Human Parasitology - Blacklock & Southwell.

**GEOLOGY****B.Sc. Geology**

Candidates who have passed the Proficiency Certificate or equivalent Examination with science subject from Tribhuvan University or any equivalent examination of other Universities or Institutions are eligible for admission to the B.Sc. course in geology. The combination of geology will be with any two of the following: Physics, Chemistry, Mathematics, Statistics, Botany and Zoology.

The B.Sc. course in geology shall run for two academic years. Candidates will be examined at the end of each year in respective courses in theory, practicals, etc. The total aggregate of marks for the two years of B.Sc. in Geology will be 300. The distribution of marks is shown below.

Each theory paper shall be of three hours duration and each practical examination will be for 4 hours. Field work for a period of 4 weeks is compulsory and will carry 20 marks. Besides this there will be field trips of short duration to areas of geological importance around Kathmandu. These trips are arranged to apprise the students of the regional geological aspects.

**First Year**

<u>Theory</u>	Lecturs. p/w	Marks
Paper 1. Physical geology	2	100
Structural geology and Surveying	2	
Crystallography and Minerology	2	
Practical	Pract. Class/w	Marks
Paper 1. (Related to theory paper I)	2	40

## A. PHYSICAL GEOLOGY

The science of geology, its various branches, scope and application, method of study, origin of the Earth, shape and surface relief of the Earth, the key to the past, the succession of strata, significance of fossils, crustal movements, and geological time-scale; atmosphere, hydrosphere and lithosphere and their constituents, rock weathering and soils, underground water, surface erosion and landscapes, the work of rivers, development of river systems, and associated landscapes, glaciers and glaciation, ice ages and their problems, wind action and desert landscapes; oceans and shore lines.

Earthquake and the Earth's interior, isostasy, igneous activity and volcanos. Diastrophism. Introduction to Plate tectonics and mountain building processes.

## B. STRUCTURAL GEOLOGY AND SURVEYING

### a. STRUCTURAL GEOLOGY

Definition, scope of structural geology and its relation to other branches of geology. Attitude of a line (trend, plunge and pitch) and a plane (strike and dip). Introduction to force, stress and strain. Parts of fold, various schemes of classification of folds, cylindrical and noncylindrical folds, drag folds, field study of folds. Criteria for recognition of folds.

Joints: Definition, principles of failure by rupture, classification.

Faults: Description and classification of faults, criteria for recognition of faults.

**Unconformity:** Definition, kinds of unconformities, recognition of unconformities in the field.

**Cleavage and schistosity:** Secondary lineations - kinds and origin. Primary sedimentary structures, stress of extrusive and intrusive igneous rocks and their significance in structural geology.

## **b. SURVEYING**

Objectives of surveying, scope of topographical surveying, topographic maps and their use in geology. Important surveying instruments (their various parts, and use), prismatic and brunton, compass, theodolite, telescopic alidade, dumpy level, Abney's level, chain survey, plane table survey, prismatic compass survey, aerial photo study.

## **C. CRYSTALLOGRAPHY AND MINERALOGY**

### **a. CRYSTALLOGRAPHY**

Introduction, Structure of crystals. Properties of crystals. Crystal symmetry. Symmetry classes. Crystal systems. Axial ratio. Parameters. Indices. Forms. Zones. Elements of crystal projections. Crystallographic axes, form symbols, symmetry, forms and examples of normal class of crystal systems. Twin crystals. Crystal habit and crystalline aggregates.

### **b. MINERALOGY**

Introduction to mineralogy. Physical criteria of identifying minerals: Cleavage, parting and fracture, hardness, tenacity, specific gravity, lusture, colour, streak, play of colours, chatoyancy and asterism, luminescence and special properties.

Nature of light, reflection, refraction, total reflection and the critical angle. Isotropic and anisotropic crystals. Polarised light. Nicol prism and the polarising microscope. Isotropic crystals and the Becke line. Uniaxial and biaxial crystals. Extinction, pleocroism, interference colours, accessory plates, sign of elongation.

Classification of minerals. Study of physical, optical and chemical properties and important uses of the following minerals: NATIVE: sulphur, diamond, graphite. OXIDES: Corundum, rutile, spinel, HALIDES: halite and fluorite CARBONATES: calcite, magnesite, dolomite, aragonite. SULPHATES: barite and gypsum. SILICATES: olivine, garnet, zircon, kyanite, staurolite, epidote, beryl, tourmaline, enstatite, hypersthene, augite, diopside, tremolite, actinolite, hornblende, kaolinite, talc, muscovite, phlogopite, biotite, serpentine, quartz, tridymite, cristobalite, orthoclase, microcline, plagioclase, nepheline, sodalite.

#### PRACTICAL PAPER - I

Full Marks 50

**SURVEYING:** Use of Clinometers, Prismatic and Brunton Compasses, Chain survey, Plane Table survey, Abney's level, Dumpy level, Recognition of simple features of geologic interests on a topographic survey sheets.

**STRUCTURAL GEOLOGY:** Contour lines, stratum contour lines. Effects of outcrops on topography. Completion of outcrops. Study of geological maps and preparation of cross sections. Simple structural problems relating to dip, strike and thickness of beds. Fault plane solutions.

**CRYSTALLOGRAPHY AND MINERALOGY:** Use of contact goniometer, study of symmetry and forms of holosymmetric classes. Study of simple twins. Determinations of axial ratios.

**References**

1. Geology with the elements of Geomorphology: Yakushova Mir Publishers, Moscow.
2. The Earth Science: A.N. Strahler, Harper & Row Publishers.
3. Principles of Physical Geology: J.E. Sander's John Willey and Sons.
4. An Introduction to the Structure of the Earth: EW Spencér.
5. Rutley's Mineralogy: Reeds
6. An Introduction to Crystallography: Phillips.

**MICRO-BIOLOGY**

There shall be two years course on Micro-Biology consisting of two theory papers namely Microbiology paper I (General and Pathogenic Microbiology) and paper II (Environmental, Food and Industrial Microbiology) each carrying 100 marks and two practical papers, namely, Microbiology practical I and Microbiology practical II each carrying 50 marks. These papers will be dealt with as given below.

Paper I

Full Marks: 100

**General and Pathogenic Microbiology****Objective**

1. To introduce the student to the unique world of Microorganisms..
2. Provide answers to three basic questions.
  - a. What are Microorganisms?
  - b. What do they do?
  - c. How do they affect their surroundings by their activities?
3. Provide basic exposure in methods and techniques in microbiology.
4. Provide an understanding of microbial diseases, the processes and mechanisms of pathogenicity and means of prevention and control.

## Subject outline

### Theory:

1. History and scope of microbiology.
2. Bacteria as the procaryotic model.
- 3.1 a. Characteristics and Classification.  
b. Morphology.  
c. Cultivation, Reproduction and Growth  
d. Enzymes and Metabolism  
e. Genetics-Modification, mutation, Recombination.
- 3.2 General account of following specific groups of Microorganism  
a. Bacteria. b. Fungi. c. Algae. d. Protozoans.  
e. Viruses.
4. Microbial Control  
a. Fundamentals of control.  
b. Physical control, temperature, irradiation, osmosis and filtration.  
c. Chemical control - Chemotherapeutic agents, Antibiotics, Disinfectants.
5. Brief introduction to microbial applications  
a. Soil microbiology  
b. Food microbiology  
c. Industrial microbiology  
d. Aquatic microbiology  
e. Microbiology of air
6. Principles of Infection and Immunity
7. Immunology  
a. Immune responses  
b. Antigen antibody reactions

- c. Humoral immunity
- d. Cellular immunity

## 8. Bacterial Infections

- a. Corynebacteria
- b. Pneumococci
- c. Streptococci
- d. Staphylococci
- e. The Neisseria
- f. The Entero-bacteriaceae
- g. Haemophilus
- h. Bordetella group
- i. Yersinia
- j. Francisella
- k. Pasteurella
- l. Brucella
- m. Aerobic spore-forming bacteria
- n. Anaerobic spore forming bacteria
- o. Mycobacteria
- p. Actinomycetes
- q. Spirochaetes
- r. Leptospira
- s. Rickettsia
- t. Chlamydia
- u. Mycoplasma

## 9. Fungal infections

- a. Systemic
- b. Subcutaneous
- c. Cutaneous
- d. Superficial

## 10. Introduction and classification of viruses, multiplications of viruses: cell virus interactions.

- a. An introduction to common viral diseases.
- b. Smallpox c. Measels d. Influenza e. Rabies
- f. Japanese Encephalitis g. Newcastle disease  
(Ranikhet diseases)

## 11. Protozoan Diseases

- a. Amoebiasis    b. Giardiasis    c. Malaria    d. Babesiasis  
 e. Leishmaniasis    f. Thileriasis.

## Practical Paper 1

**Full Marks: 50**

Practical and its part- General and pathogenic microbiology.

1. Theory and the use of light microscope.
2. Washing of glass-wares.
3. Different types of sterilization techniques
4. Preparation and use of the following stains:
  - a. Dorner stain    b. Gram's stain    c. Loaffler's methylene blue
  - d. Spore stain    e. Ziehl nelsen's carbolfuchsin
  - f. Nigrosin, India-Ink stain.
5. Preparation of media - Broth and agar (a) Synthetic media (b) Differential media (c) Enriched media.
6. Biochemical tests
7. Identification of an unknown bacteria.
8. Methods of isolation and cultivation of micro-organisms.
9. Isolation of pure culture:
  - (a) Plating method (b) Serial dilution method
10. Factors affecting microbial growth
11. Agglutination test
12. Precipitation test
13. Bacterial growth density
14. Water test as biological pollution
15. Stool test protozoan test
16. Antibiotic sensitivity test
17. Phenol coefficient test
18. Fungal culture and identification

19. Protozoan culture and identification
20. Oligodynamic test
21. Throat culture
22. Pathogenicity and animal inoculation test
23. Cultivation of virus in chicken embryo
24. Hemagglutination (HA) and Hemagglutination inhibition (HI)
25. Method of anaerobic cultivation
  - a. Cooked meat medium method
  - b. Anaerobic jar method

### **Recommended Books (Latest edition)**

1. Frobiser, Sommeneyer & Furest - Microbiology in health and diseases.
2. Davis - Microbiology
3. Cruickshank - Medical microbiology
4. Dey & Dey - Bacterial diseases.
5. Stainer - The microbial world.
6. Topley & Wilson - Principle of bacteriology, virology and immunology, Volumes 1,2,3, & 4.
7. T.D. Brock & Brock - The biology of micro-organisms.
8. Martin Alexander - Soil Microbiology
9. James Jay - Modern Food Microbiology
10. Frazier - Food Microbiology
11. Betty hobbs - Food Poisoning & Food handling
12. Miller & Lilsky - Industrial microbiology
13. Reinheimer - Aquatic microbiology
14. Kavanagh - Analytical Microbiology.

## STATISTICS

### Objectives

#### Broad objectives :

1. To provide basic and advanced knowledge of statistical methods,
2. To produce middle and high level manpower in statistics according to the needs of the nation.

#### Specific Objectives:

- a. To impart knowledge of basic statistical theories and methods,
- b. To produce middle level manpower according to the needs of the nation,
- c. To develop pre-requisite knowledge required for Master's level study in statistics.

### Teaching and Examination

1. In theory papers, teaching will be concentrated in imparting the knowledge on the basic concepts, derivations of formulas and relationships of various statistical methods, statements of theorems and their proofs will be given. In case of t, F and  $X^2$ -tests, only their applications will be taught at Bachelor level. The teaching method will be lecture method. Besides, group discussions and seminar methods will also be introduced.
2. Students would be given mathematical as well as numerical exercises for each of the topics taught.
3. Centre-level annual examination will be held for each paper taught. Usually there shall be

3-hours examination in each theory paper (full paper). In each full paper, about 10 to 11 questions will be asked. General pattern of each question shall consist of two parts; 1st part (a) usually dealing with theoretical part and 2nd part (b) usually dealing with mathematical or numerical exercises (lengthy numerical problems are to be avoided).

**4. Practical Class:**

Each class will be of three periods and will be held twice a week. Detailed exercises of the problems solved should be recorded in practical sheets by each and every student. The record should be duly signed by concerning teachers with remarks and dates. Uses of calculators, statistical tables are allowed in classes and examinations.

5. Examination of each practical paper will be held in the campus itself. An external examiner appointed by T.U.'s Central Examination Office and Internal Examiner appointed by the Campus will conduct the examination and evaluate the performances of students on the following basis.

i.	Via-va	10 marks
ii.	Records of practical problems performed in the campus	10 marks
iii.	Examination	30 marks

Total :	<u>50 marks</u>
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For examination, each student will be given a set of questions consisting of four to five questions. The set differs for each and every students (unless waved by the examiners due to unavoidable circumstances). The problem in the question will usually be of numerical type with lot of arithmetics to be performed. Emphasis will be given while

designing the problem - to assess the student's skill in understanding and uses of statistical methods. Students are expected to answer three questions during specified period.

**Paper : I (Mathematical Statistics.)** Full Marks: 100  
No. of Lectures

**1.1 Introductory: (4)**

**Definition,** development, importance, scope and limitations of statistics. Diagrametical presentation of data.

**1.2 Frequency Distribution: (4)**

**Concept of a variable, tally marks, frequency and cumulative frequency. Basic principles for forming a frequency distribution. Graphical representation of frequency; histogram, frequency polygon, frequency curve, ogive.**

**1.3 Measures of Central Tendency: (10)**

Concept and requisites of a good measures of central tendency. Averages, Derivation of formulae to compute arithmetic, geometric and harmonic means. Partition values: definition and computation of percentiles, quartiles and deciles. Mode: Merits and demerits of various measures of central tendency. Mathematical properties of arithmetic, geometric and harmonic means.

**1.4 Measures of Dispersion (12)**

Concept and requisites of a good measure of dispersion. Various measures of dispersion: quartile deviation semi-quartile deviation, mean deviations, variance and standard deviation and root-mean-square deviation. Determination of formulae to compute above measures of dispersions and their properties. Coefficient

of variation. Moments: Definition and relationships between moments about arithmetic mean and arbitrary value. Charlier's checks and Shepard's corrections. Skewness: Concept and its measures. Kurtosis: Concept and its measures.

### **1.5. Set and Probability: (20)**

Set: Concept of sets and operations. Probability: Introduction, definition of sample space, events; exhaustive equally likely, mutually exclusive and independent events. Definition of probability. Additive law of probability. Concept of conditional probability, multiplicative law of probability. Generalization of the above laws. Statistical independence. Baye's theorem (excluding future events).

### **1.6 Mathematical Expectation:**

Concept of a random variable and probability mass function. Definition of mathematical expectation of a random variable. Definition of moments of random variables. Expectation of sum and products of independent random variables. Variance of a linear combination of random variables. Definition and properties of moment generating functions.

### **1.7 Probability Distributions: (20)**

Concept of density functions and distribution functions their properties. Discrete Distribution: Derivations, properties including moments, and applications of Binomial and Poission distributions. Fitting of these distributions. Continuous Distribution: Derivations, properties and moments of normal distribution. Fiting of a normal distribution.

## 1.8 Correlation and Regression: (20)

**Simple Correlation:** Scatter diagram. Concept of correlation, coefficient of correlation and its properties, Bi-variate frequency case; Concept, derivations, properties and applications of a rank correlation co-efficients including cases of ties. Definition of intraclass-correlation coefficient.

**Regression:** Methods of least squares, plausible estimates. Properties of regression coefficients. Regression lines. Fitting of straight line, parabola and exponential curves. Coefficient of determination.

**Partial and Multiple Correlation and Regression:** Derivation of partial and multiple correlation co-efficients (upto three variables) and their properties. Residuals and their properties. Multiple regression (upto three variables).

## 1.9. Inference:

Idea of sample and population. Parameters and statistics. Standard error of sample mean. Idea about point and interval estimation. Determination of confidence limits for sample mean. Properties of good estimators (concept only). Null hypothesis. Types of errors. Level of significance. Degree of freedom. Tests of significances based on t, F, Z and  $X^2$  tests.

## Paper III: Practical

It consists of two parts. Each consist of 50 marks. Ist part will be dealt in 1st year and IInd Part will be dealt in 2nd year.

Tentative exercises to be completed for practical papers from different topics are as follows:

## Part I

S.No.	Subject Area	Tentative No. of Problems
1.	1.1	2
2.	1.2	5
3.	1.3	5
4.	1.4	5
5.	1.5	7
6.	1.6	8
7.	1.7	7
8.	1.8	5
9.	1.9	6
Total :		50

**Course Arrangements:**

<u>1st Year:</u>	Theory Paper I	F.M. = 100
	Practical Paper Part I	F.M. = 50
	Total	150 Marks

**Recommended Reading Books:**

1. Gupta, S.C. and Kapoor, V.K. (1977). Fundamental of Mathematical Statistics, S. Chand and Co. India.
2. Kapoor J.N. and Sexena, H.C. (1963). Mathematical Statistics, S. Chand and Co., India.
3. Goon, A.M. Gupta, M.K. and Dass Gupta B. (1976), Fundamental of Statistics, Vol. 1, World Press, India.
4. Weatherrburn, C.E., A First Course in Mathematical Statistics, E.L.B.S. Low Price Text Book, England.

5. Backhouse, J.K. (1967). Statistics: An Introduction to Test of Significance. Longmans, Green and Co., Ltd., England.
6. Shrestha, H.B. (1988). Elementary Statistical Methods. Orient Longmans, Calcutta, India.
7. Singh, M.L. (1969), Probability. Singh's Publication, Nepal.

## METEOROLOGY

There shall be one theory paper and one practical paper in each academic year. Every student is required to pass in theory and practical, separately.

There shall be six periods per week for theory and two periods per week for practical

### Paper I

Full Marks 100

Group A: Physical Meteorology

Group B: Dynamical Meteorology

Group C: Synoptic Meteorology and Aviation Meteorology.

### Group 'A' - Physical Meteorology:

1. Introduction: The physical foundation units and dimensions, the earth, the atmosphere.
2. The Equation of State: The variables of state, Charles' law, Boyle's law. The equation of state of an ideal gas, mixture of gases.
3. The Principle of Thermodynamics: Work, Heat, The law of conservation of energy. Internal energy and specific heat capacities of ideal gas. Adiabatic processes, Entropy and second law of thermodynamics.
4. The Thermodynamics of Water Vapour and Moist Air: Law of thermodynamics. Isotherms on pv diagram, the equation of state of moist air. Changes of phase and latent heat, the Clausius-Clapeyron equation. Adiabatic processes of dry air and saturated air, Moisture variables.

5. Thermodynamic Diagram: General consideration, the emagram, the tephigram, the skew, T-log, P-diagram.
6. Hydrostatic Equilibrium: The hydrostatic equation, height computations for upper air sounding. The hydro-statics of special atmospheres.
7. Hydrostatic Stability and Convection: The dry and moist adiabatic lapse rate. The parcel method. The slice method, Entrainment and bubble theory
8. Condensation and Precipitation: Size spectrum of aerosol particles, Physics of condensations, Solution effect, growth and evaporation of drops, growth in mixed cloud, ice nucleation growth by coalescence.

### **Group 'B' - Dynamic Meteorology**

1. Vector operators Dimensions, units and time, vector rotation, addition and subtraction of vector. Dot product, cross product, differentiation of vector, Del operator. Non-divergence and the stream function, Total differentiation.
2. Horizontal Motion in Atmosphere: Inertial and non-inertial co-ordinate system, absolute and relative motion, Coriolis force, Pressure gradient, Force, Equation of motion, Zonal flow. Apparent and true weight. The relative equation of motion, Acceleration in natural coordinates, The equations of horizontal motion in natural coordinates.
3. Classification of Flow: Geostrophic flow, The inertial wind, Eulerian flow, Gradient flow, Representation of constant pressure surfaces, Other properties on constant pressure surfaces,

Thermal wind, Vertical shear of the geostrophic wind, Barotropic atmosphere, Baroclinic atmosphere, Autobarotropic atmosphere.

4. Characteristics of Fluid flow applied to the atmosphere: Streamlines and trajectories, Relation between streamlines and trajectories, Definition of vorticity, vector, vertical component of vorticity, circulation and its relationship to vorticity, The vorticity equation, circulation and solenoids, Continuity and divergence, Continuity equation, Tendency equation. The Bjerknes-Holmboe theory. The isobaric wind, Lee of the mountain trough, CAV trajectories, Land and sea breezes.
5. General Circulation: The mean circulation in the troposphere and lower stratosphere, Jet streams, Models of the general circulation.

### **Group 'C' - Synoptic Meteorology and Aviation Meteorology**

1. Front, Cyclones and Anticyclones: Concept of air mass, The cyclone model, Vertical structure, Pressure and temperature distributions, Dynamic effects, The nature of fronts, Moving fronts, Cyclones, and the upper waves, the Life cycle of cyclones, Wave theory of cyclones, simplified vertical structure, Bergeron's model of occluded cyclones, Flow over shallow and cold domes, Energy of cyclones, Frontogenesis anticyclones and their behaviour.
2. Tropical Meteorology: Tropical weather systems, Trade winds in the tropics, Intertropical convergence zone, The summer and winter monsoon of Asia Monsoon depression tropical cyclones, Life cycle, structure and movement interaction between the extra tropics and tropics.

3. Thunderstorms and Related Phenomena: Definition and relation to convection, Structure and life cycle of a cell, Thermodynamics of entrainment and of the downdraft, Thunderstorm weather near the surface, Dry thunderstorms development of new cells, Thunderstorm electricity, Hail, Tornadoes, Waterspouts.
4. Introduction: Standard atmosphere, Altimetry and altimeter setting.
2. Turbulence: Aircraft response to atmospheric turbulence. Thermal and frictional turbulence, Turbulence in thunderstorm, Turbulence in mountain wave, Clear air turbulence .
6. Pressure Pattern Flying: Equivalent headwind, Equivalent tail wind, Effect of wind on aircraft, Drift due to geostrophic wind, Determination of drift from altimeter reading.
7. Ice Formation on Aircraft: Types of ice formation, Physical aspect of ice formation, The effect of air on performance, Engine icing.
8. Visibility at ground level, Runway visual range, Air to ground visibility.
9. Meteorological Services for International Aviation: Area forecast centre and aeronautical meteorological offices, Aerodrom weather reports, Aviation forecasts, Aerodrom forecast, Landing forecasts, Area route and flight forecasts, Amendment to forecast.

### **Practical Paper 1**

Full Marks 50

1. Introduction of the meteorological observations (SYNOP only).
2. Elements of weather message and coding practice (SYNOP).
3. Station models and plotting of synoptic message (SYNOP).

4. Preparation of the pseudo-adiabatic diagram.
5. Introduction of the following meteorological instruments: (a) Thermograph, (b) Hygrograph, (c) Raingauge and rainfall recorder, (d) Dry bulb, Wet bulb, Maximum and minimum thermometers, (e) Solar radiation recorder.
6. Data extraction technique of thermograph, Hygrograph, Sunshine cards etc.
9. To prepare correction tables for the Fortin's barometer and reduction to mean sea level.
8. To prepare correction tables for Kew pattern barometer.
9. To determine the lag coefficient of a given thermometer.
10. To determine the height difference between two stations.
11. To draw the vertical cross-section of meridional distribution of temperature.
12. To construct geostrophic wind scales both on a level surface and isobaric surface.
13. Determination of vapour pressure and relative humidity.
14. To evaluate the coriolis parameter for each  $5^{\circ}$  latitude from equator to pole in the Northern Hemisphere.
15. Analysis of surface charts (Isobars Isotherms and Colouring).

#### References:

1. General Meteorology - Horace Robert Byers: McGraw-Hill Book Company.
2. Dynamical & Physical Meteorology : George J. Haltiner & Frank Martin, McGraw Hill Book Company.

3. Weather Analysis & Forecasting: Petterson.
4. Introduction to Theoretical Meteorology: Seymour L. Hess, Hort, Rinenart & Winston, New York.
5. Handbook of Aviation Meteorology, London Her Majesty's Stationery Office.
6. Compendium of Lecture notes for training class iii meteorological personnel W.M.O. No. 291.
7. Compendium of lecture notes for training class iv meteorological personnel W.M.O. No. 266. TP 150.

*Printed by*  
**Tribhuvan University Press**  
**Kirtipur, Kathmandu, Nepal.**