B.Sc. Four Year System

Course Structure & Curriculum

B.Sc. (Physics)

Central Department of Physics

Tribhuvan University, Kirtipur

July 2015

Note: The one major system in the IoST, TU is approved by the Academic Council on Feb 2014. The full curriculum of B.Sc. (Physics) is finalized by the Physics Subject Committee on 2072/01/06 and finally approved by the Academic Council, TU.

Tribhuvan University

Institute of Science & Technology

STRUCTURE OF
B.Sc. Four Year System

Year	Description	Nature
First Year	**a) Core Course:** Any three subjects from first/second year from either physical or biological group.	Theory (100 x 3) Practical (50 x 3) **(450)**
	b) Scientific Communication	Theory (50 x1 1) **(50)**
Second Year	**a) Core Course:** Any three subjects from first/second year from either physical or biological group.	Theory (100 x 3) Practical (50 x 3) **(450)**
	b) Applied Statistics	Theory (50 x1 1) **(50)**
Third Year	a) **Core Course:** Any two subjects from first/second year from either physical or biological group.	Theory (100 x 2) Practical (50 x 2) **(300)**
	b) **Research Methodology**	Theory **(100)**
	c) **Elective Course**: Any two subjects from the respective subject pool.	Theory (50 x 2) **(100)**
Fourth Year	a) **Core Course:** any one subject from third year (one-major)	Theory (100 x 2) Practical (50 x 2) **(300)**
	b) **Project Work/Field Work** OR **Applied Science** (leading to core subject)	Research work & Presentation Theory **(100)**
	c) **Computational Course**	Theory/Lab **(50)**
	d) **Interdisciplinary Course**: one	Theory **(50)**
Marks		**2000**

STRUCTURE OF

BSC FOUR YEAR SYSTEM

(Physics Stream)

The structure and the curriculum of B.Sc. IV year (Physics) course is extensively reviewed discussed and finally approved by the Full Subject Committee Meeting held on **2072/01/06**.

Year	Course Code	Course Name	Course Nature	Full Marks	Hour
I	PHY101	Mechanics, Thermodynamic, Statistical Physics, Electricity and Magnetism	Theory/ Core	100	160
I	PHY102	Physics Laboratory*	Practical/Core	50	180
II	PHY201	Optics, Modern Physics, Electronics	Theory/Core	100	160
II	PHY202	Physics Laboratory*	Practical/Core	50	180
III	PHY301	Math Physics & Classical Mechanics	Theory/Core	100	160
III	PHY302	Physics Laboratory*	Practical/Core	50	180
III	PHY303	Applied Mathematics	Theory/ Elective	50	80
III	PHY304	Space Science	Theory/ Elective	50	80
IV	PHY401	Quantum Mechanics	Theory/Core	100	160
IV	PHY402	Physics Lab (General)	Practical/Core	50	180
IV	PHY403	Nuclear Physics & Solid State Physics	Theory/Core	100	160
IV	PHY404	Physics Lab (Electronics)	Practical/Core	50	180
IV	PHY405	Material Science	Theory	100	160
IV	PHY406 PRO406	OR Project	OR Research	100	-
IV	PHY407	Econophysics	Theory / Interdisciplinary	50	80
TOTAL (Core+Elective+Optional+Interdisciplinary)				950	

Note: A total of 2000 marks credited to BSC four year system.
The symbol * indicates the revision in the previous curriculum.

B.Sc. FIRST YEAR

Mechanics, Thermodynamic, Statistical Physics, Electricity and Magnetism

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

Course Title: (**Mechanics, Thermodynamic, Statistical Physics, Electricity and Magnetism**)
Year: I
Course Code: PHY101
Full Marks: 100
Nature of Course: Theory
Pass Marks: 35

Course Objectives

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

MECHANICS [54 hours]

Course Contents:

1. **Review of Laws of Motion: 1.1** Dynamics of a particle, General equations of motion, Types of forces, Conservation laws, Work-Energy theorem, Conservative forces, 1.2 Motion of a body near the surface of the earth, Linear restoring force, Potential energy curve, Non-conservative forces. [3 hours]
2. **Linear and Angular Momentum: 2.1** Conservation of linear momentum, Centre of mass, Collision of two particles, 2.2 Deflection of a moving particle by a particle at rest, Rocket, Angular momentum and torque, 2.3 Motion under central force, Areal velocity, 2.4 Examples of conservation of angular momentum. [5 hours]
3. **Gravitational Potentials and Fields: 3.1** Central Forces, Inverse square-law of force, 3.2 Gravitational field and potential, Velocity of escape, 3.3 Potential and field due to a thin spherical shell and due to a solid sphere, Gravitational self energy, 3.4 Gauss's and Poisson's equation for gravitational field, 3.5 Kepler's laws of planetary motion, 3.6 Deduction of Newton's law of gravitation from Kepler's Laws. [8 hours]
4. **Dynamics of Rigid Bodies: 4.1** Equations of motion for a rotating rigid body, 4.2 Theorems on moment of inertia (M.I.), M.I. of a rectangular lamina, Solid uniform bar of rectangular cross-section, Circular disc, Solid cylinder, Solid sphere and spherical shell, 4.3 Kinetic energy of a rotating and rolling bodies, 4.4 Motion of a body rolling

down an inclined plane, 4.5 Reduction of two body problem to a single body problem. [6 hours]

5. **Harmonic Oscillator: 5.1** Simple harmonic motion (S.H.M.) and harmonic oscillator, 5.2 Examples of harmonic oscillator, Simple pendulum, Compound pendulum, 5.3 Mass-spring system, 5.4 Torsional pendulum, 5.5 Helmholtz resonator, 5.6 Oscillation of two particles connected by a spring ,N-coupled oscillators, 5.7 Damping force, Damped and forced harmonic oscillator, 5.8 Power dissipation, Quality factor, 5.9 Power absorption. [10 hours]
6. **Wave Motion: 6.1** General equation of wave motion, 6.2 Equation of plane progressive harmonic wave, 6.3 Particle velocity and wave velocity, 6.4 Energy density for a plane progressive wave, 6.5 Intensity of wave and spherical waves, 6.6 Transverse waves in stretched strings, Modes of vibration, 6.7 Longitudinal waves in rods and gases, 6.8 Flow of energy in stationary waves. [8 hours]
7. **Elasticity: 7.1** Relations connecting various elastic constants, 7.2 Angle of twist and angle of shear, 7.3 Twisting couple on a cylindrical rod or wire, 7.4 Work done in twisting a rod or wire, 7.5 Bending of beams, Bending moment, 7.6 Cantilever, 7.7 Beam supported at its ends and loaded in the middle. [8 hours]
8. **Fluid Mechanics - Viscosity: 8.1** Kinematics of moving fluid, 8.2 Equation of continuity, 8.3 Bernoulli's theorem and its applications, 8.4 Viscous fluids, Streamline and turbulent flow, Critical velocity, 8.5 Reynold's number, 8.6 Poiseuille's equation, Capillaries in series and parallel. [6 hours]

THERMODYNAMICS [38 hours]

Course Contents:

9. **Thermodynamic Fundamental Concepts: 9.1** Thermodynamic systems, Thermal and thermodynamic equilibrium, Equation of state, Thermodynamic processes, 9.2 External and internal work, Internal energy, Quasi-static, Isothermal, Adiabatic, Isobaric and isochoric processes. [3 hours]
10. **Laws of Thermodynamics and Their Application: 10.1** Zeroth law, First law of thermodynamics, Second law of thermodynamics, 10.2 Carnot's theorem, 10.3 Absolute scale of temperature, 10.4 Entropy changes in reversible and irreversible processes, Principle of increase of entropy, 10.5 Entropy and second law, 10.6 Third law of thermodynamics and its applications. [6 hours]
11. **Thermodynamic Relations**: 11.1 First and second latent heat equations, 11.2 Triple point, Thermodynamic potentials, 11.3 Helmholtz's function, Enthalpy, 11.4 Gibb's function, 11.5 Maxwell's thermodynamic relations, Phase transition, 11.6 Clausius-Clapeyron equation. [6 hours]
12. **Concept of Ideal and Real Gases: 12.1** Concept of ideal and real gases, 12.2 Joule expansion, Joule's law for perfect gas, 12.3 van der Waals equation, Critical constants of van der Waals gas, 12.4 Joule-Thomson expansion, Porous plug experiment, 12.5 Constancy of enthalpy, Adiabatic expansion. [5 hours]
13. **Production of Low Temperature: 13.1** Thermodynamics of refrigeration, Refrigeration cycle, Co-efficient of performance, 13.2 Cooling in Joule-Thomson expansion, Regenerative cooling, Cascade cooling, 13.3 Boyle's temperature of

inversion, 13.4 Critical temperature and their relations, 13.5 Liquefaction of Helium and its properties. [5 hours]

14. **Transport Phenomenon: 14.1** Molecular collisions, Collision cross-section, Molecular diameter, Mean free path, 14.2 Transport phenomenon, Transport of momentum - viscosity, 14.3 Transport of energy - thermal conductivity, 14.4 Transport of mass - diffusion, 14.5 Brownian motion, Einstein's theory of Brownian motion. [6 hours]
15. **Black Body Radiation: 15.1** Total energy density, Spectral energy density, 15.2 Emissive power, Absorptive power, Kirchoff's law, 15.3 Pressure of radiation, Pressure of diffusive radiation, Stefan-Boltzmann's law , 15.4 Spectrum of black body radiation, Wien's displacement law, 15.5 Planck's radiation law, Rayleigh-Jean's law. [7 hours]

STATISTICAL PHYSICS [15 hours]

Course Contents:

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

ELECTRICITY AND MAGNETISM [53 hours]

Course Contents:

18. **Elementary Vector Analysis: 18.1** Gradient of a scalar, Divergence and curl of a vector in cartesian coordinates, 18.2 Divergence in polar coordinates, 18.3 Gauss's, Stoke's and Green's theorems, 18.4 Laplacian in polar co-ordinate system, 18,5 Laplace's and Poisson's equation. [5 hours]
19. **Electrostatic Potential and Field: 19.1** Coulomb's law, Electric Potential energy of a system of charges, Electric field strength, Electric flux, 19.2 Gauss's law and it's applications, 19.3 Electric potential and the line integral of the electric field, 19.4 Equipotential surface, Potential and field due to an electric dipole, Potential due to an infinitely long charged wire, Potential and field due to an uniformly charged disc, 19.5 Force on a surface charge, 19.6 Method of electrical images. [7 hours]
20. **Electric Fields in Dielectrics: 20.1** A dipole in an electric field, Polar and non-polar molecules, 20.2 Dielectric polarization, Electric field due to a polarized dielectric (three electric vectors), 20.3 Gauss's law in dielectric, Energy stored in an electric field in the presence of dielectric, Boundary conditions on field vectors, Molecular

field in a dielectric, 20.4 The Clausius-Mossotti relation, Polar molecules, 20.5 The Langevin Debye formula. [7 hours]

21. **Magnetic Fields of Moving Charges: 21.1** Magnetic field and the magnetic flux, 21.2 Biot-Savart's law and its applications, 20.3 Lorentz force, Ampere's circuital law and its applications, Curl **B** and div **B,** 20.4 Magnetic vector and scalar potentials, 20.5 Magnetic dipole, 20.6 Force between current carrying parallel wires. [6 hours]
22. **Magnetic Properties and Fields: 22.1** The absence of isolated magnetic poles, 22.2 Magnetic dipole moment of current loop and angular momentum, Magnetization, 22.3 Langevin's theory of diamagnetism and paramagnetism, 22.4 Theory of ferromagnetism, 22.5 Energy loss due to hysteresis, 22.6 Magnetic susceptibility and permeability, Ferrites. [7 hours]
23. **Electromagnetic Inductions: 23.1** Faraday's law, Skin effect, 23.2 Moving coil ballistic galvanometer, Search coil, Flux meter, Earth inductor, Self and mutual induction, 23.3 Reciprocity theorem of mutual inductances, Self inductance of a solenoid, Toroid and two long parallel wires, 23.4 Energy stored in magnetic field, Transformer. [4 hours]
24. **Varying Currents: 24.1** Charging and discharging of a condenser through a resistance, 24.2 Rise and decay of current in LR & LC circuit, 24.3 Charging and discharging of a capacitor through inductance and resistance. [3 hours]
25. **Alternating Current Circuit: 25.1** The complex number method for AC analysis, Impedance, Reactance and admittance, 25.2 LCR circuits, Phase diagrams, Sharpness of resonance, 25.3 Quality factor, Power factor. [4 hours]
26. **Maxwell's Electromagnetic Equations: 26.1** The displacement current, Maxwell's equations and their use in propagation of electromagnetic wave, 26.2 Poynting vector, Derivation of Gauss's theorem, 26.3 Faraday's law, Lenz law, 26.3 Biot-Savrat's law and Ampere's circuital law, 26.4 Energy of a charged particle in an electromagnetic field, 26.5 Reflection and refraction of electromagnetic waves at the interface between two media, 26.6 Plane wave solution of Maxwell's equations, The wave equation, 26.7 Plane electromagnetic waves in isotropic dielectric and in conducting media. [10 hours]

Text Books:

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

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

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

Reference Books:

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

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

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

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

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

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

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

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

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

Course Title: Physics Laboratory	**Year:** I
Course Code: PHY102	**Full Marks:** 50
Nature of Course: Practical	**Pass Marks:** 20

Course Description:

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

Course Objectives:

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

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

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

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

Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)

2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

Evaluation Scheme:

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

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

B.Sc. SECOND YEAR

Optics, Modern Physics, Electronics

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

Course Title: (**Optics, Modern Physics, Electronics**)	**Year:** II
Course Code: PHY201	**Full Marks:** 100
Nature of Course: Theory	**Pass Marks:** 35

Course Objectives

At the end of this course the students will be able to acquire sufficient basic knowledge on such topics in Physics as Optics, Modern Physics and Electronics and apply their knowledge to learning major courses.

OPTICS [60 hours]

Course Contents:

1. **Wave Nature of Light: 1.1** Nature of light, 1.2 Huygen's wave theory and its application for propagation of waves [2 hours]
2. **Aberration at Spherical Surfaces: 2.1** Refraction through spherical surfaces from Huygen's wave theory, 2.2 chromatic aberrations; astigmatism, coma, curvature, distortion and their elimination, 2.3 Ramsden's and Huygen's eyepieces [7 hours]
3. **Interference: 3.1** Condition for obtaining interference, 3.2 spatial and temporal coherence, 3.3 interference by division of wave front, Fresnel's biprism, Lloyd's mirror, 3.4 division of amplitude, thin and wedge films, Newton's ring, Michelson interferometer, Fabry-Perot interferometer, 3.5 intensity distribution, 3.6 antireflection gratings [10 hours]
4. **Diffraction: 4.1** Huygen's principle, 4.2 Fresnel and Fraunhoffer diffraction, 4.3 Fresnel's diffraction: zone plate, circular aperture, straight edge, disc. 4.4 Fraunhoffer's diffraction: diffraction through a single and double slit, circular aperture and disc, 4.5 dispersive and resolving power of grating, 4.6 microscope and telescope [10 hours]
5. **Polarization: 5.1** Unpolarized plane, circular and elliptically polarized light, double refraction, crystal polarizer, 5.2 Malus law, polarization by reflection and scattering, 5.3 double refraction and Huygen's explanation, production and analysis of polarized light, 5.4 optical activity, 5.5 Laurent half shade polarimeter and its applications [8 hours]

6. **Dispersion and Scattering: 6.1** Dispersion of a Prism, 6.2 Normal and anomalous dispersion, 6.3 Cauchy's equation, scattering of light, 6.4 Scattering by small particles, 6.5 Scattering and Refractive Index, 6.6 Raman Effect [6 hours]
7. **Lasers: 7.1** Spontaneous and stimulated emission, 7.2 conditions for laser action, population inversion, optical pumping, 7.3 Ruby and He-Ne lasers and applications [4 hours]
8. **Holography: 8.1** Basic principles of holography, 8.2 applications [3 hours]

MODERN PHYSICS [60 hours]

Course Contents:

9. **Atomic Structure: 9.1** The nuclear atom, 9.2 Rutherford scattering and its conclusions, 9.3 limitations of Rutherford model of atom, electron orbits, 9.4 atomic spectra, 9.5 the Bohr's atom, energy level diagram and spectra of hydrogen atom, 9.6 Frank-Hertz experiment and limitations of Bohr's model, 9.7 the Sommerfeld atom [8 hours]
10. **Many Electron Atom: 10.1** Electron spin, 10.2 Stern-Gerlach experiment, 10.3 Pauli's exclusion principle, 10.4 shells and subshells of electrons, 10.5 vector atom model, 10.6 LS coupling and s, p, d, f notation [5 hours]
11. **Atomic Spectra: 11.1** Fine structures of H, Na, He and Hg, 11.2 Paschen-Back effect, 11.3 Stark effect, 11.4 normal and 11.5 anomalous Zeeman effect [7 hours]
12. **Particle properties of waves: 12.1** Electromagnetic waves and its interaction with matter, 12.2 absorption, 12.3 photoelectric effect, 12.4 Compton scattering, 12.5 pair production, 12.6 photons and gravity [6 hours]
13. **X-ray Spectrum: 13.1** Characteristic X-ray, 13.2 X-ray diffraction and spectrometer, 13.3 fine structure of X-ray transitions, 13.4 Moseley's law and its application [4 hours]
14. **Nuclear Structure: 14.1** Proton-electron and proton-neutron hypothesis, 14.2 nuclear composition and its properties (mass, charge, density, magnetic and electric properties), 14.3 nuclear stability and binding energy, 14.4 Meson theory of nuclear forces [6 hours]
15. **Nuclear Transformations: 15.1** Radioactivity, law of radioactive disintegration, 15.2 law of successive disintegration, 15.3 half-life, mean life, natural radioactive series, 15.4 alpha, beta and gamma ray spectra, 15.5 absorption of α particles, range, 15.6 straggling and stopping power, 15.7 theory of α decay, 15.8 neutrino hypothesis of β-decay, 15.9 biological effects of ionizing radiation [7 hours]
16. **Particle Detectors and Accelerators: 16.1** Ionization chamber, 16.2 G. M. counter, 16.3 scintillation counter, 16.4 bubble chamber, 16.5 Cerenkov detectors, 16.6 semiconductor detectors, 16.7 linear accelerator, 16.8 cyclotron, 16.9 synchrocyclotron, 16.10 betatron, the 16.11 LHC project [7 hours]

ELECTRONICS [60 hours]

Course Contents:

17. **Network Theorems: 17.1** Superposition Theorem, 17.2 Ideal constant-voltage source, 17.3 Ideal constant current source, 17.4 Thevenin's and Norton's Theorem and their applications, 17.5 maximum power transfer theorem [4 hours]
18. **Semiconductor and Diodes: 18.1** Review of semiconductor, types of semiconductor, 18.3 energy bands in semiconductors, 18.3 Different types of diodes, P-N junction diode, characteristics, 18.4 application of junction diode as half wave and full wave rectifier, 18.5 bridge rectifier, R-C filter, ripple factors, 18.6 zener diode and it's application in voltage regulation circuit [6 hours]
19. **Bipolar Junction Transistors: 19.1** PNP and NPN transistors, transistor input, output and transfer characteristics in different configurations, 19.2 α and β of transistor, 19.3 transistor biasing, load lines, Q-point, optimum Q-point, bias stabilization, stability factor, 19.4 CB, CE, and CC amplifiers and their DC and AC equivalent circuits, 19.5 amplifier gain (voltage, current, power) calculations, 19.6 AC-input and output impendances of different amplifiers, 19.7 phase inversion in CE amplifier [10 hours]
20. **Amplifiers: 20.1** Cascaded amplifiers, 20.2 R-C coupled amplifier, 20.3 overall voltage gain, 20.4 frequency response, 20.5 power amplifiers. **[**4 hours]
21. **Operational amplifiers: 21.1** Differential amplifiers, ac analysis of differential amplifier, 21.2 differential gain, input impedance, common mode gain, 21.3 common mode rejection ratio (CMRR), 21.4 Operational amplifier, 21.5 inverting and non-inverting mode of Op-Amp [5 hours]
22. **Feedback Amplifier: 22.1** Introduction of feedback and their types, 22.2 Negative feedback and positive feedback, advantages of negative voltage feedback, 22.3 different types of feedback amplifier: voltage-series feedback, 22.4 voltage shunt feedback, current series feedback, current shunt feedback [4 hours]
23. **Oscillators: 23.1** Barkhausen criterion, 23.2 working principle of Hartely, Colpitt's and phase shift oscillators, 23.3 Multivibrators and their working principle. [5 hours]
24. **FET and UJT: 24.1** Field effect transistor, its characteristics, 24.2 FET as an amplifier with infinite input impedance. 24.3 Unijunction transistor and its characteristics, 24.4 UJT as a relaxation oscillator [4 hours]
25. **Digital Electronics and Logic gates: 25.1** Decimal, Binary, Octal and Hexadecimal number of systems and their inter-conversion, 25.2 Addition and subtraction of binary numbers, 25.3 Boolean algebra and de Morgan's theorem, 25.4 OR, AND, NOT, NOR, NAND, X-OR and X-NOR gates NOR and NAND gate as basic building block, 25.5 Half adders and full adders, 25.6 RS, JK, D-flip flops [8 hours]

Text books:

1. *Jenkins F. A. and White H. E*. - **Fundamentals of Optics**, McGraw Hill Book Co. Ltd., 4th Edition (2011)

2. *Beiser A., Mahajan S. and Choudhury S. R*. - **Concepts of Modern Physics**, Tata McGraw Hill Education, New Delhi (2011)

3. *Murugeshan R. and Sivaprasad K*. - **Modern Physics**, S. Chand and Company, New Delhi (2012)

4. *Malvino A. P.* - **Electronic Principles**, Tata McGraw Hill Publishing House, New Delhi (1984)

Reference books:

1. *Subrahmanyam N. and Lal B*. - **Text Book of Optics***,* S. Chand and Co., Ltd. (1994)

2. *Blatt F. J*. - **Modern Physics**, McGraw Hill International (1992)

3. *Wahr M. R., Richard J. A. and Adir T. W.* - **Physics of the Atom**, Addison Wesley (1984)

4. *Leighton R. B.* - **Principles of Modern Physics**, McGraw-Hill Education (1959)

5. *Theraja B. L.* - **Basic Electronics**, S.Chand & Co.Ltd., New Delhi (2002)

6. Mehta V. K. and Mehta Rohit - **Principles of Electronics**, , S. Chand & co. Ltd., New Delhi (1996)

7. *Malvino A. P.* - **Semiconductor circuit approximation (4th edition),** Tata McGraw Hill Publishing House, New Delhi (1986)

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

Course Title: Physics Laboratory	**Year:** II
Course Code: PHY202	**Full Marks:** 50
Nature of Course: Practical	**Pass Marks:** 20

Course Description:

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

Course Objectives:

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

B.Sc. Second Year Lab Works [180 hours]

1. To determine the wave length of given source of light by Newton's Ring method.

2. To determine the wavelength of given source of light using a plane diffraction grating.

3. To determine the resolving power of a prism.

4. To determine the resolving power of a plane transmission diffraction grating.

5. To determine the refractive index of the material of a prism for light of different wavelengths.

6. To determine the value of Cauchy's constants for the material of the given prism using a spectrometer.

7. To determine the specific rotation of sugar solution using Laurent half-shade polarimeter

8. To determine the charge of an electron by Millikan's method.

9. To determine the specific charge of an electron (e/m) by magnetron tube method.

10. To determine the specific charge of an electron (e/m) by Thomson's method.

11. To study the characteristics of Geiger Muller (G.M.) counter and its reliability.

12. To determine the linear absorption coefficient of β-particles in a matter using a G.M. counter.

13. To determine the resonant frequency and quality factor of series LCR circuit.

14. To study oscilloscope and calibrate it for the measurement of voltage and frequency.

15. Determine the unknown frequency of a given source using Lissajous figure.

16. To verify the maximum power transfer theorem.

17. To verify the network theorems: Thevenin's theorem and Norton's theorem.

18. To study the CB characteristics of a PNP and NPN junction transistor.

19. To study the CE characteristics of a PNP and NPN junction transistor.

20. To study the CC characteristics of a PNP and NPN junction transistor.

21. To study the characteristics of regulated power supply using Zener diode.

22. To study the characteristics of regulated power supply by using integrated circuit (IC).

23. To study logic gates OR, AND and NOT by using DTL and TTL.

24. To study logic gates NOR and NAND by using DTL and TTL.

25. To verify NAND and NOR gates are universal gates.

Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)

2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

Evaluation Scheme

1. Student must perform three hours laboratory work twice a week to complete PHY202 lab works.
2. PHY202 will be examined for the duration of six hours in two different three hours sessions.
3. The practical exam will be graded on the basis of the following marking scheme:

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

B.Sc. THIRD YEAR

Mathematical Physics and Classical Mechanics

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

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

Course Objectives:

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

MATHEMATICAL PHYSICS (60%) [96 hours]

1. **Vector analysis: 1.1** Scalar and vector fields, 1.2 law of transformation of vectors, polar and axial vectors, solenoidal vectors, rotational and irrotational vectors, vortex lines, 1.3 Curvilinear coordinates: direction cosines, scale factors, curvature of co-ordinate lines, volume element, rotation of axes, contravarient and covariant vectors, 1.4 Gradient, divergence, curl and Laplacian in curvilinear co-ordinates, 1.5 Special orthogonal curvilinear coordinates: cylindrical, spherical, ellipsoidal, hyperbolic and parabolic co-ordinates [20 hours]
2. **Tensor analysis: 2.1** Contravariant, covariant and mixed tensors, 2.2 Kronecker delta, tensors of rank greater than two, scalars or invariants, 2.3 Tensor fields, symmetric and skew symmetric tensors, fundamental operations with tensors, stress tensor, 2.4 Line element and matric tensor, reciprocal tensors, associated tensors, length of a vector, angle between vectors, physical components, 2.5 Christoffel's symbols, transformation laws of Christoffel's symbols, geodesics, covariant derivatives, 2.6 Tensor form of gradient, divergence, curl and Laplacian [20 hours]
3. **Linear vector spaces: 3.1** Vectors in n-dimensions, linear independence, inner product, 3.2 Schwartz inequality, 3.3 Representation of vectors and linear operators with respect to a basis, change of basis, 3.4 Schmidt orthogonalization process, 3.5 Linear operators and their matrix representation: symmetric, Hermitian, orthogonal, unitary (normal) matrices, 3.5 Determination of eigen values and eigen vectors of the matrix, diagonalization [18 hours]
4. **Fourier series and transforms: 4.1** Fourier series representation, even and odd functions, 4.2 Fourier series expansion of square, triangular, saw-tooth waves and

out put of full wave rectifier, 4.3 Complex representation of Fourier series, 4.4 Dirac delta function, 4.5 Parseval relation, 4.6 Fourier transform and convolution theorem, 4.7 Laplace transform, Laplace transform of derivatives and integrals, 4.8 Use of Fourier and Laplace transform in solving partial differential equations. [18 hours]

5. **Differential equations: 5.1** Series solutions of Bassels's, Legendre's, Hermite's, Laguerre's differential equations, 5.2 Rodrigue's formula, Recurrence relations, associated Legendre and Laguerre polynomials, orthogonality and generating functions [10 hours]
6. **Partial differential equations: 6.1** Wave equations, Laplace, Poisson and diffusion equations, boundary value problems, 6.2 Method of separation of variables [10 hours]

CLASSICAL MECHANICS (40%) [64 hours]

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

Text Books:

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

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

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

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

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

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

References:

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

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

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

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

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

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

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

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

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

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

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

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

Course Description:

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

Course Objectives:

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

PHYSICS THIRD YEAR LAB WORKS [180 hours]

1. Calibrate the experimental set-up of photoelectric effect using yellow filter, standard value of planck's constant and work function of the given photocell. Find calibration factor.
2. Study photoelectric effect and estimate the value of Planck's constant using various color filters.
3. Study photoelectric effect and find the wavelength of the unknown color filters using calculated value of planck's constant *h*.
4. Use the measured dataset of photoelectric effect and calculate the standard deviation, standard error and probable error with significant figures. Generate theoretical data using photoelectric equation for given filters and photocell. Test how well the measured data agrees with the theoretical data in this experiment. Show the trend of measured and theoretical data in a graph and interpret it.

5. Study the activity of given γ-radioactive source using GM counter. Show that the gamma rays obey inverse square law.
6. Study the absorption of gamma rays by the given absorber and GM counter. Find the value of linear absorption coefficient.
7. Use measured dataset of the experiments 6, calculate the standard deviation for each absorber material, and then standard error and probable error with significant figures. Generate theoretical data using radioactive equation and study the differences in the measured and theoretical data.
8. Use the method of least square, draw the best straight line through a set of measured data in the experiment 6 with error bar and find the error in slope and intercept.
9. To study the level of natural background radiation at the laboratory in the given condition.
10. To study the level of natural background radiation in the outdoor field in all directions (east, west, north, south, up and down) in the given condition.
11. Use the dataset of experiment 10 and find the standard error in all directions separately. Compile this database in a single set and make a histogram showing Gaussian like distribution. Interpret the result.
12. To study the Michelson Interferometer to determine the wavelength of monochromatic light.
13. To use the microwave source for studying the phenomenon of (a) Refraction, (b) Interference, (c) Diffraction, and (d) Polarization.
14. To study the band gap of semiconductor using leakage current method.
15. Study the working of fine beam tube for the determination of the specific charge of an electron.
16. Study the functioning of Earth inductor and determine the dip using it.
17. Study the working of CRT for the determination of specific charge of electron.
18. To estimate the current gain (β) in a Common-Emitter Configuration.
19. Construct CE amplifier and determine the voltage gain of the amplifier with phase relation.

20. Construct CC amplifier and determine the voltage gain, input and output impedance with phase relation.

21. Construct CS amplifier and determine the voltage gain of the amplifier with phase relation.

22. Study the characteristic of inverting and non-inverting operational amplifier (Using IC).

23. To study operational amplifier for integrator (Using IC).

24. To study operational amplifier for differentiator (Using IC).

25. To study the working of half-adder and half-subtractor circuit.

26. Design and constructs the 1-bit digital comparator.

27. To study the astable multivibrator by using transistors and find its frequency and duty cycle.

28. To study the characteristics of phase shift oscillator.

29. To study the drain and transfer characteristics of junction field effect transistor (JFET).

30. To study the characteristics of uni-junction transistor.

Text Books

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)

2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

Evaluation Scheme

1. Student must perform three periods laboratory work twice a week to complete both PHY302 lab works.
2. PHY302 will be examined for the duration of six hours in two different three hours sessions.
3. The practical exam will be graded on the basis of the following marking scheme:

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

ELECTIVE PAPERS

Applied Mathematics

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

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

Course Objectives:

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

APPLIED MATHEMATICS [80 hours]

1. **Applications of differential equation:** 1.1 Differential equation of particle dynamics 1.2 Differential equation of electric circuit theory 1.3 Differential equation in nuclear physics 1.4 Differential equation in geometry 1.5 Elimination of arbitrary constant from a functional relation 1.6 Determination of arbitrary constants – initial and boundary value problems 1.7 Problems leading to first order equation with the variable separable 1.8 Problem leading to first order linear equations 1.9 Dynamical problem leading to ordinary linear differential equations 1.10 The damped harmonic oscillators: free vibrations 1.11 Systems of several masses 1.12 Geared systems [20 hours]
2. **Electric circuit theory:** 2.1 Electrical networks 2.2 Mechanical analogies 2.3 Steady state theory: Impedance 2.4 Filter circuits – variation of impedance with frequencies 2.5 Oscillator circuit: stability 2.6 Impulsive motion [10 hours]
3. **Particle dynamics:** 3.1 Function of position 3.2 Function of velocity 3.3 Non-linear problem in electric circuit theory 3.4 Oscillation of non-linear systems 3.5 Relaxation oscillation 3.6 Motion in two or more dimensions 3.7 Motion on a fixed plane curve 3.8 Central Forces 3.9 Motion of a particles whose mass varies [15 hours]
4. **Rigid dynamics:** 4.1 moments and products of inertia 4.2 Fundamental equations 4.3 Motion about a fixed axis 4.4 Motion in two-dimension 4.5 Problems of rolling and sliding 4.6 Impulsive motion 4.7 The gyrostat [15 hours]
5. **Applications of Fourier series:** 5.1 Fourier series in electric circuit theory 5.2 Fourier series in mechanical problems 5.3 Fourier series in boundary value problems 5.4 Double and multiple Fourier series 5.5 Fourier transforms: applications [10 hours]

6. **Applications of partial differential equations:** 6.1 The wave equation in one-dimension: simple solutions 6.2 The equations for the uniform transmission line 6.3 The Laplace equation in two dimensions 6.4 The use of Fourier series 6.5 The use of Laplace transformation 6.6 The use of conformal representation 6.7 Equation of continuity [10 hours]

Text Book:

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

Reference Books:

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

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

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

ELECTIVE PAPERS

Space Science

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

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

Course Objectives

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

SPACE SCIENCE [80 hours]

1. **Space Systems:** 1.1 Basic of orbital Mechanics 1.2 Concepts of orbits – propulsion 1.3 Aerodynamics, navigation, guidance and control systems 1.4 History and developments of Manned and Unmanned Space travel 1.5 Rocket launch technology [10 hours]
2. **Physics of Remote Sensing:** 2.1 Introduction – Electromagnetic Spectrum 2.2 Effects of Atmosphere – Fundamentals of Radiometry 2.3 Spectral Reflectance 2.4 Physical basis of signatures 2.5 Data Acquisition: Remote sensors 2.6 Optical-infrared sensors 2.7 Microwave 2.8 Geographical Information System: Components of GIS – Map Projections – Spatial and Non-Spatial data – Data model and input – data analysis and output 2.9 Remote Sensing Applications: Agriculture – forestry – land use / land cover mapping – water resources – snow and glacier – wetland management [15 hours]
3. **Earth System:** 3.1 Components of Earth System -- Atmosphere – Hydrosphere – Cryosphere – Lithosphere – Biosphere 3.2 Earth crust and Mantle. 3.3 Climate System – Feedback processes in Climate System – concept of feedback 3.4 Applications of feedback to the climate system. 3.5 Equations for the Atmosphere and Oceans 3.6 Equation of Continuity 3.7 Equations of Motion 3.8 Thermodynamic Energy Equation 3.8 Equation of state 3.9 Hydrological Cycle in the Earth System; 3.10 Carbon Cycle in the Earth System; 3.11 Oxygen in the Earth System [20 hours]
4. **Astronomy:** 4.1 Solar system 4.2 Comets and Asteroids 4.3 Exoplanets 4.4 Types and Population of stars 4.5 Magnitudes – apparent and absolute 4.6 Distance-magnitude relation 4.6 Extinction, 4.7 Hydrodynamic equilibrium 4.8 Linear Stellar Model 4.9 Gaseous Nebulae 4.10 Dust clouds & Molecular Clouds 4.11 HR diagram

4.12 Stellar nucleosynthesis 4.12 Stellar spectra 4.13 Telescopes and Detectors at various wavelengths. [20 hours]

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

Text Books:

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

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

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

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

Reference Books:

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

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

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

B.Sc. FOURTH YEAR

Quantum Mechanics

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

Course Title: Quantum Mechanics	**Year:** IV
Course Code: PHY401	**Full Marks:** 100
Nature of Course: Theory	**Pass Marks:** 35

Course Description:

This course aims at providing students with basic knowledge and skill in theoretical as well as experimental aspects non-relativistic quantum mechanics.

Course Objectives:

At the end of this course the student should be able:

- to acquire fundamental knowledge of quantum mechanics
- to apply this knowledge for higher studies and research in physics

QUANTUM MECHANICS [160 hours]

Course Contents:

1. **Introductory Wave Mechanics:** 1.1 Inadequacy of classical mechanics 1.2 Historical development of quantum theory 1.3 Davisson-Germer experiment: Result and its interpretation 1.4 de Broglie waves, 1.5 Group and phase velocity: relations and applications, 1.6 Uncertainty principle and its application [15 hours]
2. **Quantum Mechanical Wave Propagation:** 2.1 Equation of wave propagation, 2.2 Time dependent and time independent Schrödinger equation, 2.3 Wave function: information, importance & explanation 2.4 Normalization of wave function, 2.5 Expectation values of dynamical quantities, 2.6 General solution of Schrodinger equation 2.7 Time-independent Schrodinger equation in spherical polar coordinates [20 hours]
3. **Operator Formalism in Quantum Mechanics:** 3.1 Commuting and non-commuting operators, 3.2 Linear Operator, 3.3 Hermitian operator, 3.4 Orthogonal functions and orthogonality, 3.5 Parity operator, 3.6 Projection operator, 3.7 Position and momentum operators 3.8 Angular momentum operators 3.9 Hamiltonian operator 3.10 Commutation relations between

position, momentum, angular momentum and Hamiltonian operators: physical interpretation, 3.11 Angular momentum operators in spherical polar coordinates [20 hours]

4. **Postulates of Quantum Mechanics:** 4.1 Introduction 4.2 Statement of the postulates 4.3 Physical interpretation 4.4 Physical implications of the Schrodinger equation: 4.5 superposition principle 4.6 Conservation of probability: equation of continuity 4.7 Probability density and probability current density: their relations with group velocity 4.8 equation of motion for an observable 4.9 Principle of first quantization 4.10 Parity and observable 4.11 Ehrenfest theorem [20 hours]
5. **One Dimensional Quantum Mechanical Problems:** 5.1 Free particle, 5.2 Particle in a box, 5.3 Box normalization 5.4 Free particle in an infinite potential well 5.5 Particle in a finite potential well 5.6 Concept of potential: potential with finite walls, 5.7 Potential step, 5.8 Potential barrier, 5.9 Reflection and transmission coefficient 5.10 interpretation tunneling effect 5.11 Ramsauer Townsend effect, 5.12 Smooth barrier, 5.13 Cold emission of electrons in a metal: scanning tunneling microscope, 5.14 Alpha decay: Geiger Nuttal law, 5.15 Virtual binding [30 hours]
6. **Harmonic Oscillator and Applications:** 6.1 Linear harmonic oscillator, 6.2 Hermite polynomials, 6.3 Oscillator wave function 6.4 Even and odd parity states 6.5 Energy of harmonic oscillator, 6.6 Zero point energy 6.7 Hamiltonian of harmonic oscillator in terms of Creation and annihilation operator, 6.8 eigenvalue and eigenfunction of harmonic oscillator, 6.9 Momentum representation for oscillators, 6.10 Two coupled harmonic oscillators. [20 hours]
7. **Quantum Mechanical Problems and Solutions:** 7.1 Schrödinger equation for spherically symmetric potential 7.2 Angular part of Schrodinger equation: Spherical harmonics 7.3 Shapes of orbitals 7.4 Radial part of Schrodinger equation and its solution for Hydrogen atom, 7.5 Laguerre polynomials solution of Schrödinger equation for hydrogen atom 7.6 Transition probabilities and selection rules. [20 hours]
8. **Central Potential Problems:** 8.1 Two interacting particles, 8.2 Schrodinger equation for two interacting particles in spherical coordinates 8.3 Rigid rotator, 8.4 Free particle radial function, 8.5 Particle in a spherical box, 8.6 Spherical potential well of finite depth, 8.7 General results for two particles bound states. [15 hours]

Text Books:

1. *Agrawal, B.K. and Prakash, H*. – **Quantum Mechanics,** Prentice Hall of India, New Delhi (1997)

2. *Powell J. L. and Craseman B.*- **Quantum Mechanics**, Narosa, New Delhi (1994)

Reference Books:

1. *Merzbacher, E.* - **Quantum Mechanics,** 2nd ed., John Wiley, New York (1969)

2. *Mathews P. M. and Venkatesan K.* - **A Text Book of Quantum Mechanics**, Tata McGraw Hill Publishing Co. Ltd, New Delhi (1997)

3. *Prakash S. and Saluja S.*- **Quantum Mechanics,** Kedar Nath Ram Nath Publishing Co. (2002)

4. *Singh S. P., Bagde M. K. and Singh K*.- **Quantum Mechanics**, S. Chand & Company Ltd. (2002)

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

Course Title: Physics Laboratory (General)	**Year:** IV
Course Code: PHY402	**Full Marks:** 50
Nature of Course: Practical	**Pass Marks:** 20

Course Description:

Physics Laboratory (General) Practical course consists of three sections: (a) General Experiments, (b) Optical Experiments, and (c) Nuclear Experiments. Students have to perform at least 13 experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

Course Objectives:

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

PHYSICS LAB (General) [180 hours]

1. To determine the wave length of given source of light by Fresnel's Bi-Prism.
2. To study Lloyd's mirror for the determination of wavelength of Hg light.
3. To study the formation of fringe pattern by wedge shape and find the thickness of mica sheet.
4. To study the variation of refractive index with concentration of sugar solutions using a hollow prism.
5. Use the measured dataset of experiment 4 and calculate the standard deviation, standard error and probable error with significant figures. Generate theoretical data and test how well the measured data agrees with the theoretical data in this experiment. Show the trend of measured and theoretical data in a graph and interpret it.
6. To determine the value of Stefan's constant.

7. To determine the ratio of Cp and Cv by Clement and Desorme's apparatus.
8. To determine the ratio of C_p / C_v by using Ruchardt's Method.
9. To study the absorption of X-ray by the materials.
10. To determine the half-life period of a given radioactive substance using a G.M. counter.
11. To study the phenomenon of Back-Scattering using a thin radioactive β-source.
12. To study the absorption of β-particle by material to estimate the end-point energy of the β-particle.
13. To study the phenomenon of hysteresis loss of the material and to determine the hysteresis loss of the material over a cycle.
14. To design and study the parallel LCR circuits for finding the quality factor of the elements.
15. To find the dielectric constant of a material using resonance method.
16. To study the specific heat capacity of the materials using Calorimetric method.
17. To study the temperature dependence of resistance of a given semiconductor.

Text Books

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)

2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

Evaluation Scheme

1. Student must perform three periods laboratory work twice a week to complete both PHY402 lab works.
2. PHY402 will be examined for the duration of six hours in a session.
3. The practical exam will be graded on the basis of the following marking scheme:

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

Nuclear Physics & Solid State Physics

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

Course Title: Nuclear Physics and Solid State Physics **Year:** IV
Course Code: PHY403 **Full Marks:** 100
Nature of Course: Theory **Pass Marks:** 35

Course description:

This course aims at providing students with basic knowledge and skill in theoretical as well as experimental aspects of Nuclear Physics and Solid State Physics.

Course objective:

- To acquaint student with the theoretical and experimental methods in Nuclear and Solid State Physics.
- To prepare them in developing skill to pursue further study and research in the field of physics.

NUCLEAR PHYSICS (50%) [80 hours]

Course Contents:

1. **Nuclear Forces**: 1.1 Nuclear binding energy and saturation of nuclear forces, 1.2 Charge independence 1.3 Two nucleon system – deuteron problem, 1.4 Ground state of deuteron, 1.5 Magnetic moment, 1.6 Quadrupole moment tensor, 1.7 Interaction: nucleon - nucleon scattering, 1.8 singlet and triplet parameters, 1.9 Charge independence, 1.10 Isospin [12 hours]
2. **Nuclear Reactions**: 2.1 Nuclear transmutation, 2.2 Dscovery of neutrons, 2.3 Characterization and types of nuclear reactions, 2.4 Conservation theorems in nuclear reactions, 2.5 Q-value, 2.6 Threshold energy, 2.7 Cross-section of nuclear reactions, 2.8 Differential cross section, 2.9 Compound nucleus hypothesis [10 hours]
3. **Nuclear Models**: 3.1 Condition of nuclear stability 3.2 Liquid drop model, nuclear fission 3.3 Semi-empirical mass formula 3.4 Bohr-Wheeler theory, 3.5 Shell model: prediction, 3.6 Energy level scheme and explanations of magic numbers 3.7 Experimental evidences for nuclear magic numbers 3.8 Spin-orbit coupling, 3.9 Spins of nuclei, 3.10 Magnetic moments. [12 hours]
4. **Nuclear Reactors:** 4.1 Nuclear reactor: components, 4.2 Power of a nuclear reactor 4.3 Classification of nuclear reactors: Fission & Fusion, 4.4 Fission production and energy release chain reactions, 4.5 Multiplication factors and critically conditions, 4.6

Uranium reactor 4.7 Moderator 4.8 Controlled thermonuclear reactions 4.9 Proton-proton chain 4.10 Carbon-nitrogen-oxygen cycle [12 hours]

5. **Weak Nuclear Force**: 5.1 Beta decay - energy spectrum, 5.2 Fermi theory: neutrino hypothesis, 5.3 Fermi Curie plot, 5.4 Properties of neutrino 5.5 Types: electron neutrino, muon neutrino and Taon neutrino 5.6 Cross-section of neutrino 5.7 Fermi and Gammow – Teller selection rules, 5.8 Decay rates - non conservation and selection rules, 5.9 Nuclear isometrics, 5.10 Angular correction in successive gamma emissions [12 hours]
6. **Cosmic Rays:** 6.1 Discovery and properties of cosmic rays, 6.2 Primary and secondary cosmic rays, 6.3 Origin of cosmic rays, 6.4 Detection of cosmic rays [4 hours]
7. **Elementary Particles**: 7.1 Introduction 7.2 Classification of elementary particles: leptons and quarks 7.3 Meson theory of nuclear forces, 7.4 Conservation laws: lepton number, baryon number, parity, charge conjugation 7.5 Parity violation: examples and explanation, 7.6 Isospin conservation 7.7 Strangeness conservation 7.8 Hypercharge conservation [10 hours]
8. **Particle Interaction:** 8.1 Quark model: generations and properties 8.2 Baryon and Meson: properties and examples 8.3 Hyperon: examples 8.4 Interaction of quarks and leptons 8.5 Symmetry properties of interactions 8.6 Crossing symmetry 8.7 Standard Model of particle physics: matter sector [8 hours]

SOLID STATE PHYSICS (50%) [80 hours]

Course Contents:

1. **Types and Structure of Crystals**: 1.1 Crystalline types of solid, amorphous and glassy, liquid state, 1.2 Lattice and lattice translational vector, 1.3 symmetry operations and space groups, basis and crystal structure, 1.4 Primitive lattice cell, 1.5 Fundamental types of lattices - two and three dimensional lattices, 1.6 Simple crystal structures- (i) simple, body-centered and face-centered cubic (ii) sodium chloride, (iii) hexagonal close-packed, (v) diamond structures, 1.7 Primitive unit cell,1.8 Wigner-Seitz cell [12 hours]
2. **Crystal Structure from Diffraction:** 2.1 Neutron and X-ray diffraction techniques for studying crystal structure, 2.2 Bragg's law, 2.3 Laue method, 2.4 Brillouin zone: First Brillouin zone of (i) simple cubic, (ii) body centered cubic and (iii) face centered cubic lattices, 2.5 Lattice Planes and Miller indices, 2.6 reciprocal lattice- reciprocal lattice vectors, reciprocal lattice to simple cubic, body centered cubic and face centered cubic lattices; 2.7 Geometrical Structure Factor, 2.8 Atomic Form Factor [12 hours]
3. **Bonding in Crystals:** 3.1 Equilibrium lattice constant, 3.2 Different types of bonding (ionic, covalent, metallic, hydrogen) in crystals and lattice energy, 3.3 Bonding in Crystals of Inert gases [5 hours]
4. **Defects in Crystals:** 4.1 Lattice vacancies, colour-centers, alloy, slip, types of dislocations, 4.2 Burgers vector, 4.3 Dislocation and crystal growth [6 hours]

5. **Lattice Dynamics:** 5.1 Lattice vibration, 5.2 phonon spectrum, 5.3 lattice specific heat – Dulong and Petits relation, Einstein theory, Debye's theory, 5.4 Thermal conductivity – Thermal resistivity of phonon gas, 5.5 Umklapp processes [8 hours]
6. **Free Electron Theory:** 6.1 Free electron theory of metals, 6.2 density of states, 6.3 Fermi energy, 6.4 electron specific heat, relaxation time, mean free path, mobility, thermal conductivity, electrical conductivity, 6.5 Wiedmann-Franz law, 6.6 Hall effect [7 hours]
7. **Band Structure of Crystals:** 7.1 Bloch Functions**,** 7.2 Concept of energy bands in solids, 7.3 Energy bands in one dimension, 7.4 Energy-wave vector curves in three dimensions, 7.5 The tight binding method – Linear combination atomic orbitals, applications to bands from s-levels, 7.6 Valence and conduction band, 7.7 distinction between conductor, insulator and semiconductor on the basis of band theory, 7.8 Fermi surfaces, 7.9 Number of orbitals in a band [12 hours]
8. **Semiconductors**: 8.1 Types of semiconductors (extrinsic and intrinsic) and carrier concentration, 8.2 Impurity conductivity- donor states, acceptor states, 8.3 Thermal ionization of donors and acceptors; Mobility [4 hours]
9. **Superconductivity**: 9.1 General properties of superconductors, 9.2 zero resistivity, 9.3 Critical temperature, Critical magnetic field, 9.4 Meissner effect, 9.5 Type I and type II Superconductors [7 hours]
10. **Dielectric properties**: 10.1 Dielectric constant and polarizability, 10.2 Electronic, ionic and orientational polarizabilities, 10.3 Electric Susceptibility, 10.4 Clausius Mosotti Equation [4 hours]
11. **Magnetism**: 11.1 Dia-, Para-, Ferri-,Antiferro- and Ferromagnetic Materials, 11.2 Classical Langevin Theory of dia – and Paramagnetic Domains, 11.3 Quantum Mechanical Treatment of Paramagnetism, 11.4 Curie's law, 11.5 Weiss's Theory of Ferromagnetism and Ferromagnetic Domains [7 hours]

Text Books:

1. *Roy R. R. and Nigam B. P.* - **Nuclear Physics: Theory and Experiment,** New age International (P) Limited, India (1967)

2. *Marmier, P. and Sheldon E.* - **Physics of Nuclei and Particles**, Academic Press New York London (1970)

3. *Kittel C.* – **Introduction to Solid State Physics,** 8th ed., John Wiley & Sons Ltd, India (2005)

4. *Ashkroft N. L. W. and Mermin*- **Solid State Physics**, Holt Rinehart and Winston, New York (1976)

Reference Books

1. *Kaplan I.* - **Nuclear Physics**, 2nd ed., Oxford & IBH Publishing Co. Pvt. Ltd (1962)

2. *Srivastava B. N.* - **Basic Nuclear Physics**, 8th ed., Pragati Prakashan, Meerut, India, (1968)

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

4. *Elliot R. J. & Gibson A. F.* – **An Introduction to Solid state Physics and its Application**, ELBS, Macmilan (1974)

5. *Harrison W. A.* – **Solid State Theory**, Tata McGraw Hill, India (1977)

6. *Dekker A. J.* – **Solid State Physics**, Macmillan, Students Edition (1991)

7. Luth H. and Ibach H. – **Solid State Physics**, Narosa Publishing House, New Delhi (1991)

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

Course Title: Physics Laboratory (Electronics)	**Year:** IV
Course Code: PHY404	**Full Marks:** 100
Nature of Course: Practical	**Pass Marks:** 35

Course Description:

Students have to perform at least 13 Electronics experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

Course Objectives:

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

PHYSICS LAB (Electronics) [180 hours]

1. Study the low frequency response circuits and calculate their cut-off frequencies.
2. Study the high frequency response circuits and calculate their cut-off frequencies.
3. To construct astable multivibrator using 555 timer and study its performance.
4. To construct monostable multivibrator using 555 timer and study its function.
5. To construct and to study the characteristics of RS flip-flop.
6. To construct and to study the characteristics of J-K flip-flop.
7. To construct a voltage multipliers (doubler) and study its characteristics.
8. To construct a voltage multipliers (tripler) and study its characteristics.
9. To construct and study the working of NOT, AND, OR gates using diodes and transistors.
10. Calculate the power loss in transistors in each case (NOT, AND and OR) wherever it is applicable.

11. To study operational amplifier for its input-output waveform and use it as an integrator and differentiator.

12. To construct differential amplifier and estimate it's CMRR (Common mode rejection ratio).

13. To study the working of half adder.

14. To study the working of full adder.

15. To construct D/A converter and to study its working.

Text Books

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)

2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

Evaluation Scheme

1. Student must perform three periods laboratory work twice a week to complete both PHY404 lab works.
2. PHY404 will be examined for the duration of six hours in a session.
3. The practical exam will be graded on the basis of the following marking scheme:

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

Material Science

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

Course Title: Material Science	**Year:** IV
Course Code: Phy405	**Full Marks:** 100
Nature of Course: Theory/Optional	**Pass Marks:** 35

Course Description:

This course aims at providing students with basic knowledge and skill in theoretical as well as experimental aspects of Material Science.

Course Objective:

- To acquaint student with the theoretical and experimental methods in Material Science.
- To prepare them in developing skill to pursue further study and research in the field of physics.

MATERIAL SCIENCE [160 hours]

Course Contents:

1. **Introduction**: 1.1 Historical perspectives 1.2 Importance of Materials science 1.3 Classification of materials 1.4 Advanced Materials 1.5 Modern Materials need [5 hours]
2. **Synthesis of Materials**: 2.1 Definition of synthesis; historical examples of key synthetic discoveries; future prospects 2.2 Review of thermodynamics and kinetics in synthesis [8 hours]
3. **Atomic Structures and Bonding**: 3.1 Atomic structure; 3.1.1 Fundamental concepts 3.1.2 Electrons in atoms 3.2 bonding forces and energies 3.3 Interatomic bonds 3.4 Molecules [4 hours]
4. **Structure of Crystalline Solids**: 4.1 Crystalline and Non crystalline materials 4.2 Crystallographic directions 4.3 Crystallographic planes 4.4 Single crystals 4.5 Review of Metallic crystal structures – fcc, bcc and hcp structure 4.6 Density computation 4.7 Idea of ceramic crystal structures 4.8 Polymer crystallinity 4.9 Polycrystalline materials 4.10 X-ray diffraction – Determination of Crystal Structures [16 hours]
5. **Imperfections in Solids:** 5.1 Introduction 5.2 Point defects 5.3 Linear defects [8 hours]

6. **Phase diagrams**: 6.1 Phases and phase diagrams – one component system 6.2 Binary phase diagrams; two component systems 6.3 Gibbs phase rule 6.4 examples – Ni-Cu and Fe-C [12 hours]
7. **Mechanical Properties of Metals**: 7.1 Concept of stress and strain 7.2 Elastic deformation 7.3 Plastic deformation 7.4 Hardness [5 hours]
8. **Failure of Metals**: 8.1 Fundamentals of fracture 8.2 Principles of fracture mechanics 8.3 Crack initiation and propagation [5 hours]
9. **Mechanical properties of ceramics and polymers**: 9.1 Stress-strain behavior of ceramics 9.2 Stress-strain behavior of polymers 9.3 Viscoelastic deformation of polymers [8 hours]
10. **Electrical Properties of Materials**: 10.1 Electrical conductivity 10.2 Energy band structures in solid 10.3 Conduction in terms of bands and atomic bonding models 10.4 Electrical characteristics of commercial alloys 10.5 Semiconductors – Temperature dependence of carrier concentration, factors that affect carrier mobility, semiconductor devices 10.6 Dielectric strengths 10.7 Dielectric materials 10.7 Ferroelectricity 10.8 Piezoelectricity [18 hours]
11. **Magnetic Properties of Materials**: 11.1 Diamagnetism and paramagnetism 11.2 Ferromagnetism and antiferromagnetism 11.3 Ferrimagnetism 11.4 Magnetic storage 11.5 Soft and Hard magnetic materials [8 hours]
12. **Thermal Properties of Materials**: 12.1 Heat capacity 12.2 Thermal expansion 12.3 Thermal conductivity 12.4 Thermal stress [7 hours]
13. **Optical Properties of Materials**: 13.1 Electromagnetic radiation 13.2 Interaction of light with solids 13.3 Atomic and electronic interactions 13.4 Luminescence 13.5 Photoconductivity 13.6 Lasers 13.7 Optical fibers in communications [10 hours]
14. **Science of Nanomaterials**: 14.1 Introduction to nanomaterials 14.2 Methods of synthesis of nanoparticles – chemical methods, pulsed laser methods 14.3 Size Dependence of Properties of Materials 14.4 Methods of measuring properties 14.4.1 Particle size determination 14.4.2 Microscopy techniques – Transmission electron microscopy and Scanning microscopy 14.4.3 Spectroscopic Techniques – IR and Raman spectroscopy, Magnetic Resonance 14.5 Carbon nanostructures 14.6 Electrical and mechanical properties of carbon nanotube 14.7 Applications of carbon nanotube 14.8 Quantum wells, wires and dots 14.8.1 Size effects 14.8.2 Conduction electrons and dimensionality 14.8.3 Fermi gas and dimensionality 14.8.4 potential well 14.8.5 Properties dependent on density of states 14.9 Applications – Quantum dot Lasers [30 hours]
15. **Processing of Materials**: 15.1 Introduction 15.2 Fabrication of metals – Forming operations, Casting, Heat treatment of steels 15.3 Processing of Ceramics – Glass forming, Fabrication and processing of clay products 15.4 Processing of Polymers – Forming techniques for plastics, fabrication of fibers and films [10 hours]
16. **Economic, Environmental and Societal Issues in Materials Science**: 16.1 Component design 16.2 materials 16.3 manufacturing techniques 16.4 Recycling issues 16.5 Essays on social issues, safety issues, economic issues etc. [6 hours]

Text Books

1. *Callister W. D. and Rethwisch D.G.* - **Callister's Material Science and Engineering**, 2nd Edition, Wiley India, New Delhi (2014)

2. *Poole C. P. and Owens F. J.* - **Introduction to Nanotechnology**, Wiley India, New Delhi (2006)

References Books

1. *Tiley R. J. D.* - **Understanding solids: The Science of Materials**, John wiley & Sons, England (2004)

2. *Patton W. J.* - **Materials in Industry**, Prentice-Hall of India, New Delhi (1975)

3. *Raghavan V.* - **Materials Science and Engineering**, 4th Edition, Prentice-Hall of India, New Delhi, (2003)

4. *Lindsay S. M.* - **Introduction to Nanoscience**, Oxford University Press, New York (2010)

Project Work

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

Course Title:	Project Work	**Year:**	IV
Course Code:	**PRO406**	**Full Marks:**	100
Nature of Course:	Research Work / Presentation	**Pass Marks:**	40

Course Description

This course offers students to learn the research works in science leading to their core subject. Students are required to review literature of his/her field of interest to identify a problem in the project work, that problem should be addressed by the students.

PROJECT WORK RESEARCH

Project Guidelines

1) A student or a group of student can do project work only if a faculty or a subject teacher agrees to supervise his/her project work. It is the responsibility of TU faculties to carry our educational and research activities.

2) The nature of project work can be field work, theoretical work, computational work, observational work and experimental work. Whatever the nature of the work, students should **critically review literature** of the area of interest and identify the problem specifically.

3) Students should prepare a proposal and submit it to the department within three month of the enrollment in the fourth year. The general format of the proposal should like this:
   (a) Background/Introduction
   (b) Literature Review
   (c) Motivation/Objectives
   (d) Methodology
   (e) Expected Result
   (f) References (format should be decided by concerned subject committee)
4) The final VIVA examination should be held within a couple of month of the fourth year final examination. Three names of the external examiner will be proposed by the concerned colleges upon consultation with the department. An external examiner will be appointed by the Dean office, IoST, TU. The internal examiner will be appointed by the concerned department.

5) The format of the project work will be decided by the Central Department Research Committee (CDRC) of particular subject. The general format should be similar to that of the M.Sc. dissertation of respective subject.
6) The evaluation committee consist 4 members - HoD or program coordinator, supervisor, external and internal examiners. A separate evaluation form will be given to all four members of the evaluation committee during the VIVA examination that contains the following:
    (a) Introduction to the subject 10%
    (b) Literature review 10%
    (c) Motivation/Objectives 10%
    (d) Originality and creativity: 10%
    (e) In-depth Research: 10%
    (f) Methods 10%
    (g) Figures/plots/tables 10%
    (h) Interpretation 10%
    (i) Comparison 10%
    (j) Presentation: 10%
7) There will be additional fee for the project. Student needs to pay this amount. Remuneration for the supervisor is recommended. It will be decided by the Dean Office, IoST, TU.
8) The eligibility criteria for the students, supervisors, co-supervisors will be decided by the Dean office.

Note: *The detail of point (8) is added in the appendix here.*

Econophysics

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

Course Title: Econophysics	**Year:** IV
Course Code: Phy407	**Full Marks:** 50
Nature of Course: Theory / Interdisciplinary	**Pass Marks:** 17.5

Course Description:

This course aims at providing students with basic knowledge of economics and its connections with physics.

Course Objectives:

At the end of this course the student will learn about the interplay between economics and physics: an interdisciplinary area, where physics theories is used to solve problems in economics.

ECONOPHYSICS [80 hours]

1. **Introduction:** 1.1 Motivation 1.2 Pioneering approaches 1.3 The chaos approach 1.4 The present focus [6 hours]
2. **Efficient market hypothesis:** 2.1 Introduction 2.2 Concepts, paradigms, and variables 2.3 Arbitrage 2.4 Efficient market hypothesis 2.5 Algorithmic complexity theory 2.6 Amount of information in a financial time serie 2.7 Idealized systems in physics and finance [10 hours]
3. **Random walk:** 3.1 Introduction 3.2 One-dimensional discrete case 3.3 The continuous limit 3.4 Central limit theorem 3.5 The speed of convergence 3.6 Berry-Esseen Theorem-1 3.7 Berry-Esseen Theorem-2 3.8 Basin of attraction [16 hours]
4. **Levy stochastic processes and limit theorems:** 4.1 Introduction 4.2 Stable distributions 4.3 Scaling and self-similarity 4.4 Limit theorem for stable distributions 4.5 Power-law distributions 4.6 The St Petersburg paradox 4.7 Power laws in finite systems 4.8 Price change statistics 4.9 Infinitely divisible random processes 4.10 Stable processes 4.11 Poisson process 4.12 Gamma distributed random variables 4.13 Uniformly distributed random variables 4.14 Summary [22 hours]
5. **Scales in financial data:** 5.1 Introduction 5.2 Price scales in financial markets 5.3 Time scales in financial markets 5.4 Summary [6 hours]
6. **Stationary and time correlation:** 6.1 Introduction 6.2 Stationary stochastic processes 6.3 Correlation 6.4 Short-range correlated random processes 6.5 Long-range correlated random processes 6.6 Short-range compared with long-range correlated noise 6.7 Time correlation in financial time series 6.8 Autocorrelation

function and spectral density 6.9 Higher-order correlations: The volatility 6.10 Stationary of price changes 6.11 Summary [20 hours]

Text Book

2. *Mantegna R. N. and Stanley H. E.* **- An Introduction to Econophysics: Correlations and Complexity in Finance**, First Edition, Cambridge University Press (2000)

Reference Book

1. *Sinha S., Chatterjee A., Chakraborti A., Chakrabarti B. K.* - **Econophysics: An Introduction,** Wiley-VCH (2010)