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)