CURRICULUM

OF

PHYSICS
BS (4-YEAR)

2008

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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PREFACE

Curriculum development is a highly organized and systematic process and involves a number of procedures. Many of these procedures include incorporating the results from international research studies and reforms made in other countries. These studies and reforms are then related to the particular subject and the position in Pakistan so that the proposed curriculum may have its roots in the socio-economics setup in which it is to be introduced. Hence, unlike a machine, it is not possible to accept any curriculum in its entirety. It has to be studied thoroughly and all aspects are to be critically examined before any component is recommended for adoption.

In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification No. D773/76-JEA (cur.), dated December 4th 1976, appointed the University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at the bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellor's Committee, the curriculum of a subject must be reviewed after every 3 years.

A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The new BS degree shall be of 4 years duration, and will require the completion of 130-136 credit hours. For those social sciences and basic sciences degrees, 63.50% of the curriculum will consist of discipline specific courses, and 36.50% will consist of compulsory courses and general courses offered through other departments.

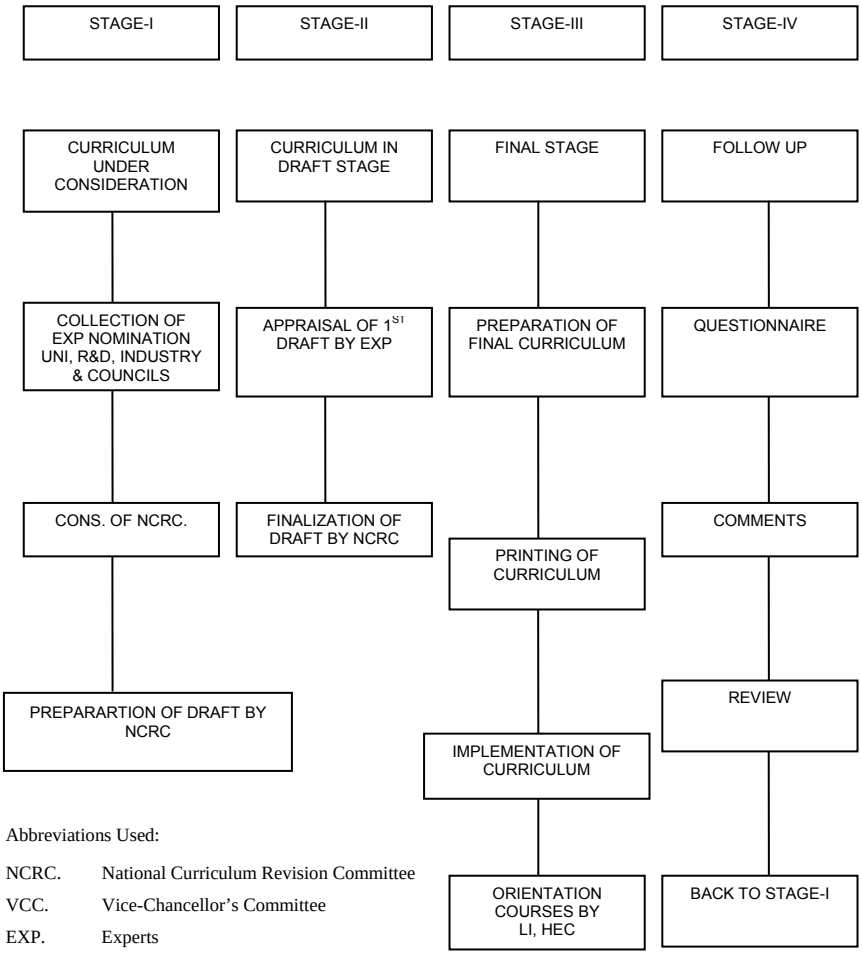
For the purpose of curriculum revision various committees are constituted at the national level, comprising of senior teachers nominated by universities, degree awarding institutions, R&D organizations and respective accreditation councils. The National Curriculum Revision Committee for Physics in a meeting held on March 28-29, 2008 at the

HEC Regional Center, Karachi in continuation of its earlier meeting held on November 16-17, 2007 at HEC Regional Center, Lahore, revised the curriculum in light of the unified template. The final draft prepared by the National Curriculum Revision Special Committee, duly approved by the competent authority, is being circulated for implementation in the concerned institutions.

DR.RIAZ-UL-HAQ TARIQ
Member Academics

June 2008

CURRICULUM DEVELOPMENT



Abbreviations Used:

NCRC.	National Curriculum Revision Committee
VCC.	Vice-Chancellor's Committee
EXP.	Experts
COL.	Colleges
UNI.	Universities
PREP.	Preparation
REC.	Recommendations
LI	Learning Innovation
R&D	Research & Development Organization
HEC	Higher Education Commission

Introduction

The 2nd and Final NCRC Special Meeting in Physics was held on March 28-29, 2008 at HEC Regional Centre, Karachi to adjust and finalize the BS Physics (4 Year) curriculum in the light of HEC approved guidelines and generic unified frame work / template for social and natural sciences for the program. This meeting was follow up of the preliminary meeting, held on November 16-17, 2007 at HEC Regional Centre, Lahore. The following attended the Meetings:

1. Prof. Dr. Muhammad Ayub, Convener
   Professor, Department of Physics,
   Gomal University, D.I. Khan
2. Prof.Dr.Muhammad Riaz Khan, Member
   Director, Centralized Resource Laboratory,
   Department of Physics,
   University of Peshawar, Peshawar.
3. Prof. Dr. Muhammad Siddique Kalhoro, Member
   Director Institute of Physics,
   University of Sindh,
   Jamshoro.
4. Prof. Dr. Qurban Ali Bhatti, Member
   Chairman, Department of Physics,
   Shah Adul Latif University,
   Khairpur.
5. Prof. Dr. Manzoor Hussain, Member
   Department of Physics,
   University of the Punjab,
   Lahore.
6. Prof. Dr. Ansar A. Qidwai, Member
   Chairman, Department of Physics,
   University of Karachi, Karachi.
7. Prof.Dr.Hassan Amir Shah, Member
   Department of Physics,
   Government College University,
   Lahore.
8. Prof. Dr. Ashraf Chaudhry, Member
   Department of Physics,
   Bahauddin Zakria University,
   Multan

9. Prof. Dr. Syed Zafar Ilyas, Member
   Department of Physics,
   University of Balochistan,

10. Prof. Dr. M. Younis Nadeem, Member
    Chairman,
    Department of Physics,
    B.Z. University
    Multan

11. Dr. Riaz Ahmad, Member/ Secretary
    Associate Professor,
    Government College University,
    Lahore

The Meeting started with a recitation from Holy Quran by Mr. Shafiullah Khan, Assistant Director HEC, Islamabad. Mr. Muhammad Rafiq Rai, Incharge HEC Regional Centre, Karachi welcomed the participants. Mr. Shafiullah Khan requested the participants to finalize the revised curriculum of Physics (2005) in line with HEC approved template for BS (4 year) program in the light of decisions taken in the first NCRC special meeting in physics held on November 16-17, 2007 at HEC, Regional Centre, Lahore. The objective of the meeting was explained and the forum was requested to select a convener & secretary of the meeting. The committee unanimously selected Prof. Dr. Muhammad Ayub as convener and Dr. Riaz Ahmad as a secretary.

After a thorough and long discussion, the participants agreed to the following scheme of study and course outlines for BS (4 Year) program in Physics in the light of the guidelines and format approved by HEC for BS (4-years) program for natural sciences:

Objectives of BS 4 Year program in Physics

The Objective of BS 4 Year Program is to impart the best possible education in the subject so that students will utilize the knowledge of Physics in practical life which will be beneficial for the society. The primary aim of the programme is to produce broad-based graduates, able to face the challenges of the modern world. This programme will equip the students with firm foundation in principles of Physics and their applications. The graduates will be able to apply their knowledge of Physics for their professional growth and for obtaining further Higher Education in specialized fields of Physics

The main educational objectives of BS (4-year) program are:

1. Student will learn fundamentals principles of Physics.
2. Students will develop and understanding of different basics of Physics and their applications to real problems.
3. Students will develop problem-solving skills which will be helpful in applying their knowledge to the real world. Students will develop habit of independent learning and get motivation for self-education.
4. Students will develop effective skills in mathematics and its applications to the solutions of Physics problems.
5. Students will develop skills in written as well as oral communication in English.
6. Students will develop the ability of working in an interactive group.
7. Students will develop hands-on experience in different laboratory techniques.
8. Students will be able to design and conduct experiments and analyse experimental data.
9. Students will develop in-depth understanding of some specialized area of Physics by opting for a number of elective courses.
10. Students will be prepared for careers in teaching, research and industry in government / private organizations.
11. Students will develop critical and rational reasoning so that they will be able to work on complex and unforeseen problems and seek their solution.

LAYOUT FOR BS (4 YEAR) PHYSICS

Compulsory Requirements (the student has no choice)		General Courses to be chosen from other departments		Discipline Specific Foundation Courses	
9 courses		7-8 courses		9-10 courses	
25 Credit hours		21-24 Cr. hours		30-33 Credit hours	
Subject	**Cr hr**	**Subject**	**Cr hr**	**Subject**	**Cr hr**
1. ENGLISH-I	3	GOF-I	3	1. Mechanics – I	2
2. ENGLISH-II	3	GRF-I	3	2. Waves and Oscillations,	3
3. ENGLISH-III	3	Maths-III	3	3. Mechanics – II	2
4. ENGLISH-IV*	3	GOF-II	3	4. Heat & Thermodynamics	3
5. PAKISTAN STUDIES	2	GOF-III	3	5. Electricity & Magnetism-I	3
6. ISLAMIC STUDIES / ETHICS	2	GRF-II	3	6. Modern Physics & Electronics	3
		Maths-IV	3	7. Electricity & Magnetism – II	3
7. MATHEMATI-CS-I	3			8. Optics / University Option	3
8. MATHEMATICS-II**	3			9. Atomic & Molecular Physics	3
9. INTRODUCTION TO COMPUTER	3			10. Lab-I	1
				11. Lab-II	1
				12. Lab-III	1
				13. Lab-IV	1
	25		21		29

Major courses including research project/internship		Elective Courses within the major	
11-13 courses		4 courses	
36-42 Credit hours		12 Credit Hours	
Subject	**Cr hr**	**Subject**	**Cr hr**
1. Quantum Mechanics – I	3	1. Elective I - I	3
2. Classical Mechanics	3	2. Elective - II	3
3. Electronics	3	3. Elective - III	3
4. Lab-V	2	4. Elective – IV / Research Project	3
5. Mathematical Methods – I	3		
6. Quantum Mechanics –II	3		
7. Electromagnetic Theory-I	3		
8. Thermal & Statistical Physics	3		
9. Nuclear Physics	3		
10. Solid State Physics	3		
11. Lab-VI	2		
12. Computational Physics	3		
13. Lab-VII	2		
14. Electromagnetic Theory-II	3		
15. University Option	3		
16. Mathematical Methods – II	3		
	45		12

Total Credit Hours 132

* University has the option to recommend any other course in lieu of English-IV

** University may recommend any other course in lieu of Mathematics-II

GOF= General Subjects from Faculties other than Science
GRF= General Subject from Science Faculty

SCHEME OF BS (4 YEAR) PROGRAMME IN PHYSICS

Semester-1		
Title	**Cr. Hrs.**	**Remarks**
English-I	3	Comp-1
Pak Studies	2	Comp-2
Maths-1	3	Comp-3
Introduction to Computers	3	Comp-4
Mechanics-I	2	Found-1
GOF-I	3	Gen-1
Lab-I	1	Found-2
Total	**17**	

Semester-II		
Title	**Cr. Hrs.**	**Remarks**
English-II	3	Comp-5
Islamic Studies	2	Comp-6
Maths-II	3	Comp-7
GRF-I	3	Gen-2
Waves & Oscillations	3	Found-3
Mechanics-II	2	Found-4
Lab-II	1	Found-5
Total	**17**	

Semester-III		
Title	**Cr. Hrs.**	**Remarks**
English-III	3	Com-8
Electricity & Magnetism-I	3	Found-6
Heat & Thermodynamics	3	Found-7
Maths-III	3	Gen-3
Optics/University Option*	3	Found-8
GOF-II	3	Gen-4
Lab-III	1	Found-9
Total	**19**	

Semester-IV		
Title	**Cr Hrs.**	**Remarks**
English-IV University Option	3	Comp-9
Modern Physics & Electronics	3	Found-10
GOF-III	3	Gen-5
Maths-IV	3	Gen-6
Electricity & Magnetism-II	3	Found-11
GRF-II	3	Gen-7
Lab-IV	1	Found-12
Total	**19**	

Semester-V		
Title	**Cr Hrs.**	**Remarks**
Mathematical Methods of Physics-I	3	Maj-1
Quantum Mechanics-I	3	Maj-2
Thermal & Statistical Physics	3	Maj-3
Classical Mechanics	3	Maj-4
Electronics	3	Maj-5
Lab-V	2	Maj-6
Total	**17**	

Semester-VI		
Title	**Cr. Hrs.**	**Remarks**
Mathematical Methods of Physics -II	3	Maj-7
Quantum Mechanics -II	3	Maj-8
Electromagnetic Theory -I	3	Maj-9
Nuclear Physics	3	Maj-10
Solid State Physics	3	Maj-11
Lab-VI	2	Maj-12
Total	**17**	

Semester-VII		
Title	**Cr. Hrs.**	**Remarks**
Computational Physics	3	Maj-13
Atomic & Molecular Physics	3	Found-13
Electromagnetic Theory-II	3	Maj-14
Elective-I	3	Elective
LAB-VII	2	Maj-15
Total	**14**	

Semester-VIII		
Title	**Cr Hrs.**	**Remarks**
Elective-II	3	Elective
Elective-III	3	Elective
Elective-IV/Research Project	3	Elective
University Option*	3	Maj-16
Total	**12**	

Total Credit Hours = 132

Note: *GOF= General Subjects from Faculties other than Science Faculty*
GRF= General Subject from Science Faculty
The Universities may reshuffle courses within semesters

* **University Option** is given to universities in order to introduce subjects according to specialization of qualified staff available

Course Profiles

Dr. Riaz Ahmed was requested to prepare the course profiles for different courses and submit the same to Mr. Shafiullah Khan, Assistant Director (Curriculum), HEC, Islamabad on the prescribed format by 10th April, 2008.

The Meeting ended with thanks from the chair.

Dr. Riaz Ahmad
(Secretary)

Prof. Dr. Muhammad Ayub
(Convener)

DETAILS OF COURSES

MECHANICS-I 2 Cr.h

Pre-requisite
A Level Physics and F.Sc. (Physics + Math)

Objectives:
1. To give concept of vector and their various properties.
2. To give basic understanding of laws of motion and their applications is daily life.
3. To give mathematical concept and expressions of various physical parameters used in mechanics.

Vector Analysis:
Review of Vector in 3 dimensions and fundamental Operations, Direction, Cosines, Spherical polar coordinates, Cylindrical Coordinaties. Vector and scalar triple products, gradient of a scalar, Divergence and curl of a vector, Physical significance of each type, Divergence of a vector, flux, curl and line integral (mutual relation). Vector identities, Divergence Theorem, Stoke's Theorem, their derivation, physical importance and applications to specific cases.

Particle Dynamics:
Dynamics of uniform, circular motion, the banked curve, Equations of motion, Deriving kinetic equations for x(t), v(t) via integration, Constant and variable forces, normal forces and contact forces, special examples, Time dependent forces, Obtaining x(t), v(t) for this case using integration method, Effect of drag forces on motion, Applying Newton's Laws to obtain v(t) for the case of motion with time dependent (Integration approach) drag (viscous) forces, terminal velocity, Projectile motion with and without air resistance, Non inertial frames and Pseudo forces, Qualitative discussion to develop understanding, Calculation of pseudo forces for simple cases (linearly accelerated reference frames), Centrifugal force as an example of pseudo force, Coriolis force.

Work, Power and Energy:
Work done by a constant force, work done by a variable force (1-2 dimension), (Essentially a review of grade-XII concepts via integration technique to calculate work done (e.g. in vibration of a spring obeying Hooke's Law), Obtaining general expression for work done (2-dimensional case) and applying to simple cases e.g. pulling a mass at the end of a fixed string against gravity, Work energy theorem, General

proof of work energy theorem: Qualitative review of work energy theorem, Derivation using integral calculus, Basic formulae and applications, Power, Energy changes with respect to observers in different inertial frames, Conservation of Energy in 1, 2, and 3 dimensional conservative systems, Conservative and non conservative forces: Conservation of energy in a system of particles, Law of conservation of total energy of an isolated system.

Systems of Particles:

Two particle systems and generalization to many particle systems, Centre of mass, Position, velocity and equation of motion, Centre of mass of solid objects, Calculation of Centre of Mass of solid objects using integral calculus, Calculating C.M. of Uniform Rod, Cylinder and Sphere, Momentum Changes in a system of variable mass, Derivation of basic equation, application to motion of a rocket (determination of its mass as a function of time).

Collisions:

Elastic Collisions, Conservation of momentum during collision in one and two dimensions, Inelastic collision, Collisions in centre of Mass reference frame (One and two dimensions), Simple applications, obtaining velocities in C.M. frame.

Recommended Books:

1. Halliday, D. Resnick, Krane, Physics, Vol. I & II, John Wiley, 5th ed. 1999.
2. D. Kleppner and R. Kolenkow, An Introduction to Mechanics, McGraw Hill, 1978.
3. M. R. Speigel, Vector Analysis and an Introduction to Tensor Analysis, Mc-Graw Hill, 1959.

MECHANICS-II 2 Cr.h

Pre-requisite

A Level Physics and F.Sc. (Physics + Math)

Objectives:

1. To give the basic concept of rotational motion, law of gravitation, physical properties of matter and relativistic mechanics
2. Uses of above concepts in daily life in a scientific way

Rotational Dynamics:

Relationships between linear & angular variables, scalar and vector form. Kinetic energy of rotation, Moment of Inertia, Parallel axis and Perpendicular axis theorems, Proof and Illustration, application to simple cases, Determination of moment of inertia of various shapes i.e. for disc, bar and solid sphere, Rotational dynamics of rigid bodies, Equations of rotational motion and effects of application of torques, Combined rotational and translational motion, Rolling without slipping.

Angular Momentum:

Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum, Stability of spinning objects, Discussion with examples, The spinning Top, Effects of torque on the angular momentum, precessional motion.

Gravitation:

Gravitational effect of a spherical mass distribution, Its mathematical treatment, Gravitational Potential Energy (develop using integration techniques), calculation of escape velocity, Gravitational field & Potential, Universal Gravitational Law. Radial and transversal velocity and acceleration, Motion of Planets and Keplers' Laws (Derivation & explanation) Motion of Satellites, Energy considerations in planetary and satellite motion, Qualitative discussion on application of gravitational law to the Galaxy.

Bulk Properties of Matters.

Elastic Properties of Matter, Physical basis of elasticity, Tension, Compression & shearing, Elastic Modulus, Elastic limit. Poisson's ratio, Relation between three types of elasticity, Fluid Statics, Variation of Pressure in fluid at rest and with height in the atmosphere, Surface Tension, Physical basis; role in formation of drops and bubbles, Viscosity, Physical basis, obtaining the Coefficient of viscosity, practical example of viscosity; fluid flow through a cylindrical pipe (Poiseulle's law).

Special Theory of Relativity:

Inertial and non inertial frame, Postulates of Relativity, The Lorentz Transformation, Derivation, Assumptions on which inverse transformation is derived, Consequences of Lorentz transformation, Relativity of time, Relativity of length, Relativity of mass, Transformation of velocity, variation of mass with velocity, mass energy relation and its importance, relativistic momentum and Relativistic energy, (Lorentz invariants) $E^2=c^2 p^2+m^2_o c^4$

Recommended Books:

1. Halliday, D. Resnick, Krane, Physics, Vol. I & II, John Wiley, 5th ed. 1999.
2. D. Kleppner and R. Kolenkow, An Introduction to Mechanics, McGraw Hill, 1978.
3. M. R. Speigel, Vector Analysis and an Introduction to Tensor Analysis, Mc-Graw Hill, 1959.

WAVES & OSCILLATIONS 3 Cr.h

Pre-requisite
A Level Physics and F.Sc. (Physics + Math)

Objective:
1. To understand the basics of waves, mechanism of wave production,
   propagation and interaction with other waves
2. use of basic concept of waves in their application in daily life

Harmonic Oscillations:
Simple harmonic motion (SHM), Obtaining and solving the basic equations of motion x(t), v(t), a(t), Longitudinal and transverse Oscillations, Energy considerations in SHM. Application of SHM, Torsional oscillator, Physical pendulum, simple pendulum, SHM and uniform circular motion, Combinations of harmonic motions, Lissajous patterns, Damped harmonic motion, Equation of damped harmonic motion, Quality factor, discussion of its solution, Forced oscillations and resonances, Equation of forced oscillation, Discussion of its solution, Natural frequency, Resonance, Examples of resonance.

Waves in Physical Media:
Mechanical waves, Travelling waves, Phase velocity of traveling waves, Sinusoidal waves, Group speed and dispersion, Waves speed, Mechanical analysis, Wave equation, Discussion of solution, Power and intensity in wave motion, Derivation & discussion, Principle of superposition (basic ideas), Interference of waves, Standing waves. Phase changes on reflection.

Sound:
Beats Phenomenon, Analytical treatment.

Coupled Oscillators and Normal modes:

Two coupled pendulums, General methods of finding normal modes, Beats in coupled oscillations, Two coupled masses, Two coupled LC circuits, Energy relations in coupled oscillations, Forced oscillations of two coupled oscillators, Many coupled oscillator.

Normal Modes of Continuous systems:

Transverse vibration of a string, Longitudinal vibrations of a rod, Vibrations of air columns, Normal modes, Fourier methods of analyzing general motion of a continuous system, Atomic vibrations.

Recommended Books:

1. Halliday, D. Resnick, Krane, Physics, Vol. I & II, John Wiley, 5th ed. 1999.
2. N.K. Bajaj, The Physics of Waves & Oscillations, Tata McGraw-Hill Publishing company Limited, 1986.
3. H. J. Pain, The Physics of Vibrations and Waves, 5th Edition 1999.

LAB-I 1 Cr.h

Pre-requisites

Intermediate with Physics and Math or A level Physics

Objectives

To develop the experimental capability of students in understanding the concept of Mechanics.

1. Modulus of Rigidity by Static & Dynamic method (Maxwell's needle, Barton's Apparatus).
2. To study the damping features of an oscillating system using simple pendulum of variable mass.
3. Measurement of viscosity of liquid by Stoke's / Poiseulli's method.
4. Surface tension of water by capillary tube method.
5. To determine the value of "g" by compound pendulum / Kater's Pendulum.
6. To study the dependence of Centripetal force on mass, radius, and angular velocity of a body in circular motion.
7. Investigation of phase change with position in traveling wave and measurement of the velocity of sound by C.R.O.
8. Determination of moment of inertia of a solid/hollow cylinder and a sphere etc.

9. To study the conservation of energy (Hook's law).

Recommended Books:

1. D. H. Marrow, Selected Experiments in Physical Sciences, Longman.
2. Nelkon and Ogborn, Advanced Level Practical Physics, Heimann Educational Books
3. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind.
4. C. K. Bhattacharya, University Practical Physics, CBS Publishing

Note: At least five experiments to be performed and Universities may opt for other experiments according to the available facilities

LAB-II 1 Cr.h

Pre-requisites

Intermediate with Physics and Math or A level Physics

Objectives

To develop the understanding of students in measuring the thermal and optical parameters and to remove the fear of students to use various gadgets in laboratory

1. To determine thermal Emf and plot temperature diagram.
2. Determination of temperature coefficient of resistance of a given wire.
3. Determination of "J" by Callender – Barnis method.
4. The determination of Stefan's constant.
5. Calibration of thermocouple by potentiometer.
6. To determine frequency of AC supply by CRO.
7. To determine Horizontal/Vertical distance by Sextant.
8. The determination of wavelength of Sodium –D lines by Newton's Ring.
9. The determination of wavelength of light/laser by Diffraction grating.
10. Determination of wavelength of sodium light by Fresnel's bi-prism.
11. The determination of resolving power of a diffraction grating.
12. The measurement of specific rotation of sugar by Polarimeter and determination of sugar concentration in a given solution.

13. To study the combinations of harmonic motion (Lissajous figures).
14. To study the parameters of waves (Beats phenomenon).
15. To determine the Thermal conductivity of good and bad conductors using Lee's and Searl's apparatus.
16. To study the laws of vibration of stretched string using sonometer.
17. To determine the stopping potential by photo cell.

Recommended Books:

1. D. H. Marrow, Selected Experiments in Physical Sciences, Longman.
2. Nelkon and Ogborn, Advanced Level Practical Physics, Heimann Educational Books
3. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind.
4. C. K. Bhattacharya, University Practical Physics, CBS Publishing

Note: At least nine experiments to be performed and Universities may opt for other experiments according to the available facilities

ELECTRICITY AND MAGNETISM-I 3 Cr.h

Pre-requisites

Intermediate with Physics and Math or A level Physics

Objectives

1. To give the concept of electric field, electrical potential and dielectrics
2. To understand the DC circuits
3. To know the effect of magnetic field and basic magnetic properties of materials

Electric Field:

Field due to a point charge: due to several point charges. Electric dipole. Electric field of continuous charge distribution e.g Ring of charge, disc of charge, infinite line of charge. Point charge in an electric field. Dipole in an electric field, Torque and energy of a dipole in uniform field. Electric flux: Gauss's law; (Integral and differential forms) and its application. Charge in isolated conductors, conductor with a cavity, field near a charged conducting sheet. Field of infinite line of charge, field of infinite sheet of charge, field of spherical shell and field of spherical charge distribution.

Electric Potential:

Potential due to point charge, potential due to collection of point charges, potential due to dipole. Electric potential of continuous charge distribution. Poisson's and Laplace equation without solution. Field as the gradient or derivative of potential. Potential and field inside and outside an isolated conductor.

Capacitors and dielectrics:

Capacitance, calculating the electric field in a capacitor. Capacitors of various shapes, cylindrical, spherical etc. and calculation of their capacitance. Energy stored in an electric field. Energy per unit volume. Capacitor with dielectric, Electric field of dielectric. An atomic view. Application of Gauss's Law to capacitor with dielectric.

D C Circuits:

Electric Current, current density J, resistance, resistivity, ρ, and conductivity, σ, Ohm's Law, energy transfer in an electric circuit. Equation of continuity. Calculating the current in a single loop, multiple loops, voltages at various elements of a loop. Use of Kirchhoff's Ist & 2nd law, Thevenin theorem, Norton theorem and Superposition theorem, Growth and Decay of current in an RC circuit and their analytical treatment.

Magnetic Field Effects and Magnetic Properties of Matter:

Magnetic force on a charged particle, magnetic force on a current, Recall the previous results. Do not derive. Torque on a current loop. Magnetic dipole: Energy of magnetic dipole in field. Discuss quantitatively, Lorentz Force with its applications in CRO. Biot-Savart Law: Analytical treatment and applications to a current loop, force on two parallel current changing conductors. Ampere's Law, Integral and differential forms, applications to solenoids and toroids. (Integral form), Gauss's Law for Magnetism: Discuss and develop the concepts of conservation of magnetic flux, Differential form of Gauss's Law. Origin of Atomic and Nuclear magnetism, Basic ideas.Bohr Magneton. Magnetization, Defining M, B, μ. Magnetic Materials, Paramagnetism, Diamagnetism, Ferromagnetism - Discussion. Hysteresis in Ferromagnetic materials.

Recommended Books:

1. F. J. Keller, W. E. Gettys, M. J. Skove *Physics Classical and Modern (2nd edition)*, McGraw-Hill, Inc., 1993.

2. A. F. Kip *Fundamentals of Electricity and Magnetism (2nd Ed.)*, McGraw-Hill Book Co., 1969.
3. D. Halliday, R. Resnick, K. S. Krane *Physics (Vol-II)*, John Willey & sons, Inc., 1992.
4. D. N. Vasudeva *Magnetism and Electricity*, S. Chand & Co., 1959.
5. J. A. Edminister *Schaum's Outline Series; Theory and Problems of Electromagnetism*, McGraw-Hill Book Co., 1986.

HEAT AND THERMODYNAMICS 3 Cr.h

Pre-requisites

Intermediate with Physics and Math or A level Physics

Objectives

1. To give the concept of heat and temperature
2. To give the concept of classical distribution function
3. To understand the laws of thermodynamics and their application

Statistical Mechanics:

Statistical distribution and mean values, Mean free path and microscopic calculations of mean free path. Distribution of molecular speeds, Distribution of energies, Maxwell distribution, Maxwell-Boltzmann energy distribution, Internal energy of an ideal gas. Brownian motion, Qualitative description. Diffusion, Conduction and viscosity.

Heat and Temperature:

Temperature, Kinetic theory of the ideal gas, Work done on an ideal gas,Review of previous concepts. Internal energy of an ideal gas: Equipartition of energy. Intermolecular forces. Qualitative discussion. Van der Waals equation of state.

Thermodynamics:

Review of previous concepts. First law of thermo-dynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reversible and irreversible processes, Second Law of thermodynamics, Carnot theorem, Carnot engines. Heat engine. Refrigerators. Calculation of efficiency of heat engines. Thermodynamic temperature scale: Absolute zero: Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy & second law. Entropy & probability. Thermodynamic functions: Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions) Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Liquification of gases, Joule-Thomson effect and

its equations. Thermoelectricity,Thermocouple, Seabeck's effect, Peltier's effect, Thomson effect

Recommended Books:

1. J. F. Lee and F. W. Sears, Thermodynamics, Addison-Wesley 1954.
2. A. J. Pointon, Introduction to Statistical Physics, Longman 1967.
3. M. W. Zemansky, Heat and Thermodynamics, 3rd Edition, McGraw Hill, 1951.
4. Reif, Statistical Physics, Berkley Physics series, McGraw Hill 1965.
5. M. M. Abbott, Schaum's Outline of Thermodynamics, McGraw-Hill Professional Book Group, 1995.

OPTICS 3Cr.h.

Pre-requisites

Intermediate with Physics and Math or A level Physics

Objectives

1. To understand the concept of reflections, refraction, interference, diffraction and polarization.
2. To develop understanding about the optical devices

Geometrical Optics

Geometrical optics and its laws, sign convention, Refraction at a spherical surface, lens formula, lens formula by deviation method, two lens systems, Aberrations, Review of topics related to chromatic aberration, Chromatic aberration, Eye pieces, Fibre optics.

Polarization

Plane elliptically and circularly polarized light, Production of each type and their uses, Malus law, Polarizing angle and Brewster law, Uni-axial crystals, Induced optical effects, Optical activity in liquids

Interference

Far field approximation, Analytical treatment of interference phenomenon, point source and extended source, Typical cases of interference phenomena, (thin films, Fabry Perot & Michelson interferometer, Fresnel's biprism), Holography.

Diffraction

Huygen's principle, Fraunhofer diffraction, Fresnel diffraction, Diffraction by a single slit, Diffraction pattern of a rectangular aperture, Diffraction pattern of a circular aperture, Resolving power of lenses, Double slit diffraction pattern, Diffraction grating, Dispersing properties of prism and grating, X-ray diffraction, neutron and electron diffraction. Study of Fourier theorem and its analysis, Application to grating, Diffraction applications.

Recommended Books:

1. E. Hecht, Optics, Addison – Wesley Publishing Company 1987.
2. D. Halliday, R. Resnick, K. S. Krane, *Physics,* John Willey & sons, Inc., 1992.

ELECTRONICS & MODERN PHYSICS 3 Cr.h

Pre-requisites

Intermediate with Physics and Math or A level Physics

Objectives:

1. To give the concept of modern physics
2. To know the nuclear structure and radioactivity
3. To know some nuclear reactions and production of nuclear energy
4. To give basic understanding of Plasma and LASER

Electronics:

Basic crystal structure, free electron model, energy band in solid and energy gaps, p-type, n-type semiconductor materials, p-n junction diode, its structure. characteristics and application as rectifiers. Transistor, its basic structure and operation, transistor biasing for amplifiers, characteristics of common base, common emitter, common collector, load line, operating point, hybrid parameters (common emitter), Transistor as an amplifier (common emitter mode), Positive & negative feed back R.C. Oscillators, Monostable multi- vibrator (basic), Logic gates OR, AND, NOT, NAND, NOR and their basic applications.

Origin of Quantum Theory:

Black body radiation, Stefan Boltzmann-, Wiens- and Planck's law, consequences. The quantization of energy, Photoelectric and Compton effect, Line spectra, Explanation using quantum theory.

Wave Nature of Matter:

Wave behaviour of particle (wave function etc.) its definition and relation to probability of particle, d'Broglie hypothesis and its testing, Davisson-Germer Experiment and J.P. Thomson Experiment, Wave packets and particles, localizing a wave in space and time.

Atomic Physics:

Bohr's theory (review), Frank-Hertz experiment, energy levels of electron, Atomic spectrum, Angular momentum of electrons, Vector atom model, Orbital angular momentum. Spin quantization, Bohr's Magnetron. X-ray spectrum (continuous and discrete) Moseley's law, Pauli's exclusion principle and its use in developing the periodic table.

Recommended Books:

1. Robert M Eisberg, Fundamentals of Modern Physics, John Wiley & Sons 1961
2. Sanjiv Puri, Modern Physics, Narosa Publishing House, 2004.
3. Paul A. Tipler and Ralph A. Llewellyn, Modern Physics 3rd edition, W H Freeman and Company 2000.
4. Arthur Beiser, Concepts of Modern Physics (fifth edition) McGraw-Hill 1995.
5. Robert M. Eisberg and Robert Resnick, Quantum Physics of Atoms, molecules, Solids, Nuclei and Particles, 2nd edition, John Wiley & Sons, 2002.
6. D. Halliday, R. Resnick, K. S. Krane, *Physics,* John Willey & sons, Inc., 1992.

ELECTRICITY AND MAGNETISM-II 3Cr.h

Pre-requisites:

FSC level Physics and Electricity and Magnetism I

Objectives:

1. To understand the laws of electromagnetic induction
2. To understand the AC circuits
3. To know the generation and propagation of Electromagnetic waves

Inductance:

Faraday's Law of Electromagnetic Induction, Review of emf, Faraday Law and Lenz's Law, Induced electric fields, Calculation and application using differential and integral form, Inductance, "Basic definition". Inductance of a Solenoid; Toroid. LR Circuits, Growth and Decay of

current, analytical treatment. Energy stored in a magnetic field, Derive. Energy density and the magnetic field. Electromagnetic Oscillation, Qualitative discussion. Quantitative analysis using differential equatins. Forced electromagnetic oscillations and resonance.

Alternating Current Circuits:

Alternating current, AC current in resistive, inductive and capacitative elements. Single loop RLC circuit, Series and parallel circuits i.e. acceptor and rejector, Analytical expression for time dependent solution. Graphical analysis, phase angles. Power in A.C circuits: phase angles, RMS values, power factor.

Electro-Magnetic Waves (Maxwell's Equations):

Summarizing the electro- magnetic equations, (Gauss's law for electromagnetism, Faraday Law, Ampere's Law). Induced magnetic fields & displacement current. Development of concepts, applications. Maxwell's equations, (Integral & Differential forms) Discussion and implications. Generating an electro- magnetic wave. Travelling waves and Maxwell's equations. Analytical treatment; obtaining differential form of Maxwell's equations, obtaining the velocity of light from Maxwell's equations. Energy transport and the Poynting Vector. Analytical treatment and discussion of physical concepts.

Recommended Books:

1. F. J. Keller, W. E. Gettys, M. J. Skove *Physics Classical and Modern (2nd edition)*, McGraw-Hill, Inc., 1993.
2. A. F. Kip *Fundamentals of Electricity and Magnetism (2nd Ed.)*, McGraw-Hill Book Co., 1969.
3. D. Halliday, R. Resnick, K. S. Krane *Physics (Vol-II)*, John Willey & sons, Inc., 1992.
4. D. N. Vasudeva *Magnetism and Electricity*, S. Chand & Co., 1959.
5. J. A. Edminister *Schaum's Outline Series; Theory and Problems of Electromagnetism*, McGraw-Hill Book Co., 1986.

LBORATORY III 1 Cr.h

Pre-requisites:

FSC level Physics and Electricity and Magnetism I

Objectives:

To know the electrical circuit elements, their experimental measurement and to give understanding of electrical circuits and use of CRO.

1. Measurement of resistance using a Neon flash bulb and condenser
2. Conversion of a galvanometer into Voltmeter & an Ammeter
3. To study the characteristics of Photo emission and determination of Plank's constant using a Photo cell
4. Calibration of an Ammeter and a Voltmeter by potentiometer
5. Charge sensitivity of a ballistic galvanometer
6. Comparison of capacities by ballistic galvanometer.
7. To study the B.H. curve & measure the magnetic parameters.
8. Measurement of low resistance coil by a Carey Foster Bridge.
9. Resonance frequency of an acceptor circuit
10. Resonance frequency of a Rejecter Circuit.
11. Study of the parameter of wave i.e. amplitude, phase and time period of a complex signal by CRO.
12. Measurement of self/mutual inductance.
13. Study of electric circuits by black box.
14. To study the network theorems (Superposition, Thevinin, Norton).
15. To study the application of Lorentz force by CRO.

Note: At least eight experiments to be performed and Universities may opt for other experiments according to the available facilities.

Recommended Books:

1. G L Squires, Practical Physics, 3rd Edition, Cambridge University Press
2. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind.
3. C K Bhattacharya, University Practical Physics, CBS Publishing.

LAB-IV **1 Cr.h**

Pre-requisites:

FSC level Physics and Electricity and Magnetism I

Objectives:

1. To develop understanding and uses of electronic devises including GATS, Transistors.
2. To understand the behaviour of nuclear radiation including beta and gama radition.
3. Determination of e/m of an electron.
4. Determination of ionization potential of mercury.
5. Characteristics of a semiconductor diode (Compare Si with Ge diode)
6. Setting up of half & full wave rectifier & study of following factors
   i. Smoothing effect of a capacitor
   ii. Ripple factor & its variation with load.
   iii. Study of regulation of output voltage with load.
7. To set up a single stage amplifier & measure its voltage gain and bandwidth.
8. To set up transistor oscillator circuit and measure its frequency by an oscilloscope.
9. To set up and study various logic gates (AND, OR, NAND etc) using diode and to develop their truth table.
10. To set up an electronic switching circuit using transistor LDR and demonstrate its use as a NOT Gate.
11 Characteristics of a transistor.
12. To study the characteristic curves of a G. M. counter and use it to determine the absorption co-efficient of β-particle in Aluminum.
13. Determination of range of α particles.
14. Mass absorption coefficient of lead for γ-rays using G.M counter.
15. Use of computer in the learning of knowledge of GATE and other experiments.

Recommended Books:

1. G L Squires, Practical Physics, 3rd Edition, Cambridge University Press
2. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind.
3. C K Bhattacharya, University Practical Physics, CBS Publishing.

Note: At least five experiments to be performed and Universities may opt for other experiments according to the available facilities.

MATHEMATICAL METHODS-I 3 Cr.h

Pre-requisite
General Mathematics

Objectives
1. To develop the mathematical background of student in vectors, tensors, matrices and some of their uses in the world of physics
2. To give basic understanding of group theory and complex variables used in physics

Vector Analysis:
Review of vectors Algebra, Vector differentiation and gradient, Divergence and Gauss's theorem, Vector integration, Green's theorem in the plane, Curl and Stoke's theorem.

Curvilinear Coordinates and Tensors:
Curvilinear coordinate system, Gradient, Divergence and Curl in the curvilinear coordinates system, Cartesian, Spherical and Cylinderical coordinate system, Covariant and contravariant tensors, Tensor algebra, Quotient rule.

Matrices:
Linear vector spaces, Determinants, Matrices, Eigenvalues and eigenvectors of matrices, Orthogonal matrices, Hermitian matrices, Similarity transformations, Diagonalization of matrices.

Group Theory:
Introduction to groups, Group representation, Invariant subgroups, Discret groups-Dihedral groups, Continuous groups-O groups, SU(2) groups, Lie groups

Complex Variables:
Functions of a complex variable, Cauchy Riemann conditions and analytic functions, Cauchy integral theorem and integral formula, Taylor and Laurent series, Calculus of residue, Complex integration.

Recommended Books:

1. G. Arfken, Mathematical Physics, 2nd ed, Academic Press, 1970.

2. E. Butkov, Mathematical Physics, Addison-Wesley 1968.
3. Pipes and Harvill, Applied Mathematics for Engineers and Physicists, McGraw Hill, 1971.
4. M. R. Speigel, Complex Variables Schaum's Outline Series, McGraw Hill 1979.
5. H. P. Hsu, Fourier Analysis Simon Schuster Series, 1967.

QUANTUM MECHANICS-I 3 Cr.h

Pre-requisite
FSc Physics and Modern Physics & electronics

Objectives
1. Understanding the behaviour of quantum mechanical particle and development of Schrodinger equation in one and three dimensions
2. introduction to Quantum mechanical operators and determination of angular momentum of a quantum mechanical particle

Quantum Mechanics of One Dimensional Problems:
Review of concepts of classical mechanics, State of a system, Properties of one dimensional potential functions, Functions and expectation values, Dirac notation, Hermitian operators, Solutions of Schrodinger equation for free particles, The potential barrier problems, The linear harmonic oscillator, Particle in a box.

Formalism of Quantum Mechanics:
The state of a system, Dynamical variables and operators, Commuting and non commuting operators, Heisenberg uncertainty relations, Time evolution of a system, Schrodinger and Heisenberg pictures, Symmetry principles and conservation laws.

Angular Momentum:
Orbital angular momentum, Spin, The eigenvalues and eigen functions of L^2 and L_z, Matrix representation of angular momentum operators, Addition of angular momenta.

Schrodinger Equation in Three Dimensions:
Separation of Schrodinger equation in cartesian coordinates, Central potentials, The free particle, Three dimensional square well potential, The hydrogenic atom, Three dimensional square well potential, The hydrogenic atom, Three dimensional isotopic oscillator.

Books Recommended:

1. B.H. Bransden & C.J. Joachain, 'Introduction to Quantum Mechanics' Longman Scientific & Technical London (1990).
2. J.S. Townsend, 'A Modern Approach to Quantum Mechanics', McGraw Hill Book Company, Singapore (1992).
3. W. Greiner, 'Quantum Mechanics: An Introduction', Addison Wesley Publishing Company, Reading Mass. (1980).
4. R.L. Liboff, 'Introductory Quantum mechanics', Addison Wesley Publishing Company, Reading Mass. (1980).
5. Bialynicki-Birula, M. Cieplak & J. Kaminski, 'Theory of Quantua', Oxford University Press, New York (1992).
6. W. Greiner, 'Relativistic Quantum Mechanics', Springer Verlag, Berlin (1990).
7. F. Schwable, 'Quantum Mechanics', Narosa Publishing House, New Delhi (1992).
8 David J. Griffiths, Introduction to Quantum Mechanics, PRENTICE Hall, Int., Inc.

THERMAL AND STATISTICAL PHYSICS 3 Cr.h

Pre-requisite:

FSc Physics and Heat and Thermodynamics

Objectives:

1. To develop the understanding of thermal properties by using statistical means in thermodynamics
2. Development of various statistics like Boltzmann Statistics, Bose – Einstein statistics and Fermi- Dirac Statistics
3. To develop the understating of lattice dynamics in solid materials.

Equilibrium Thermodynamics:

Basic postulates, fundamental equations and equations of state, response functions Maxwell's relation, reduction of derivatives.

Elements of Probability Theory:

Probabilities, distribution functions, statistical interpretation of entropy, Boltzmann H-theorem.

Formulation of Statistical Methods:

Ensembles, counting of states (in classical and quantum mechanical systems, examples) partition function, Boltzmann distribution. Formation of Microcononical, canonical and grand canonical partion function.

Partition Function:

Relations of partition function with thermodynamic variables, examples (collection of simple harmonic oscillators, Pauli and Van Vleck paramagnetics, Theorem of equipartition of energy.

Statistical Systems:

Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistical systems. Examples of thermodynamics of these systems; Black body radiations, Gas of electrons in solids.

Statistical Mechanics of Interacting Systems:

Lattice vibrations in solids; Van der Waals Gas: mean field calculation; Ferromagnets in Mean Field Approximation.

Advanced Topics:

Fluctuations, Bose-Einstein Condensation, Introduction to density matrix approach.

Books Recommended:

1. F. Mandl, Statistical Physics, ELBS/John Willey, 2nd Ed. 1988.
2. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill, 1965.
3. A.J. Pointon, Introduction to Statistical Physics, Longman 1967.
4. C. Kittel, Elements of Statistical Physics, John Wiley 1958.

CLASSICAL MECHANICS 3 Cr.h

Pre-requisites:

Mechanics I & II

Objectives:

1. To develop the basic knowledge of classical world using the laws of Physics
2. To develop the understanding of two bodies central force problems

3. To give understanding of kinematics and dynamics of rigid bodies
4. Development of Hamiltonian equation and use of canonical transformation in classical physics

Elementary Principles:

Brief Survey of Newtonian mechanics of a system of particles, constraints, Alembert's principle, Lagrange's equation and its applications. Virtual work.

Variational Principles:

Calculus of variation and Hamilton's principle, Derivation of Lagrange's equation from Hamilton's principle.

Two Body Central Force Problem:

Low and least action, two body problem and its reduction to one body problem. Equation of motion and solution for one body problem, Kepler's Laws Laboratory and centre of mass systems, Rutherford scattering.

Kinematics of Rigid Body Motion:

Orthogonal transformations, Eulerian angles, Euler's theorem, The coriolis force.

Rigid Body Equation of Motion:

Angular momentum, Tensors and dyadics, Moment of inertia, Rigid body problems and Euler's equations.

Hamilton Equation of Motion:

Legendre transformation and Hamilton equations of motion, Conservation theorems.

Canonical Transformations:

Examples of canoical transformations, Lagrange and Poison brackets, Liouville's theorem.

Books Recommended:

1. H. Goldstein, 'Classical Mechanics', 2nd. Edn., Addison Wesley, Reading, Massachusetts (1980).
2. V.I. Arnold, Mathematical Methods of Classical Mechanics Springer verlag, New York (1980).
3. S.N. Rasband, 'Dynamics', John Wiley & Sons, New York (1983).

4. R.A. Matzner & L.C. Shepley, 'Classical Mechanics', Prentice Hall Inc., London (1991).
5. N.M.J. Woodhouse, 'Introduction to Analytical Dynamics', Oxford Science Publications, Oxford (1987).

ELECTRONICS 3 Cr.h

Pre-requisites:
Modern Physics and Electronics

Objectives:
1. To develop the understanding of different electronic circuit elements and devices like diode, transistors, amplifiers, oscillators and voltage regulators used in daily life alliances
2. To understand the day to day electronic devices.

Special Diodes:
Zener diodes, Zener regulators, Varactor diodes, Schottky diodes, Light emitting diodes, Photodiodes, Tunnel diodes, Varistors and their applications.

Transistor Circuits:
Bipolar transistors; parameters and ratings, Ebers-Moll, Hybrid-p and h,z and y-parameter models, Switching circuits, Biasing and stability, Common emitter, Common base and common collector amplifiers, Frequency response, Power class A, B, and C amplifiers, Field Effect

FET:
Transistors; Junction FET, MOSFET, Operation and construction, Biasing, Common source and common drain amplifiers, Frequency response. Multistage Amplifiers; RC coupled and direct coupled stages, The differential amplifiers, Negative feedback, Tuned RF Voltage amplifiers, I-F Amplifiers and automatic gain control.,

Operational Amplifiers:
Ideal op-amps, Simple op-amp arrangements, its data and sheet parameters, Non inverting and inverting circuits, Feedback and stability, Op-amp applications; Comparators, Summing, Active filters, Integrator and Differentiator, Instrumentation amplifier.

Oscillators:

Armstrong, Hartley, CMOSS, Colpit's Phase shift and 555 timer oscillators.

Voltage Regulators:

Series, Shunt and switching regulators. Power supply.

Books Recommended:

1. J. Millman & C.C. Halkias, 'Integrated Electronics', McGraw Hill Book Company, Singapore (Latest Edition).
2. T.L. Floyd, 'Electronic Devices', Merril Publishing Company Columbus (1988).
3. A.P. Malvino, 'Electronic Principles', Tata McGraw Hill, New Delhi (1988).
4. D.B. Bell, 'Electronic devices & Circuits', Reston Publishing Company Inc., Virginia (1980).
5. C.J. Savant Jr. M.S. Roden, G.L. Carpenter, 'Electronic Design Circuit & Systems', The Bengamin/Cummings Publishing Co., California (1991).

LAB V 1 Cr.h

Pre-requisites:

LAB I –IV

Objectives:

1. To expose the students to advance level experimentation in Physics.
2. To make them familiar to such experiments whose out come can be used in developing future research capabilities and teaching skills.
3. To make the students confident in their studies by showing and measuring parameter which they have used in theoretical work.

List of Experiments

1. To study the characteristics of a Geiger-Muller counter and to examine the attenuations of beta particles in Al-and Pb foils.
2. Measurement of the half life of a radio nuclide. To study the pulse-height as a function of the H.H.T. in a scintillation counter.
3. Measurement of the spectrum of gama rays from a radioisotope. Shielding and attenuation of gamma rays.

4. To study the characteristics of a solid-state detector and use it to measure the spectra of alpha and beta particles.
5. Use of a Lithium-drifted Ge-counter for gamme spectroscopy and to compare its performance with that of a nal-detector.
6. AC circuits and dielectric constants of water and ice.
7. Radio frequency measurement. Skin effect, etc.
8. Experiments with transmission lines.
9. Measurement of characteristic impedance. Velocity. Standing wave ratio, etc.

Note: At least five experiments to be performed and Universities may opt for other experiments according to the available facilities.

Books Recommended:

1. H.Mark and H.T. Olsono. Experiments in Modern Physics (McGraw-Hill).
2. A.C. Melissinos. Experiments in Modern Physics (Academic).
3. R.J. Higgings. Experimental Electronics (McGraw-Hill).

Note: At least five experiments to be performed and Universities may opt for other experiments according to the available facilities.

MATHEMATICAL METHODS-II 3 Cr.h

Pre-requisite

General mathematics and Mathematical Methods-I

Objectives:

1) To give the understanding of Differential equations and their uses in Physics
2) Introduction to special functions, Fourier Series, Fourier Transforms
3) Solution of Boundary value problems and their uses

Differential Equations in Physics:

First and second order linear differential equations, Partial differential equations of theoretical physics, Separation of variables,Homogeneous differential equations, Frobenius series solution of differential equations, Second solution, Nonhomogenous differential equations.

Special Functions:

Bessel functions and Hankel functions, Spherical Bessel functions, Legendre polynomials, Associated Legendre polynomials, Spherical harmonics Laguerre polynomials, Hermite polynomials.

Fourier Series:

Definition and general properties, Fourier series of various physical functions, Uses and application of Fourier series.

Integral Transforms:

Integral transform, Fourier transform, Convolution theorem, Elementary Laplace transform and its application.

Boundary Value Problems and Green's Functions:

Boundary value problems in Physics, Non-homogeneous boundary value problems and Green's functions, Green's functions for one dimensional problems, Eigenfunction expansion of Green's function, Construction of Green's functions in higher dimensions.

Books Recommended:

1. G. Arfken, Mathematical Physics, 2nd ed, Academic Press, 1970.
2. R. Bronson, 'Differential Equations' Schaum's Outline Series, McGraw Hill, New York.
3. E. Butkov, 'Mathematical Physics Addison-Weseley London .
4. M.L. Boas, 'Mathematical Methods in Physical Sciences', John Wiley & Sons, New York (1989).
5 C.W. Wong, 'Introduction to Mathematical Physics', Oxford University, Press, New York (1991).
6. Hassani, 'Foundations of Mathematical Physics', Prentice Hall International Inc., Singapore (1991).
7. Chattopadhyay, 'Mathematical Physics', Wiley Eastern Limited, New Delhi, (1990).
8. H. Cohen, 'Mathematics for Scientists & Engineers' Prentice Hall International Inc., New Jersey (1992).

QUANTUM MECHANICS-II 3 Cr.h

Pre-requisites:

Quantum Mechanics I

Objectives:

1. to understand the use of approximation in Quantum mechanics
2. to understand the theory of scattering and interaction of quantum systems with radiation
3. to understand the basics of relativistic quantum mechanics

Approximate Methods:

Time independent perturbation theory for non degenerate and degenerate levels, the variational method, The WKB approximation, Time dependent perturbation theory.

Identical Particles and Second Quantization:

Indistinguishability of identical particles, Systems of identical particles, Quantum dynamics of identical particle systems, statistics, Symmetry of states, Fermions, Bosons.

Theory of Scattering:

Scattering experiments and cross sections, Potential scattering, The method of partial waves, The Born's approximation.

The Interaction of Quantum Systems with Radiation:

Electromagnetic field and its interaction with one electron system, Transition rates, Spontaneous emission, Selection rules for electric dipole transitions, The spin of photon and its helicity.

Relativistic Quantum Mechanics:

Schrodinger relativistic equation, Probability and current densities, Klein-Gordon equation and hydrogen atom, Dirac relativistic equation.

Books Recommended:

1. B.H. Bransden & C.J. Joachain, 'Introduction to Quantum Mechanics' Longman Scientific & Technical London (1990).
2. J.S. Townsend, 'A Modern Approach to Quantum Mechanics', McGraw Hill Book Company, Singapore (1992).
3. W. Greiner, 'Quantum Mechanics: An Introduction', Addison Wesley Publishing Company, Reading Mass. (1980).
4. R.L. Liboff, 'Introductory Quantum mechanics', Addison Wesley Publishing Company, Reading Mass. (1980).
5. Bialynicki-Birula, M. Cieplak & J. Kaminski, 'Theory of Quantua', Oxford University Press, New York (1992).
6. W. Greiner, 'Relativistic Quantum Mechanics', Springer Verlag, Berlin (1990).

7. F. Schwable, 'Quantum Mechanics', Narosa Publishing House, New Delhi (1992).
8 David J. Griffiths, Introduction to Quantum Mechanics, PRENTICE Hall, Int., Inc.
9. S.Gasiorowicz, Quantum Physics, John Wiley & Sons, Inc., Singapore.

ELECTROMAGNETIC THEORY 3 Cr.h

Pre-requisites:
Electricity and magnetism I & II

Objectives:
1. To give the basic understanding in static electromagnetic fields and time dependent electromagnetic fields
2. To develop knowledge of propagation, reflection and refraction of electromagnetic waves
3. To develop the understanding of skin effect and wave guides

Fundamental Concepts:
Recapitulation of the fundamental concepts, Induction B, Addition of Laplace equation and methods of images. Magnetic intensity H, Maxwell's equations in differential and integral forms, Poynting theorem and energy conservation.

Static Electromagnetic Fields:
Electrostatic fields in several dielectric media, Magneto static fields of magnetized matter, Magnetostatic field of stationary current, Magnetization current.

Time Dependent Electromagnetic Fields:
Maxwell's equations for quasi stationery fields, Potentials of a rapidly varying field, Fields of uniformly moving and accelerated charges, Radiation from an accelerated charge, Field of oscillating expansion of electro magnetic field, Multiple fields. Expansion of emf.

Reflection and Refraction of Electromagnetic Waves:
Laws of reflection and refraction, Fresnel's formula, Total reflection, Refraction in conducting media, Reflection from a conducting surface.

Books Recommended:

1. H.C. Ohanion, 'Classical Electrodynamics', Allyn & bacon Inc., Massachusetts (1988).
2. Y.K. Lim, 'Introduction to Classical Elecrodynamics, World Scientific Publishing Co. Pt., Singapore (1986).
3. P.C. Lorrain & D.R. Corson, 'Electromagnetic Fields and Waves', W.H. Freeman & Co., New York (1978).
4. C.R. Paul & S.A. Nasar, 'Introduction to Electromagnetic Fields, McGraw Hill Book Company, Singapore (1987).
5. A.M. Portis, 'Electromagnetic Fields', John Wiley & Sons, New York (1978).
6. D. Grifftns, An introduction to Dynamics, Prentice Hall, 1984 Jackson, Classical Electrodynamics, John Wiley, 1975
7. Ritze Millfadad Chiristy, Foundation of Electromagnetic Theory

NUCLEAR PHYSICS 3 Cr.h

Pre-requisites:
Modern Physics and Electronics

Objectives:
1) To understand the nuclear structure using different nuclear models
2) To understand the nature of nuclear forces
3) To give understanding of radioactivity and nuclear reactions

History:
Starting from Bacqurel's discovery of radioactivity to Chedwick's neutron.

Basic Properties of Nucleus*:* Nuclear size, mass, binding energy, nuclear spin,magnetic dipole and electric quadrupole moment, parity and statistics.

Nuclear Forces: Yukawa's theory of nuclear forces. Nucleon scattering, charge independence and spin dependence of nuclear force, isotopic spin.

Nuclear Models*:* Liquid drop model; Fermi gas model, Shell model; Collective model.

Theories of Radioactive Decay:

Theory of Alpha decay and explanation of observed phenomena, measurement of Beta ray energies, the magnetic lens spectrometer, Fermi theory of Beta decay, Neutrino hypothesis, theory of Gamma decay, multipolarity of Gamma rays, Nuclear isomerism.

Nuclear Reactions:

Conservation laws of nuclear reactions, Q-value and threshold energy of nuclear reaction, energy level and level width, cross sections for nuclear reactions, compound nucleolus theory of nuclear reaction and its limitations, direct reaction, resonance reactions, Breit-Wigner one level formula including the effect of angular momentum.

Books Recommended:

1. Segre, Nuclei and Practicles, Bejamin, 1977.
2. Kaplan, Nuclear Physics, Addison-Wisely, 1980.
3. Green, Nuclear Physics, McGraw Hill, 1995.
4. Kenneth S. Krane, Introducing Nuclear Physics, 1995.
5. B. Povh, K. Rith, C. Scholtz, F. Zetsche, Particle and Nuclei, 1999.

SOLID STATE PHYSICS 3 Cr.h

Pre-requisite

Quantum Mechanics , Electricity & Magnetism I & II, Heat and Thermodynamics, Statistical Physics.

Objectives:

1. To develop a basic knowledge of crystallography
2. To understand the x-ray diffraction in crystal investigation
3. To understand the binding forces in crystalline material
4. To develop the understanding of lattice dynamics and its uses in derivation of theories of specific heat
5. To understand the behaviour of free electrons in metals and Fermi Energy.

Structure of Solids

Lattices and basis, Symmetry operations, Fundamental types of lattice, Position and orientation of planes in crystals, Simple crystal structures, Atomic potential, space groups and binding forces.

Crystal diffraction and reciprocal lattice:

Diffraction of X-rays, Neutrons and electrons from crystals, Bragg's law, Reciprocal lattice, Reciprocal lattice to sc, bcc, fcc, orthorhombic and hexagonal crystals, Laue method, rotating crystal method, Powder methods, Scattered wave amplitude, Ewald construction and Brillouin zone, Fourier analysis of the basis.

Phonons and Lattice Vibrations:

Lattice heat capacity, classical model, Einstein model, Enumeration of normal models, Density of state in one, two and three dimensions, Debye model of heat capacity, Comparison with experimental results, Thermal conductivity and resistivity, Umklapp processes.

Recommended Books:

1. C. Kittle, Introduction to Solid State Physics, 7th Ed. By, Kohn Wiley, 1996.
2. N. M. W. Ashcroft and N. D. Mermin, Solid State Physics, Holt, Rinehart & Winston, 1976,
3. S. R. Elliott, The Physics and Chemistry of Solids, Wiley, 1998.
4. M.A. Omar, Elementary Solid State Physics, Pearson Education 2000.
5. H.M. Rosenberg, The Solid State, 3rd Edition, Oxford Science Publications 1990.
6. M.A. Wahab, Solid State Physics, Narosa Publishing House, 1999.
7. G. Burns, High Temperature Superconductivity, An Introduction, Academic Press 1992.

LAB VI 1 Cr.h.

Pre-requisites

LAB I, II, III, IV

Objectives:

1. To expose the students to advance level experimentation in Physics
2. To make them familiar to such experiments whose out come can be used in developing future research capabilities and teaching skills.
3. To make the students confident in their studies by showing and measuring parameter which they have used in theoretical work.

4. Study of random processes and fluctuations in random processes (Poission distribution, etc.) Measurement of transistor hybrid parameters.
5. To build and investigate the properties of hard value multivibrators.
6. Transistor pulse-circuitry (three types of flipflop and the Schmidt trigger circuit).
7. Design of high or medium voltage dc power supply and measurement of the voltage regulation. Ripple factor etc.
8. Design of an L.F.R.C. coupled amplifier and a study of its characteristics.
9. Design of high or medium voltage dc power supply and measurement of the voltage regulation. Ripple factor, etc.
10. Design of a medium wave T.R.F. or superheterdyne receiver and measurement of its sensitivity. Power out-put selectivity, etc. the operational amplifier.
11. To design and build a linear integrator to enable digitization of photo-multiplier pulses, or to design and build a height-to-width converter.
12. To design and build a lotic circuit (using AND/OR/NOR gates) for performing a given function.
13. Study of leaser parameters. Gain characteristics and spectral response of a photo-multiplier tube.

Recommended Books:

1. G. L. Squires, Practical Physics, 3rd Edition, Cambridge University Press
2. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind.
3. C. K. Bhattacharya, University Practical Physics, CBS Publishing.

Note: At least five experiments to be performed and Universities may opt for other experiments according to the available facilities.

COMPUTATIONAL PHYSICS 3 Cr.h

Pre-requisites:

Undergraduate Level Physics and Elementary Mathematics and Linear Algebra, Mathematical Methods, Basic Numerical Analysis and Analytical Tools for Numerical Analysis, Computer and Programming Skills.

Objectives:

1. Introduction of computer languages
2. To know the use of computer in numerical anlysis
3. Computer simulation and modeling

Computer Languages:

A brief introduction of the computer languages like Basic, C. Pascal etc and known software packages of computation.

Numerical Methods:

Numerical Solutions of equations, Regression and interpolation, Numerical integration and differentiation. Error analysis and technique for elimination of systematic and random errors.

Modeling & Simulations:

Conceptual models, The mathematical models, Random numbers and random walk, Doing Physics with random numbers, Computer simulation, Relationship of modeling and simulation. Some systems of interest for physicists such as Motion of Falling objects, Kepler's problems, Oscillatory motion, Many particle systems, Dynamic systems, Wave phenomena, Field of static charges and current, Diffusion, Populations genetics etc.

Books Recommended:

1. M. L. De Jong, 'Introduction to Computational Physics', Addison Wesley Publishing Company Inc., Massachusetts (1991).
2. S.T. Koonini, Computational Physics', The Benjamin/Coming Publishing Inc., California (1986).
3. P.K. Macheown & D.J. Merman, Computational Techniques in Physics' Adm Hilger, Bristol (1987).
4. H. Gould & J. Tobochnik, 'An Introduction to Computer Simulation Methods', Addison Wesley Publishing Company, Rading Massachusetts(1988).
5. S.C. Chapra & R.P. Chanle, 'Numerical Methods for Engineers with Personal Computer Applications, McGraw Hill Book Company, New York (1965

PHYSICS-401 ATOMIC AND MOLECULAR PHYSICS 4 Cr.h

Pre-requisite

Phy-202 (Modern Physics), Phy-306 (Quantum Mechanics)

Objectives:

1. To review the existing theories of atomic structure
2. To introduce the experimental proof of quantisation
3. To introduce the use of Schrodinger Equation in real system like Hydrogen atom
4. To understand the Molecular spectrum
5. To understand the LASER production and Operation

Structure of Atoms (5 hours):

Review of Bohr's theory, Sommerfeld model, Frank Hertz experiment and approximation methods.

One Electron System (12 hours)

Review of Schrodinger equation for hydrogen atom, Fermi Golden rule, Quantum numbers, Atoms in radiation field, Radiative transitions, Einstein coefficients, Selection rules, normal Zeeman effect, Stark effect, Hyperfine structure.

Many body Systems (12 hours)

Pauli exclusion principle, Periodic system of the elemments, Stern Gerlach experiment, Spin orbit coupling, Central field approximation, Hartree Fock methods and self consistent field, Thomas Fermi potential, LS coupling, jj coupling and other type of coupling, X-ray spectra.

Interaction with field (7 hours)

Many electron atoms in an electromagnetic field, Anomalous Zeeman effect, Paschen back effect, Stark effect.

Molecules (12 hours)

Ionic and covalent bonding, Diatomic molecules-rotational, vibrational, and electronic spectra; Born Oppenhimer approximation, Transition probabilities of diatomic molecules, electron spin and Hund's cases, Polyatomic molecules (brief introduction), Raman effect, Hydrogen Molecular ion (LCAO approximation), Hydrogen molecule (Heitler London and molecular orbital theories)

Recommended Books:

1. Anne P. Thorn, Spectrophysics, second edition, Chapman and Hall, 1988.
2. B. H. Bransden and C.J. Joachain, Physics of atomic and Molecules, Longmans, London 1983,

3. R. Eisberg, and R. Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, second edition, John Wiley and sons 1985.

ELECTROMAGNETIC THEORY II 3 Cr.h.

Pre-requisites:

Electricity and magnetism I & II

Objectives:

1. To give the basic understanding in static electromagnetic fields and time dependent electromagnetic fields
2. To develop knowledge of propagation, reflection and refraction of electromagnetic waves
3. To develop the understanding of skin effect and wave guides

Propagation of Plane Electromagnetic Waves: monochromatic waves and plane waves, Forced oscillation of an electronic oscillator, Scattering by a bound electron, Dispersion in dilute medium and dense media, Dispersion in metallic conductor, Group velocity. Loren z, grange and Coloumb grange.

Skin Effect and Wave Guides:
High frequency current in a semi infinite conductor, Internal impedance at high frequencies, Waves guided by parallel plane conductor, Transmission by a rectangular. Wave Guidance, Power transfer and attenuation, Wave guides as cavity resonators, Q of a cavity resonator, Waves guided by dielectrics.

Books Recommended:

1. H.C. Ohanion, 'Classical Electrodynamics', Allyn & bacon Inc., Massachusetts (1988).
2. Y.K. Lim, 'Introduction to Classical Elecrodynamics, World Scientific Publishing Co. Pt., Singapore (1986).
3. P.C. Lorrain & D.R. Corson, 'Electromagnetic Fields and Waves', W.H. Freeman & Co., New York (1978).
4. C.R. Paul & S.A. Nasar, 'Introduction to Electromagnetic Fields, McGraw Hill Book Company, Singapore (1987).
5. A.M. Portis, 'Electromagnetic Fields', John Wiley & Sons, New York (1978).
6. D. Grifftns, An introduction to Dynamics, Prentice Hall, 1984 Jackson, Classical Electrodynamics, John Wiley, 1975
7. Ritze Millfadad Chiristy, Foundation of Electromagnetic Theory

PROJECT **3 Cr.h**

A project can be introduced instead of these experiments.

Pre-requisite:

Undergraduate physics and Labs I-VI

Objectives:

1. To expose the students to advance level experimentation in Physics.
2. To make them familiar to such experiments whose out come can be used in developing future research capabilities and teaching skills.
3. To make the students confident in their studies by showing and measuring parameter which they have used in theoretical work.

Lab-VII

1. Measurement of the total neutron cross-section.
2. To prove the Rutherford law of scattering of charged particles.
3. Measurement of the spectrum of gamma rays from a radioisotope (e.g.Cs) and study of their photoelectric and Compton absorption.
4. Source strength of Co60 by gamma coincidence methods.
5. Determination of the constituents of substance by activation analysis.
6. To examine the characteristics of a Solid-State detector and to use it for alpha and beta Spectroscopy and compare the results with those obtained by a scintillation counter.
7. Use of an analogue computer for solving differential equations.
8. To examine the stopping-power of various substances for thermal neutrons.
9. Determination of Planck's constant (h) by using the photoelectric effect.
10. Determination of the charge on an electron (e) by Millikan's method.
11. The Frank-hertz experiment (Measurement of excitation potential of Hg).
12. Determination of the Rydberg constant from the spectrum of hydrogen.
13. Fabry-Perot interferometer used as a gas refractometer.
14. To study the Zeeman effect for a line in the spectrum of helium.
15. Experiments with microwaves. Study of their optical properties.
16. Electron spin resonance (E.S.R.) by microwave absorption.

17. Nuclear magnetic resonance (N.M.R.) of protons in water.
18. The study of the Mossbauer effect.
19. The measurement of the Hall effect in germanium and silicon.
20. To build a medium or short-wave transmitter.
21. Measurement of the conductivity of Si and Ge as a functions of temperature.
22. To determine the energy gap in silicon and Germanium.
23. Drift mobility. (Shockley-Haynes experiments for Germanium, demonstrating transistor action).
24. Simple diode manufacture and point-contact transistor.

Note: At least 12 experiments to be performed and Universities may opt for other experiments according to the available facilities.

Books Recommended:

1. H.Mark and N.T. Olson, Experiments in Modern Physics (McGraw-Hill).
2. A.C. Melissionos, Experiments in Modern Physics (Academic).
3. T.S. Gray, Applied Electronics (John-Wiley and Sons).

All experimental courses are only recommended but Universities may opt other experiments according to facilities and expertise available to them.

DETAIL OF ELECTIVE COURSES

These elective courses can be chosen from the list or new elective course may be offered according to the availability of staff and necessary infrastructure.
University may also tailor these courses according to their facilities.

PLASMA PHYSICS 3 Cr.h

Pre-requisite:
Electrodynamics, waves and oscillations

Objectives:
1. To learn about the importance of the plasma alongwith the basic concept of plasma.
2. To know fluid description of the plasma.

Introduction, Occurrance of plasma. Concept of temperature. Debye shielding. The plasma parameter. Criteria for plasma. Applications of plasma physics. Single-particle motion in electromegnatic field. Uniform and nonuniform E and B fields. Time-variant E and B fields. Fluid description of plasma. Wave propagation in plasma. Derivation of dispersion relations for simple electrostatic and electromagnetic modes. Introduction to Controlled Fusion: Basic nuclear fusion reactions. Reaction rates and power density, radiation losses from plasma, operational conditions.

Books Recommended:
1. F.F.Chen, Introduction to plasma Physics, 2nd ed. (Plenum).
2. N.A.Krall and A.W.Trivelpiece, Principles of Plasma Physics, 1973 (McGraw Hill).
3. S.Glasstone and R.H.Lovberg, Controlled Thermonuclear Reactions, 1960 (D.Van Nestrand).

SURFACE PHYSICS 3 Cr.h

Pre-requisites:
Solid state Physics

Objectives:
1. To know aout the surface physics and its applications
2. Learn about the interaction of surface with the ions, electrons etc.

An Introduction to Surfaces:

What is a surface? The energetics and thermodynmics of creating a surface. An introduction to surface Physics. Surface energies and the Wulff Theorem.

Studying Surfaces:

What is UHV? Do we need UHV to study surfaces? The kinetic theory of gases, concept of vacuum and standard vacuum hardware components. Comparison of different types of pumps with measurement of vacuum pressure. Preparing a clean surface.

Surface Structures and Reconstructions:

Lattice concept. 3 D crystal structures, 2D surface structures. Specific types of surface, fcc, hcp, bcc and stepped surfaces and a discussion of their relative energies. More complex ceconstruction, stability, growth mechanisms, adsorption. Desorption and experimental probes of surface structure such a LEED and RHEED. The structure of semi-conductor surfaces. The surface structures of very small metal particles.

Adsorption, Desorption Bonding , Catalysis and Growth Processes:

Adsorption mechanisms and kinetics chemisorption vs. physiorption, the kinetics of adsorption, potential energy curves and adsorption energetics. Adsorption mechanisms and kinetics for low coverages Langmuir Isotherms, derivation, adsorbate phase diagrams and phase transitions.

The Structure of Adsorbate Layers:

Experimental probes of surface structure such as LEED and RHEED. Growth processes, vibrational spectroscopy, catalysis, Desorption.

The Electronics and Magnetic Structure of Surfaces:

Band theory, Free electron theories and the work function. The electronic structure of semiconductor surfaces, Electron emission processes. Magnetic processes at surfaces.

Electron-Surface Interactions:

Electron diffraction and quasi – elastic scattering, comparison of particle scattering techniques. Electron spectroscopes, Discussion of the merits of different types of electron energy analysers and electron deterctors. Signal processing and spectral analysis. Theory and practice of Auger electron spectroscopy, Quantification of Auger spectra, Auger depth. Profiling.

Atom/ion surface interactions:

Comparison of particle scattering techniques, An Introduciton to the theory and practice of SIMS, SIMS imaging and depth profiling, Auger depth profiling, theory and practice of Rutherford. Back scattering.

Surface Microscopy:

Classification of microscopy techniques, Basic concepts in surface imaging and localized spectroscopy, Imaging XPS, Optical microscopy, STEM. SEM. SPM. An introduction to the theory and practice of scanning Tunneling Microscopy, Scanning probe microscopy techniques, Atomic Force Microscopy.

Books Recommended

1. John A. Venables, Introduction to Surface and Thin Film Processes Cambridge University Press (2000).

FLUID DYNAMICS 3 Cr.h

Pre-requisite

Classical Mechanics, Electrodynamics

Objectives

1. To know the fundamentals of Fluid Mechanice and its applications
2. To learn about the computational aspect for solving diffusion equation.

Basic Fluid Mechanics:

Fundamentals of Continuum mechanics, Kinematics of the flow field, the continuity equation, governing equations of fluid motion, Incompressible flows, Compressible flows, Thin aerofoil.

Boundary Layer Theory:

Laminar Boundary layer, Turbulent Boundary layer. Reynold's number.

Computational Fluid dynamics-I:

Introduction to numerical computation, Introduction to numerical solution of Ordinary Differential equation's using multi-step methods, Boundary value problems, Introduction to solution of Partial Differential Equiation's using finite difference methods Advanced Techniques.

Computational Fluid Dynamics-II:

Governing equations in integral and differential form, Reduced forms of governing equations, The finite volume method, Incompressible and

compressible flow & their methods, Discrete methods for the steady state and time dependent advection diffusion equation, The pressure correction method on staggered and unstaggered grids, Time marching schemes, Incorporation of turbulence models, Schemes for solving large algebraic systems, Use of a commercial code for the predication off complex flows.

Experimental Methods:

Introduction to laboratory techniques, Laboratory sessions (preceded by lectures): water waves, air flow past a cylinder aero foils, hydraulic jumps, vortex shedding and vibrations, turbulent jets and plumes.

Books Recommended:

1. H.Lamb, Hydrodynamics, Doer, 6th edition 1993.
2. White, F.M. Viscous flud flow (second Edition), Mcgraw Hill, 1991.
3. P.J. Roache, "Computational Fluid Dynamics", Albuquerque, N.M., Hemosa Publishers.
4. Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisphere, 1980.
5. K.A. Hoffmann and S.T. Chiang. Computational Fluid Dynamics for Engineers, Vol.1 & 11, 1993.

METHODS OF EXPERIMENTAL PHYSICS 3 Cr.h

Pre-requisites

Experimental labs and techniques used in these labs.

Objectives:

1. To learn about the vacuum techniques
2. To learn the detection techniques about radiation, temperature.
3. To learn about the measuring techniques along with data analysis.

Vacuum Techniques:

Gas Transport: Throughout, Pumping Speed, Pump down Time Ultimate pressure. Fore-Vacuum Pumps: Rotary Oil pumps; sorption pumps. Diffusion pumps, sorption pumps (High Vacuum). Production of ultrahigh vacuum; Fundamental concepts; guttering pumps; Ion pumps; Cryogenic pumps; Turbo molecular pumps. Measurement of total pressure in Vacuums Systems; Units pressure ranges; Manometers; Perini gauges;

The McLoad gauges; Mass spectrometer for partial measurement of pressure. Design of high Vacuum system; Surface to Volume ratio; Pump Choice; pumping system design. Vacuum Components; Vacuum valves; vacuum Flanges; Liquid Nitrogen trap; Mechanical feed throughs & Electrical feed throughs Leak detection: Basic consideration; leak detection equipment; Special Techniques and problems; Repair Techniques.

Radiation Detection and Measurement:

GM tubes, scintillation detector, channeltron, photo multipliers, neutron detectors, alpha/beta detectors, x-rays/gamma detectors, cosmic rays detectors, Spectrographs and Interferometers.

Sensor Technology:

Sensors for temperature, pressure displacement, rotation, flow, level, speed, rotation position, phase, current voltage, power magnetic field, tilt, metal, explosive and heat.

Electronics and Electronic Instruments:

Operational amplifiers, summing amplifiers, difference amplifiers, Differentiators, Integrators, Logarithmic amplifiers, current to voltage converter, Spectroscopy amplifiers, charge sensitive pre-amplifiers, Coincidence circuits, Isolators, Ramp Generators, and single channel analyzer. Power supplies, Signal Generators, Counters, Multichannel analyzer, Lock in Amplifiers, Boxcar averages.

Computer Introduction:

Introduction to computers, GPIB Interface, RS 232. Interfacing, DA/AD conversion, Visual c/visual Basic.

Data Analysis:

Evaluation of measurement: Systematic Errors, Accuracy; Accidental Errors, Precision, Statistical Methods; Mean Value and Variance; Statistical Control of Measurements; Errors of Direct measurements, Rejection of data; Significance of results; Propagation of errors; preliminary Estimation; Errors of Computation. Least squares fit to a polynomial. Nonlinear functions. Data manipulation, smoothing, interpolation and extrapolation, linear and parabolic interpolation.

Books Recommended:

1. H.D.Young, Statistical Treatment of Methods of Experimental Physics, Academic Press, Inc. New York & London Vol.1.
2. J. Yarwood, High Vacuum Techniques, Chapman Hall.
3. P. Bevington, Data Reduction and Error Analysis for Physical Science, McGraw Hill.
4. J.B.Toping, Errors of Observations, IOP, 1962.

ENVIRONMENTAL PHYSICS 3 Cr.h

Pre-requisite:
Physics (FSc)

Objective:
1. To become familiar with the essentials of environment nad Global climate
2. To learn to use spectroscopy for environments.

Introduction to the Essentials of Environmental Physics:
The economic system, living in green house, enjoying the sun, Transport of matter, Energy and momentum, the social and political context.

Basic Environmental Spectroscopy:
Black body radiation, The emission spectrum of sun, The transition electric dipole moment, The Einstein Coefficients, Lambert – Beer's law, The spectroscopy of bi-molecules, Solar UV and life, The ozone filter.

The Global Climate:
The energy Balance, (Zero-dimensional Greenhouse Model), elements of weather and climate, climate variations and modeling.

Transport of Pollutants:
Diffusion, flow in reverse, ground water. Flow equations of fluid Dynamics, Turbulence, Turbulence Diffusion, Gaussian plumes in air, Turbulent jets and planes.

Noise:
Basic Acoustics, Human Perceptions and noise criteria, reducing the transmission of sound, active control of sound.

Radiation:

General laws of Radiation, Natural radiation, interaction of electromagnetic radiation and plants, utilization of photo synthetically active radiation.

Atmosphere and Climate:

Structure of the atmosphere, vertical profiles in the lower layers of the atmosphere, Lateral movement in the atmosphere, Atmospheric Circulation, cloud and Precipitation, The atmospheric greenhouse effect.

Topo Climates and Micro Climates:

Effects of surface elements in flat and widely unduling areas, Dynamic action of seliq. Thermal action of selief.

Climatology and Measurements of Climate Factor:

Data collection and organization, statistical analysis of climatic data, climatic indices, General characteristics of measuring equipments. Measurement of temperature, air humidity, surface wind velocity, Radiation balance, precipitation, Atmospheric Pressure, automatic weather stations.

Books Recommended:

1. Egbert Booker and Rienk Van Gron Belle, Environmental Physics, 2nd ed. John Wiley and sons. 1999.
2. Physics of Environmental and Climate, Guyot Praxis Publication. 1998.

INTRODUCTION TO QUANTUM COMPUTING 3 Cr.h

Pre-requisite:

Quantum Mechanics and Computational Physics

Objectives

1. To be familiar with the quantum computing
2. To learn about the Quantum circuits , and cryptography

Computer technology and historical background; Basic principles and postulates of quantum mechanics: Quantum states, evolution, quantum measurement, superposition, quantization from bits to qubits, operator function, density matrix, Schrodinger equation, Schmidt decomposition, EPR and Bell's inequality; Quantum Computation: Quantum Circuits, Single qubit operation, Controlled operations, Measurement, Universal

quantum gates, Single qubit and CNOT gates; Breaking unbreakable codes: Code making, Trapdoor function, One time pad, RSA cryptography, Code breaking on classical and quantum computers, Schor's algorithm; Quantum Cryptography: Uncertainty principle, Polarization and Spin basis, BB84, BB90, and Ekert protocols, Quantum cryptography with and without eavesdropping, Experimental realization; Quantum Search Algorithm.

Books Recommended:

1. Quantum Computation and Quantum Information by M. A. Nielson and I. L. Chuang, Cambridge University Press, Cambridge 2000.
2. Exploration in Quantum Computation by C.P. Williams and S. H. Clearwater, Springer Verlag (1997).
3. The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation by P. Bouwmester, A. Ekert, and A. Zeilinger, Springer Verlag, Berlin, Heidelberg (2000).
4. Mathematics of Quantum Computation by A.K.Brylinsky and G. Chen, Chapman & Hall/CRC (2002).

PARTICLE PHYSICS 3 Cr.h

Pre-requisite
Quantum Physics

Objectives
1. To know the particles and their classification.
2. To learn about the interaction of these particles.
3. To learn about the Quark models.

Particle Classification:
Quantum numbers, leptons, hadrons, baryons, mesons, quarks.

The Fundamental Interactions:
The electromagnetic coupling, the strong coupling, the weak coupling.

Symmetry Transformation and Conservation Laws:
Translation in space, rotation in space, the group SU (2), systems of identical particles, parity, iso-spin charge conjugation, time reversal, G parity, CPT theorem.

The Electromagnetic Field:

Gauge invariance and Maxwell's equations, polarization ad photon spin, angular momentum, parity and C parity of photon.

Hadron Spectroscopy:

Formation experiment, partial wave formalism and the optical theorem, the Breit-Wigner resonance formula, baryon resonances, phase space considerations, production experiments.

The Quark Model:

The group SU (3), quarks, hadrons baryons, mesons in quark model, heave meson spectroscopy, the quarkonium model.

The Standard Model (qualitative treatment only):

Unification of weak and electromagnetic interactions Glashow-Salam-Weinberg Model.

Books Recommended:

1. Relatvistic Quantum Mechanics by Bjorken, J. D. and Drell, S.D., McGraw Hill, (1995).
2. Quarks and Leptons by Halzen, F. and Martin, A.D., John-Wiley and Sons. (1984).
3. Quantum Mechanics by Riazuddin and Fayyazuddin, World Scientific, (1990).
4. Introduction to Elementary Particles by Griffiths, D., John-Wiley and Sons, (1987).

COMPUTER SIMULATION 3 Cr.h

Pre-requisites

Mathematical Physics

Objectives;

1. Learn techniques to understand and develop compter simulations.
2. To use numerical techniques to solve the differential equations,
3. To understand the simulation in classical physics and Quantum Physics

Introduction:

Importance of computers in physics, nature of computer simulation, computer graphics and programming languages, Techniques and class of computer simulation, Accuracy and stability of numerical techniques, External points and strings, principles of vector computing in Cartesian, spherical and cylindrical coordinates.

Numerical Approaches:

Solution of Ordinary Differential Equations, initial (boundary) and eigen value problems, numerical integrations, special functions and Guassian quadrarure, matrix operation, partial differential equations (elliptic and parabolic types)

Simulation in Classical Physics:

Motion of Falling Objects, One Dimensional Dynamics (Accelerating cars and objects on springs), Two-Dimensional Trajectories (Kepler's Laws, Oscillatory Motions), Energy and Center of Mass, Electric Fields and Potentials, LRC Circuits, Driven LRC Circuits (Time varying), Wave phenomena (Fourier analysis, Coupled oscillator), Interference, Diffraction and Polarization, Geometrical Optics (Ray Tracing an Principle of Least Time), Electric Currents and Magnetic Fields, Electromagnetic Waves.

Random Process and Quantum Physics:

Random Number and their uses, Random-walk problem, percolation theory, radio- activity and radioactive decay series, Noise in Signal, Guassian Distribution, Distribution Functions in Statistical Physics, Molecular Dynamics in Solids, Approaches to Equilibrium, Monte- Carlo Simulation, Canonical and Micro-Canonical Ensembles, Numerical Solution of time-independent (and dependent), Schrodinger Wave Equation, Particle in Bound and Free States.

Computational Methods for Continuous Medium:

Fluid equations, Governing equation in integral and differential forms, Reduce forms of the governing equation, finite volume method, compressible and incompressible flow and their methods, Discrete methods for the steady state and time dependent diffusion equation. The pressure-corection method on staggered and unstaggered grids. Time marching schems, incorporation of furbulence model, schemes for solving large algebric system, use of commercial code for prediction of off complex flow, Raynold averaging and its applications to Navier stokes equations. Mean and Turbulant kinetic energy equation,

Magnetohydrodynamics, Modelling ideal (MHD), resistive and viseus flow of plasmas, thermal conduction and heat transport.

Books Recommended:

1. Hillar, Johnston and Styer, Quantum Mechanics Simulation. (A Series of the Consortium for upper level Physics software), John Wiley & Sons, Inc. New York.1995.
2. P.J. Roache, Computational Fluid Dynamics, Albuquerque, N.M. Hemosa Publishers. 1993.
3. Marvin L. De Jong, Introduction to Computational Physics, Addison Wesley Publishing Company, Inc. New York, 1991.
5. D. Stauffer, F.W. Hehl, W. Winkelman and J.G. Zabolitzky, Computer Simultation and Computer Algebra (Lectures for Beginers), Springer-Verlage Berlin, New York, 1988.
6. Harvey Gould and Jan Tobochink, An Introduction to "Computer Simulation Methods" Part-I & II, Addison Wesley Publishing Company, Inc., New York. 1988.

DIGITAL ELECTRONICS 3 Cr.h

Pre-requisites

Electronics

Objectives

1. To learn the basics of digitl electronics sucha sa Boolian Algebra.
2. To develop logic circuit using th Boolean Algebra.
3. To understand the computer interface and micro-controller alongwith the emedded system.

Review of Number Systems:

Binary, Octal and Hexadecimal number system, their inter-conversion, concepts of logic, truth table, basic logic gates.

Boolean Algebra:

DeMorgan's theorem, simplification of Boolean expression by Boolean Postulates and theorem, K-maps and their uses. Don't care condition, Different codes. (BCD, ASCII, Gray etc.). Parity in Codes

IC logic families:

Basic characteristics of a logic family. (Fan in/out, Propagation delay time, dissipation, noise margins etc. Different logic based IC families (DTL, RTL, ECL, TTL, CMOS).

Combinational logic circuit:

Logic circuits based on AND – OR, OR-AND, NAND, NOR Logic, gate design, addition, subtraction (2's compliments, half adder, full adder, half subtractor, full subtractor encoder, decoder, PLA. Exclusive OR gate.

Sequential Logic Circuit:

Flip-flops clocked RS-FF, D-FF, T-FF, JK-FF, Shift Register, Counters (Ring, Ripple, up-down, Synchronous) A/D and D/A Converters.

Memory Devices:

ROM, PROM, EAPROM, EE PROM, RAM, (Static and dynamic) Memory mapping techniques.

Micro Computers:

Computers and its types, all generation of computers, basic architecture of computer, micro processor (ALU, UP Registers, Control and Time Section). Addressing modes, Instruction set and their types, Discussion on 8085/8088, 8086 processor family, Intel Microprocessor Hierarchy;

Micro-controller/ Embedded System:

Introduction to Embedded and microcontroller based systems; The Microprocessor and microcontroller applications and environment; microcontroller characteristics; features of a general purpose microcontroller; Microchip Inc and PIC microcontroller; Typical Microcontroller examples:, Philips 80C51 & 80C552 and Motorola 68Hc05/08; Interfacing with peripherals.

Books Recommended

1. Larry D. Jones, Principles and applications of digital electronics, Macmillan Publishing Company, 1993.
2. Digital System Design and Micro possessor J.C. BORTIE (NBF).
3. McMillan, Micro Electron, McGraw Hill.
4. Digital Logic and Computer Design Morris Mono 1995 Prentic Hall
5. Tocheim, Digital Electronics, (1999).
6. Barrey B. Brey, Intel UPS Architecture, programming and interfacing, Prentic Hall (1998).

7. T.L.Floyd, Digital Fundamental, 8th edition.
8. Tim Wilmshurst, The Design of Small-Scale Embedded Systems, Palgrave (2003).

EXPERIMENTAL NUCLEAR PHYSICS 3 Cr.h

Pre-requisite
Nuclear Physics

Objectives
1. To learn the nuclear detection system and techniques fr their measurements
2. To learn about the charged particles accelerator and nuclear reactor
3. To develop understanding of neutrons physics.

Nuclear Radiation Detection and Measurements:
Interaction of nuclear radiation with matter; photographic emulsions; Gas-filled detectors; Scintillation counters and solid-state detectors; Cloud chambers; Bubble chambers.

Charged Particle Accelerators:
Linear and orbital accelerators Van de Graaff, Cyclotron; Betatron; Synchrocyclotron; Electron-Synchrotrons; Proton-synchrotron; Alternating-gradient Synchrotron.

Neutron Physics:
Neutron Sources, Radioactive sources, Photo neutron sources Charged particle sources, Reactor as a neutron source, slow neutron detectors, fast neutron detectors, Measurement of neutron cross-sections as a function of energy, slowing down of neutrons, Nuclear fission, Description of fission reaction, Mass distribution of fission energy. Average number of neutrons released, Theory of fission and spontaneous fission, Nuclear chain reaction and applications.

Elementary Reactor Physics:
Controlled fission reactions, Types of nuclear reactors (Power and Research), Detailed study of PWR and CANDU type reactors.

Books Recommended:

1. Glenn, F. Knoll, Radiation Detection and Measurement, John Wiley, 1989.
2. William, R. Leo, Techniques for Nuclear and Particle Physics, Spinger, 1994.
3. Philips Berington and D. Keith, Data Detection and Error analysis for physical sciences, 2002.
4. Segre, Nuclei and Practicles, Bejamin, 1977.
5. Kenneth S. Krane, Introducing Nuclear Physics, 1995.
6. B. Povh, K. Rith, C. Scholtz, F. Zetsche, Particle and Nuclei, 1999.

LASERS 3 Cr.h

Pre-requisite:

Quantum Mechanics I and Atomic Physics

Objectives

1. Develop fundamental concepts about lasers
2. Learn the principles of spectroscopy of molecules and semi-conductos
3. Understand the optical resonators and laser system.
4. Applications of lasers

Introductory Concepts:

Spontaneous Emission, Absorption, Stimulated Emission, Pumping Schemes, Absorption and Stimulated Emission Rates, Absorption and Gain Coefficients, Resonance Energy Transfers. Properties of Laser Beam: Monochromaticity, Coherence, Directionality, Brightness.

Spectroscopy of Molecule and Semiconductors:

Electronic Energy Levels, Molecular Energy Levels, Level Occupation at Thermal Equilibrium, Stimulated Transition, Selection Rules, Radiative and Nonradiative Decay, Semiconductor.

Optical Resonators:

Plane Parallel (Fabry-Perot) Resonator, Concentric (Spherical) Resonator, Confocal, Resonator, Generalized Spherical Resonator, Ring Resonator, Stable Resonators, Unstable Resonators. , Matrix Formulation of Geometrical Optics, Wave Reflection and Transmission at a Dielectric Interface, Stability Condition Standing and Traveling Waves

in a two Mirror Resonator, Longitudinal and Transverse Modes in a Cavity, Multilayer Dielectric Coatings, Fabry-Perot Interferometer. Small Signal Gain and Loop Gain.

Pumping Processes:

Optical pumping: Flash lamp and Laser, Threshold Pump Power, pumping efficiency, Electrical Pumping: Longitudinal Configuration and Transverse Configuration, Gas Dynamics Pumping, Chemical Pumping.

Continuous Wave (CW) and pulsed lasers

Rate Equations, Threshold Condition and Output Power, Optimum Output Coupling, Laser Tuning, Oscillation and Pulsations in Lasers, Q-Switching and Mode-Locking Methods, Phase Velocity, Group Velocity, and Group-Delay Dispersion, Line broadening.

Lasers Systems :

Solid State Lasers: Ruby Laser, Nd: YAG & Nd: Glass Lasers and Semiconductor Lasers: Homojunction Lasers Double-Heterostructure lasers, *Gas lasers:* Helium Neon laser, CO_2 laser, Nitrogen Laser and Excimer Lasers, *Free-Electron and X-Ray Lasers*

Laser applications:

Material Processing: Surface Hardening, Cutting, Drilling, Welding etc. Holography, Laser Communication, Medicine, Defense Industry, Atmospheric Physics

Books Recommended

1. O. Svelto, Principles of Lasers, Plenum Press New York & London (1992).
2. J. Eberly and P. Milonni, Lasers, Wiley, New York. (Latest Edition).
   Scully and Zubairy, Quantum Optics, Cambridge University Press (1997).
3. A.E. Siegman, Laser, University, Science Books Mill Valley, C.A. (1986).
4. H. Haken, Laser Theory, Springer, Berlin (Latest Edition).
5. W. T. Silfvast, Laser Fundamentals, latest edition.

RELATIVITY AND COSMOLOGY 3 Cr.h

Pre-requisites
Mechanics, FSc Physics

Objectives
1. To learn about the Special theory of relativity
2. To learn the basics of relativistic mechanics and develop understanding about the General theory.

Special Relativity:
Galilean relativity, concept of ether, Michelson-Morley experiment, Einstein's postulates of special relativity, Lorentz transformations, structure of space-time, Minkowski space time tensors, the light-cone, line element, four-vectors, relativity of simultaneity, time dilation, proper time, length contraction, time paradox, velocity transformation and velocity addition.

Relativistic Mechanics: Force equation in relativity, rest mass, kinetic and total energy, conservation of energy and momentum.

Elements of Tensor Calculus: Manifolds and coordinates, curves and surfaces, tensor fields, Lie derivative, geodesics, Riemann tensor, metric tensor.

General Relativity*:* Principles of general relativity, equation of geodesics deviation, Einstein's field equations.

Cosmology: Newtonian cosmology, cosmological red-shift, Hubble's law, microwave background, the Big Bang expansion rate, matter and radiation domination, history of the universe.

Books Recommended:

1. W.D.McComb, Dynamics and Relativity, Oxford University Press, 1999.
2. J.V.Narlikar, Introduction to Cosmology, Cambridge University Press, 1989.
3. R.D.D'Inverno, Introducing Einstein's Relativity, Oxford University Press, 1992.

SOLID STATE PHYSICS-II 3Cr.h

Pre-requisite:
Solid State Physics I

Objectives:
1. To understand the transport properties in solids
2. To understand the crystal defects and their importance
3. To understand the dielectric and magnetic properties of materials
4. To give basic understanding of superconductivity.

Transport properties of solids. Boltzmann equation. Point defects and dislocations in solids. Dielectrics. Dia, Para and Ferro-magnetism. Magnetic relaxation and resonance phenomena. Superconductivity and devices. Introduction to superconductivity with applications.

Books Recommended:

1. C. Kittle, Introduction to Solid State Physics, 7th edition 1996, John Wiley.
2. S.O.Pillai, Solid State Physics, New Age International Pub. 2003.
3. W.T. Read Jr. Dislocations in crystals, McGraw Hill, 1991.
4. C.M. Kachaava, Solid State Physics, Tata McGraw Hill. Co. New Delhi, 1989.
5. J.R. Christman, Solid State Physics, John Wiley & Sons, New York, 1988.
6. H.E. Hall, Solid State Physics, John Wiley & Sons, New York, 1982.
7. A. Guinier & R. Jullien, The Solid State, Oxford University Press, Oxford, 1989.

General Recommendations:

The Committee made the following recommendations:

1. For the smooth and uniform implementation of the BS (4-year) program throughout the country, the HEC may take up the matter with the provincial Directorate of Colleges to introduce the BS (4-year) program both in Colleges and University departments. Until the introduction of 4-year composite bachelor degree program in Colleges and Universities, the program can be split up in two parts, namely Part-I (2-years) and Part-II (2-years), completed at College and university department respectively.

   To implement the BS (4-year) program the Colleges will have to provide extra facilities for teaching extra courses and for Lab equipment, the Provinces will have to be involved at the highest level for the implementation for the BS program.

2. Refresher courses on new topics in Physics may be arranged for college teachers.

3. The HEC should provide special funds for building infrastructure for the BS (4-year) program and development of teaching faculty at the university departments.

4. As all the BS programs are of four years duration, the suffix “Hons.” may not be used with the nomenclature of the program.

5. The Directorate Colleges of Provinces should be provided special funds by the respective provinces for qualified man-power and for building of necessary infrastructure for starting BS (4-year) program or at least the Part-I of this program at Colleges, in consistency with the approved revised scheme of studies and curriculum of Physics for the program.

Annexure "A"

COMPULSORY COURSES IN ENGLISH FOR BS (4 YEAR) IN BASIC & SOCIAL SCIENCES

English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents

Basics of Grammar
Parts of speech and use of articles
Sentence structure, active and passive voice
Practice in unified sentence
Analysis of phrase, clause and sentence structure
Transitive and intransitive verbs
Punctuation and spelling

Comprehension

Answers to questions on a given text

Discussion

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Listening

To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills

Urdu to English

Paragraph writing

Topics to be chosen at the discretion of the teacher

Presentation skills

Introduction

Note: Extensive reading is required for vocabulary building

Recommended books:

1. **Functional English**

a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

English II (Communication Skills)

Objectives: Enable the students to meet their real life communication needs.

Course Contents

Paragraph writing
Practice in writing a good, unified and coherent paragraph

Essay writing
Introduction

CV and job application

Translation skills
Urdu to English

Study skills
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

Academic skills
Letter/memo writing, minutes of meetings, use of library and internet

Presentation skills
Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review

Recommended books:

Communication Skills

a) Grammar
   1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing
   1. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
   2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading
   1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
   2. Reading and Study Skills by John Langan
   3. Study Skills by Riachard Yorky.

English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents

Presentation skills

Essay writing
Descriptive, narrative, discursive, argumentative

Academic writing
How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing

Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

Annexure "B"

Pakistan Studies (Compulsory)

Introduction/Objectives

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

1. **Historical Perspective**
   a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
   b. Factors leading to Muslim separatism
   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.
2. **Government and Politics in Pakistan**
   Political and constitutional phases:
   a. 1947-58
   b. 1958-71
   c. 1971-77
   d. 1977-88
   e. 1988-99
   f. 1999 onward
3. **Contemporary Pakistan**
   a. Economic institutions and issues
   b. Society and social structure
   c. Ethnicity
   d. Foreign policy of Pakistan and challenges
   e. Futuristic outlook of Pakistan

Books Recommended

1. Burki, Shahid Javed. *State & Society in Pakistan,* The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy.* Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development.* Lahore, 1994.
5. Wilcox, Wayne.*The Emergence of Banglades.,* Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota,* Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan,* Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development.* Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh.* Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan.* Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research, 1993.

Annexure "C"

ISLAMIC STUDIES
(Compulsory)

Objectives:

This course is aimed at:

1 To provide Basic information about Islamic Studies
2 To enhance understanding of the students regarding Islamic Civilization
3 To improve Students skill to perform prayers and other worships
4 To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies

1) Basic Concepts of Quran
2) History of Quran
3) Uloom-ul -Quran

Study of Selected Text of Holly Quran

1) Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
5) Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

Study of Sellected Text of Holly Quran

1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

Seerat of Holy Prophet (S.A.W) I

1) Life of Muhammad Bin Abdullah (Before Prophet Hood)
2) Life of Holy Prophet (S.A.W) in Makkah

3) Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

1) Life of Holy Prophet (S.A.W) in Madina
2) Important Events of Life Holy Prophet in Madina
3) Important Lessons Derived from the life of Holy Prophet in Madina

Introduction To Sunnah

1) Basic Concepts of Hadith
2) History of Hadith
3) Kinds of Hadith
4) Uloom –ul-Hadith
5) Sunnah & Hadith
6) Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction To Islamic Law & Jurisprudence

1) Basic Concepts of Islamic Law & Jurisprudence
2) History & Importance of Islamic Law & Jurisprudence
3) Sources of Islamic Law & Jurisprudence
4) Nature of Differences in Islamic Law
5) Islam and Sectarianism

Islamic Culture & Civilization

1) Basic Concepts of Islamic Culture & Civilization
2) Historical Development of Islamic Culture & Civilization
3) Characteristics of Islamic Culture & Civilization
4) Islamic Culture & Civilization and Contemporary Issues

Islam & Science

1) Basic Concepts of Islam & Science
2) Contributions of Muslims in the Development of Science
3) Quranic & Science

Islamic Economic System

1) Basic Concepts of Islamic Economic System
2) Means of Distribution of wealth in Islamic Economics
3) Islamic Concept of Riba
4) Islamic Ways of Trade & Commerce

Political System of Islam

1) Basic Concepts of Islamic Political System
2) Islamic Concept of Sovereignty

3) Basic Institutions of Govt. in Islam

Islamic History

1) Period of Khlaft-E-Rashida
2) Period of Ummayyads
3) Period of Abbasids

Social System of Islam

1) Basic Concepts Of Social System Of Islam
2) Elements Of Family
3) Ethical Values Of Islam

Reference Books:

1) Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
2) Hameed ullah Muhammad, "Muslim Conduct of State"
3) Hameed ullah Muhammad, 'Introduction to Islam
4) Mulana Muhammad Yousaf Islahi,"
5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
7) Mir Waliullah, "Muslim Jrisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

Annexure "D"

Note: One course will be selected from the following six courses of Mathematics.

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.
Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

Sequences and Series: Arithmetic progression, geometric progression, harmonic progression.
Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.
Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Books:

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

Boston (suggested text)
Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.
Limits and Continuity: Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.
Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

Recommended Books:

Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8th edition), 2005, John Wiley, New York
Stewart J, *Calculus* (3rd edition), 1995, Brooks/Cole (suggested text)
Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston
Thomas GB, Finney AR, *Calculus* (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Geometry in Two Dimensions: Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation

Recommended Books:

Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969
Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

Title of subject:		MATHEMATICS
Discipline	:	BS (Social Sciences).
Pre-requisites	:	SSC (Metric) level Mathematics
Credit Hours	:	03 + 00
Minimum Contact Hours:		40
Assessment	:	written examination;
Effective	:	2008 and onward

Aims : To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

Objectives : After completion of this course the student should be able to:

- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

Contents :

1. *Algebra* : *Preliminaries:* Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations:* Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series:* Arithmetic, geometric and harmonic progressions. *Permutation and combinations*: Introduction to permutation and combinations, *Binomial Theorem:* Introduction to binomial theorem. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities. *Graphs:* Graph of straight line, circle and trigonometric functions.
2. *Statistics* : *Introduction*: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution*: Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean medium and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

Books Recommended:

1. Swokowski. E. W., '*Fundamentals of Algebra and Trigonometry*', Latest Edition.
2. Kaufmann. J. E., '*College Algebra and Trigonometry*', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., '*Introduction of Statistics*', Prentice Hall, Latest Edition.
4. Wilcox, R. R., '*Statistics for The Social Sciences'*,

5. MATHEMATICS FOR CHEMISTRY

Credit Hours: 3

Prerequisites: Mathematics at Secondary level

Specific Objectives of Course: To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries: Real Numbers and the Real Line, *Functions and their graphs*: Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity:* Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications:* Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. *Integration and Indefinite Integrals:* Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, Jhon Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A.Jr, Elliott Mendelson, Calculus, Schaum's Outline Series, 4th edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

6. MATHEMATICS FOR PHYSICS

Contents

1. Preliminary calculus.

   - Differentiation

   Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz' theorem; special points of a function; theorems of differentiation.

- Integration

Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.

2. Complex numbers and hyperbolic functions

- The need for complex numbers
- Manipulation of complex numbers
  Additions and subtraction; modulus and argument; multiplication; complex conjugate; division
- Polar representation of complex numbers
  Multiplication and division in polar form
- de Moivre's theorem
  Trigonometrical identities; finding the nth roots of unity; solving polynomial equations
- Complex logarithms and complex powers
- Applications to differentiation and integration
- Hyperbolic functions

Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions

3. Series and limits

- Series
- Summation of series

Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series

- Convergence of infinite series
  Absolute and conditional convergence; convergence of a series containing only real positive terms; alternating series test
- Operations with series
- Power series
  Convergence of power series; operations with power series
- Taylor series
  Taylor's theorem; approximation errors in Taylor series; standard Maclaurin series
- Evaluation of limits

4. Partial differentiation

- Definition of the partial derivative
- The total differential and total derivative
- Exact and inexact differentials
- Useful theorems of partial differentiation
- The chain rule
- Change of variables
- Taylor's theorem for many-variable functions
- Stationary values of many-variable functions
- Stationary values under constraints

5. Multiple integrals

- Double integrals
- Triple integrals
- Applications of multiple integrals
  Areas and volumes; masses, centers of mass and centroids; Pappus' theorems; moments of inertia; mean values of functions
- Change of variables in multiple integrals
  Change of variables in double integrals;

6. Vector algebra

- Scalars and vectors
- Addition and subtraction of vectors
- Multiplication by a scalar
- Basis vectors and components
- Magnitude of a vectors
- Multiplication of vectors
  Scalar product; vector product; scalar triple product; vector triple product
- Equations of lines and planes
  Equation of a line; equation of a plane
- Using vectors to find distances
  Point to line; point to plane; line to line; line to plane
- Reciprocal vectors

7. Matrices and vector spaces

- Vectors spaces
  Basic vectors; the inner product; some useful inequalities
- Matrices
- The complex and Hermitian conjugates of a matrix
- The determinant of a matrix
  Properties of determinants

- The inverse of a matrix
- The rank of a matrix
- Simultaneous linear equations
  N simultaneous linear equations in N unknowns
- Special square matrices
  Diagonal; symmetric and antisymmetric; orthogonal; Hermitian; unitary normal
- Eigen vectors and eigen values
  Of a normal matrix; of Hermitian and anti-Hermitian matrices; of a unitary matrix; of a general square matrix
- Determination of eigen values and eigen vectors
  Degenerate eigen values

8. Vector calculus

- Differentiation of vectors
  Composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments
- Surfaces
- Scalar and vector fields
- Vector operators
  Gradient of a scalar field; divergence of a vector field; curl of a vector field
- Vector operator formulae
  Vector operators acting on sums and products; combinations of grad, div and curl
- Cylindrical and spherical polar coordinates
  Cylindrical polar coordinates; spherical polar coordinates

Annexure "E"

INTRODUCTION TO STATISTICS

Credit hrs: 3(3-0)

Unit 1. What is Statistics?

Definition of Statistics, Population, sample Descriptive and inferential Statistics, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, Rounding of a Number, Collection of primary and secondary data, Sources, Editing of Data. Exercises.

Unit 2. Presentation of Data

Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Historigram, Ogive for Discrete Variable. Types of frequency curves. Exercises.

Unit 3. Measures of Central Tendency

Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

Unit 4. Measures of Dispersion

Introduction, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios. Exercises.

Unit 5. Probability and Probability Distributions.

Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

Unit 6. Sampling and Sampling Distributions

Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions. Exercises.

Unit 7. Hypothesis Testing

Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis. Exercises.

Unit 8. Testing of Hypothesis- Single Population

Introduction, Testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

Unit 9. Testing of Hypotheses-Two or more Populations

Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table. Exercises

Unit 10. Testing of Hypothesis-Independece of Attributes

Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes. Exercises.

Unit 11. Regression and Correlation

Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation. r and R^2. Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

Recommended Books

1 Walpole, R. E. 1982. "Introduction to Statistics", 3rd Ed., Macmillan Publishing Co., Inc. New York.

2 Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar Faisalabad.

Note: ***General Courses from other Departments***

Details of courses may be developed by the concerned universities according to their Selection of Courses as recommended by their Board of Studies.