D A Y A L B A G H E D U C A T I O N A L I N S T I T U T E
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS & COMPUTER SCIENCE
PHYSICS SYLLABUS: SESSION 2017-18

Course Number	Course Title	Credits	End Sem. Exam. Exists	Theory/ Practical
PHH101	PHYSICS THEORY	4.0	Yes	T
PHH102	PHYSICS LAB	2.0	Yes	P
PHW101	PRACTICAL ELECTRONICS I	2.0	No	P
PHW102	ENTERTAINMENT ELECTRONICS I	2.0	No	P
PHW103	INT.TO COMPUTERS& OPERATING SYSTEMS	2.0	No	P
PHM101	MECHANICS AND RELATIVITY	3.0	Yes	T
PHM102	MATHEMATICAL METHOD-I	3.0	Yes	T
PHM103	PHYSICS LAB	2.0	Yes	P
PHM104	SEMINAR & GROUP DISCUSSION	0.5	No	P
PHH251	APPLIED PHYSICS	4.0	Yes	T
PHH252	APPLIED PHYSICS LAB	2.0	Yes	P
PHH451	APPLIED PHYSICS	4.0	Yes	T
PHH452	APPLIED PHYSICS LAB	2.0	Yes	P
PHW201	PRACTICAL ELECTRONICS II	2.0	No	P
PHW202	ENTERTAINMENT ELECTRONICS II	2.0	No	P
PHW203	MICROSOFT OFFICE	2.0	No	P
PHM201	OSCILLATIONS, WAVES & ACOUSTICS	3.0	Yes	T
PHM202	ELECTRICITY & MAGNETISM	3.0	Yes	T
PHM203	PHYSICS LAB	2.0	Yes	P
PHM204	SEMINAR & GROUP DISCUSSION	0.5	No	P
PHM301	OPTICS	3.0	Yes	T
PHM302	THERMAL & STATISTICAL PHYSICS	3.0	Yes	T
PHM303	INTRODUCTION TO QUANTUM MECHANICS	3.0	Yes	T
PHM304	PHYSICS LAB	3.0	Yes	P
PHM305	SEMINAR & GROUP DISCUSSION	0.5	No	P
PHM401	SOLID STATE PHYSICS	3.0	Yes	T
PHM402	SEMICONDUCTOR DEVICES AND CIRCUITS	3.0	Yes	T
PHM403	NUCLEAR PHYSICS	3.0	Yes	T
PHM404	PHYSICS LAB	3.0	Yes	P
PHM405	SEMINAR & GROUP DISCUSSION	0.5	No	P
PHM501	MATHEMATICAL METHODS II	4.0	Yes	T
PHM502	CLASSICAL MECHANICS	4.0	Yes	T
PHM503	DIGITAL SYSTEMS & MICROPROCESSORS	4.0	Yes	T
PHM504	NETWORK THEORY	4.0	Yes	T
PHM505	ELECTROMAGNETIC THEORY	4.0	Yes	T
PHM506	DIGITAL & MICROPROCESSOR LAB	3.0	Yes	P
PHM507	NETWORK & SYSTEMS LAB	3.0	Yes	P
PHM601	QUANTUM MECHANICS	4.0	Yes	T
PHM602	ATOMIC & MOLECULAR SPECTRA	4.0	Yes	T
PHM603	SEMICONDUCTOR DEVICES	4.0	Yes	T
PHM604	MIXED SIGNAL CIRCUIT DESIGN	4.0	Yes	T
PHM605	COMPUTATIONAL SCIENCE & PROGRAMMING	4.0	Yes	T
PHM606	ELECTRONICS LAB	3.0	Yes	P
PHM607	PROGRAMMING LAB	3.0	Yes	P
PHM701	CONDENSED MATTER PHYSICS	4.0	Yes	T
PHM702	STATISTICAL MECHANICS	4.0	Yes	T
PHM703	ADVANCED QUANTUM MECHANICS	4.0	Yes	T
PHM704	NUCLEAR AND PARTICLE PHYSICS	4.0	Yes	T
PHM705	MATHEMATICAL PHYSICS	4.0	Yes	T
PHM706	‘C’ AND DATA STRUCTURES	4.0	Yes	T
PHM707	COMPUTER SYSTEMS ARCHITECTURE	4.0	Yes	T

PHM708	LABORATORY	4.0	Yes	P
PHM802	NEURAL NETWORKS	4.0	Yes	T
PHM803	PHYSICS AT NANOSCALE	4.0	Yes	T
PHM804	MICROWAVE TECHNIQUES	4.0	Yes	T
PHM805	LASER PHYSICS & APPLICATIONS	4.0	Yes	T
PHM806	DESIGN AND ANALYSIS OF ALGORITHMS	4.0	Yes	T
PHM807	SOFTWARE ENGINEERING	4.0	Yes	T
PHM808	ANALOG INTEGRATED CIRCUITS	4.0	Yes	T
PHM809	LABORATORY	4.0	Yes	P
PHM810	OPERATING SYSTEMS	4.0	Yes	T
PHM811	QUANTUM COMPUTING	4.0	No	P
PHM001	BASIC RES. METH., SC.COMPUT.& ANAL.	4.0	Yes	T
PHM002	PRE-DISSERTATION	4.0	No	P
PHM901	DISSERTATION	12.0	Yes	P
PHM902	OPTO ELECTRONICS	4.0	Yes	T
PHM903	PLASMA PHYSICS	4.0	Yes	T
PHM904	COMPUTER NETWORKS	4.0	Yes	T
PHM905	DIGITAL SIGNAL PROCESSING	4.0	Yes	T
PHM906	OPERATING SYSTEMS	4.0	Yes	T
PHM907	ACOUSTICS	4.0	Yes	T
PHM908	ASTROPHYSICS & GENERAL RELATIVITY	4.0	Yes	T
PHM909	NONLINEAR DYNAMICS	4.0	Yes	T
PHM910	COMPLEX SYSTEMS AND NETWORKS	4.0	Yes	T
PHM911	VLSI DESIGN TECHNIQUES	4.0	Yes	T
PHM912	STATISTICAL MECHANICS	4.0	Yes	T
PHM913	BIOPHYSICS	4.0	Yes	T
PHM914	INTRODUCTION TO EMBEDDED SYSTEMS	4.0	Yes	T
PHM915	LASER PHYSICS AND APPLICATIONS	4.0	Yes	T
PHM916	GENERAL RELATIVITY	4.0	No	P
PHM917	QUANTUM FIELD THEORY	4.0	Yes	T
PHM918	STRING THEORY AND M-THEORY	4.0	No	P
PHM951	DISSERTATION I	8.0	Yes	P
PHM952	DISSERTATION II	16.0	Yes	P
PHM953	SELF STUDY COURSE	4.0	Yes	P
PHM954	ADV. SCIENTIFIC METHODOLOGY & ANAL.	4.0	Yes	T
PHM955	NANOTECHNOLOGY	4.0	Yes	T
PHM956	QUANTUM COMPUTING	4.0	No	T
PHM957	INFORMATION CENTRIC SYSTEMS DESIGN	4.0	No	T
PHM958	OPERATING SYSTEMS	4.0	No	T
PHM959	COMPUTER NETWORKS	4.0	No	T
PHM960	INTELLIGENT INFORMATION PROCESSING	4.0	No	T
PHM961	MEDIA PROCESSING	4.0	No	T
PHM962	EXPERIMENTAL TECHNQ.& DATA ANAL	4.0	Yes	T
PHM964	QUANTUM SYSTEM MODELING	4.0	Yes	T
PHM965	QUANTUM FIELD THEORY	4.0	No	T
PHM966	STRING THEORY AND M-THEORY	4.0	No	T

FOR B.TECH. STUDENTS

PHM181	APPLIED PHYSICS I	3.0	Yes	T
PHM182	APPLIED PHYSICS LAB	1.0	Yes	P
PHM281	APPLIED PHYSICS II	3.0	Yes	T
PHM282	APPLIED PHYSICS LAB	1.0	Yes	P

Course Number: PHH101, Course Title: PHYSICS THEORY
Class: B.Sc., Status of the Course Number: HALF COURSE, Approved Since Session: 2010-11
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0), Min. Periods/Sem.: 52

UNIT 1 [10 pds]
Dynamics of a particle in conservative fields: work done by a force acting on a particle (line integral), work-energy principle, conservative force, conservative force field, conservative force as a negative gradient of potential energy, planetary motion, Kepler's laws of planetary motion, Earth's gravitational field and escape velocity, artificial satellites.
UNIT 2 [10 pds]
Frames of Reference and Special Theory of Relativity: Inertial and non-inertial frames of reference, fictitious forces, ether paradox and ether wind, Michelson and Morley experiment, Laws of Special Theory of Relativity. Length contraction, time dilation, mass and energy relation, particle of zero rest mass.
UNIT 3 [10 pds]
Interference of light: Fringe width, fresnel biprism arrangement and determination of wavelength with a biprism, Newton's rings. Idea of double refraction, Nicol prism, production of plane, circular and elliptically polarized light.
UNIT 4 [11 pds]
Electricity: Coulomb's law, superposition of charges, electric potential, E = - Grad V, flux of E, Gauss' law, Field of a sphere of charge, field lines, equipotential surfaces.
Magnetic fields and moving charges. Simple DC circuits, KVL, KCL, equivalent circuits, superposition, alternating currents, impedance, analysis of simple RLC networks, resonance.
UNIT 5 [11 pds]
Electronics: Elementary idea of metals, insulators and semiconductors, physical idea of the pn junction, I–V characteristics, application as a rectifier. pnp and npn transistors, transistor as an amplifier and oscillator.

SUGGESTED READINGS:
BERKELEY PHYSICS COURSE : Vol. I (MECHANICS)
D Halliday & R Resnick: PHYSICS VOLUME I
JC Upadhayaya: MECHANICS (BOTH ENGLISH & HINDI)
BK Mathur: INTRODUCTION TO GEOMETRICAL AND PHYSICAL OPTICS
AK Ghatak: OPTICS
Prakash Satya : OPTICS AND ATOMIC PHYSICS
RW Wood: PHYSICAL OPTICS
Arora & Saxena: ELECTRICITY AND ELECTRONICS
Brij Lal & Subramanian: ELECTRICITY AND MAGNETISM

Course Number: PHH102, Course Title: PHYSICS LAB
Class: B.Sc., Status of the Course Number: HALF COURSE, Approved Since Session: 2006-07
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52
At least <u>TEN</u> experiments out of the following to be done:
1. Q, K and relaxation time by simple pendulum.
2. To determine the value of modulus of rigidity for the material of a wire by Maxwell's needle.
3. To determine the value of the Young's modulus for the material of a beam by the method of bending of beam.
4. To determine the Poisson's ratio for rubber with the help of rubber tubing.
5. To verify formula for focal length of combination of lenses by nodal slide.
6. To determine the wavelength of Sodium light by Newton's ring method.
7. To determine the wavelength of Sodium light by Fresnel's Biprism.
8. To determine μ_o and μ_e for calcite/quartz prism by using spectrometer.
9. PN junction diode characteristics.
10. Impedance of LCR circuits.
11. Conversion of galvanometer into voltmeter.
12. Conversion of galvanometer into ammeter.
13. Use of CRO.
14. To determine ballistic constant K by using ballistic galvanometer.
15. Use of multimeter.

SUGGESTED READINGS:
Kumar & Gupta: PHYSICS PRACTICAL, Vol. I & II

Course Number: PHW101, Course Title: PRACTICAL ELECTRONICS I
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52

THEORY:
1. Basic electronic components, type of resistors, capacitors, transformers, specifications, color coding of resistors.
2. Multimeter- conversion of galvanometer into voltmeter and ammeter of different ranges, ohmmeter.
3. Electronic devices-intrinsic and extrinsic semiconductor, junction diode, transistors, zener diode and their circuit symbols.
4. Basic idea of power supplies, Amplifiers, Oscillators, Modulators and demodulators.
5. Radio receivers - superheterodyne receiver with the help of block diagram.
6. Basics of CRO.

PRACTICAL:
1. Identification of different electronic components, resistors capacitors and transformers.
2. Multimeter: use of multimeter, conversion of galvanometer into ammeter.
3. Testing of different components: resistors, capacitors, transformers, junction diode, transistors, speakers.
4. Art of soldering.
5. Fabrication of power supply: regulated and unregulated.

Course Number: PHW102, Course Title: ENTERTAINMENT ELECTRONICS I
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52

Basic electronic components, resistors, capacitors, transformers, junction diode, transistors, ICs, use of multimeter, CRO, soldering techniques. General idea of Vestigial sideband and its detection, synchronization pulses, basic receivers, block diagram study, circuits of various blocks, power supply, antenna, tuner, video IF stages, video detectors, video amplifiers, low and high frequency compensation, synchronization and AGC circuits, horizontal / vertical deflection systems, sound amplifier, audio detector.

Course Number: PHW103, Course Title: INT.TO COMPUTERS& OPERATING SYSTEMS
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52

UNIT 1: Familiarization with the IBM PC Hardware, introducing MSDOS, basic commands.
UNIT 2: File management in MSDOS, advanced commands.
UNIT 3: Working with Windows 95, file management, configuration control etc.
UNIT 4: Introducing Unix: file management commands, file creation with vi, etc.
UNIT 5: Computer viruses and anti virus protection, computer maintenance.

Course Number: PHM101, Course Title: MECHANICS AND RELATIVITY
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 3, Periods (55 mts. each) per week: 3 (L:3+T:0+P/S:0), Min. Periods/Sem.: 39

UNIT 1: INTRODUCTION [7 pds]
Dimensional analysis, Newton's Laws, Inertial Reference frames, Static Equilibrium, Free body diagrams, Projectile motion, Friction, Conservation of energy and momentum, simple harmonic oscillator, Newton's law of Gravitation and the Cavendish Experiment, Rocket motion, the CM frame, elastic and inelastic collisions.
UNIT 2: CENTRAL FORCES [8 pds]
Conservation of angular momentum, Polar Coordinates in the Plane, The Effective Potential, The Stability of Circular Orbits, Kepler's laws of planetary motion, Orbital Precession, scattering, Rutherford Scattering
UNIT 3: ROTATING OBJECTS [8 pds]
Rigid Bodies, Angular Velocity, The Moment of Inertia, Parallel Axis Theorem, The Inertia Tensor, The motion of rigid bodies. Non-Inertial Frames: Pseudo forces, examples involving the centrifugal force and Coriolis force.
UNIT 4: ELASTICITY AND VISCOSITY [8 pds]
Elasticity and Viscosity: Definition of elastic constants and their relation, Torsion of a cylinder, Bending of a beam, Cantilever, Beam supported at its ends and loaded in the middle. Streamlined and turbulent flows, equation of continuity, critical velocity, flow of a liquid through a capillary tube, capillaries in series and parallel, Stokes' formula.
UNIT 5: SPECIAL THEORY OF RELATIVITY [8 pds]
Galilean Transformation, Hypothesis of Galilean Invariance, Background of Michelson-Morley experiment, Fizeau experiment, aberration of light, Postulates of the special theory of relativity, Length contraction, Time dilation, Relativistic addition of velocities, conservation of momentum and variation of mass, relativistic momentum, Relativistic energy, Mass-Energy relation.

SUGGESTED READINGS***:***
Halliday, Resnick Walker, *Fundamentals of Physics*
David Morin, *Introduction to Classical Mechanics*, Cambridge University Press (2008)
Other Notes: David Tong, *Dynamics and Relativity*, (*University of Cambridge Part IA Mathematical Tripos)*, Notes available online.

Course Number: PHM102, Course Title: MATHEMATICAL METHOD-I
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39

UNIT 1: DIFFERENTIAL AND INTEGRAL CALCULUS [7 pds]
Review of Differentiation, Exponential and Logarithm functions, Trigonometric Functions, Plotting Functions, Differentials, Basics of Integration, Integration Tricks, Gaussian Integrals, Integration by Parts, Differential and Integral Calculus for Many Variables, Lagrange Multipliers, Solid Angles. Jacobians, Taylor Series
UNIT 2: COMPLEX NUMBER [8 pds]
Complex Numbers in Cartesian and Polar Form, Basic Properties of Complex Numbers, Analytic Functions, Cauchy-Riemann Equations, Singularities of Analytic Functions, Residue Theorem, Taylor Series for Analytic Functions
UNIT 3: VECTOR CALCULUS [8 pds]
Vector algebra, Vector Calculus -- divergence, gradient and curl, Multiple integrals, Divergence theorem, Green's theorem, Stokes' theorem. Expressions for divergence gradient and curl in polar coordinates
UNIT 4: MATRICES AND DETERMINANTS [8 pds]
Matrices, Inverses, Linear Vector Spaces, basis, basis transformations and linear operators, Determinants, Eigenvalues, Eigenvectors, simple applications, introduction to tensors
UNIT 5: DIFFERENTIAL EQUATIONS [8 pds]
Introduction, ordinary differential equations with constant coefficients, first order ODE's with variable coefficients, second order ODE's partial differential equations, the wave equation and the heat equation, introduction to Green's function method

SUGGESTED READINGS:
R Shankar, *Basic Training in Mathematics,* Springer.
PG Harper, D. L. Weaire, *Introduction to Physical Mathematics*
Zeldovich and Yagiom, *Higher Math for Beginning Physicists and Engineers*

Course Number: PHM103, Course Title: PHYSICS LAB.
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4) Min. Periods/Sem.: 52

At least TEN experiments out of the following to be done during the Semester.

1. M.I. of a regular body by Inertia table.
2. Study of the variation in M.I. with distribution of mass.
3. 'g' by Bar Pendulum.
4. 'g' by Kater's Pendulum.
5. Poisson's ratio of rubber.
6. Modulus of Rigidity 'n' by Maxwell's Needle.
7. 'Y' by bending of beam.
8. Coefficient of viscosity of liquid by Poiseuille's method.
9. Coefficient of viscosity of liquid by rotating cylinder method.
10. Compare coefficient of viscosity of two given liquids using viscometer at room temperature.
11. Study the oscillations of a rubber band.
12. Study the oscillations of a bifillar suspension arrangement.
13. Study simple harmonic damped oscillations and calculate (i) damping constant 'K' (ii) relaxation time 't' and (iii) quality factor 'Q' of the oscillations.
14. Determine Stefan's constant.
15. Thermo-emf thermometry.
16. Resistance thermometry.
17. Study of temperature dependence of total radiation.
18. Study of Brownian motion.

SUGGESTED READINGS:
Saraf, B. : MECHANICAL SYSTEMS (VIKAS PUBLISHING HOUSE, NEW DELHI)
Khandelwal,D.P.: A LABORATORY MANUAL FOR U.G. CLASSES (VANI PUBLISHING HOUSE, NEW DELHI)
Praksah, Indu: A TEXT BOOK OF PRACTICAL PHYSICS. VOLUME 1 AND KRISHNA, RAM & 2.
Sharma, H. P.: A TEXT BOOK OF PRACTICAL PHYSICS. VOLUME 1 AND SINHA, H. P. & 2.

Course Number: PHM104, Course Title: SEMINAR & GROUP DISCUSSION
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 0.5

Topics related to PHM101 and PHM102.

Course Number: PHH251/451, Course Title: APPLIED PHYSICS
Class: B.A. / B.Sc.(HS), Status of the Course: NF Half-course, Approved Since Session: 1998-1999
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Periods/Sem.: 52

UNIT 1
Mechanics: Newton's Laws of Motion, Momentum, Circular motion, Centripetal force, Planetary motion, Newton's law of gravitation, Earth satellite and escape velocity (without mathematical treatments), work, energy and power, conservation of energy, principles of household appliances such as mixer, cream separator, washing machine.
UNIT 2
HeaT:Change of state, melting point and boiling point - their changes with various factors, latent heat, freezing mixtures, various heat, freezing mixtures, various modes of transmission of heat with application in daily life. Hydrometers: humidity, atmospheric phenomena like rain, fog, thermometer, pressure cooker, thermoflask, refrigerator.
UNIT 3
Light and Sound: Nature of light, laws of reflection, refraction, dispersion of light spectrum, optical instruments such as camera, magnifying glass, microscope, telescope, working of eye and its defects, aberration of lenses (Chromatic & sphericals), vibrations, transmission of sounds, Instruments such as ear, string, flute.
UNIT 4
Electricity: Conductors and Insulators, Unit of measurement of current, DC & AC, Voltage, Ohm's law, Potential difference, resistance, parallel and series joining of resistance, electrical energy and power, calculation of cost of energy, wattmeter, housewiring, fuse and its uses, electric iron, electric bell, toaster.
UNIT 5
Electronics: Thermionic emission, semiconductor, diode, transistor, rectification, half-wave and full wave rectifier, power supply, CRO and its applications.

Course Number: PHH252/452, Course Title: APPLIED PHYSICS LAB.
Class: B.A./ B.Sc.(HS), Status of the Course Number: NF Half-course, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4) Min. Periods/Sem.: 52

1. Measurement by Vernier Caliper and Screw gauge.
2. Determination of 'g' by simple pendulum.
3. Focal length of convex lens.
4. Velocity of sound by resonance tube.
5. Verification of Ohm's law.
6. Law of resistance in series and Parallel.
7. Study of diode characteristics.
8. Study of half-wave rectifier.
9. Study of full-wave rectifier.
10. Comparison of e.m.f. of two cells by potentiometer.
11. Calculation of refractive index of prism material by i-d curve.
12. Calculation of relative humidity and dew point.
13. Refractive index of water by convex lens and plane mirror.
14. Refractive index of glass by travelling microscope.

Course Number: PHW201, Course Title: PRACTICAL ELECTRONICS II
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52

Students have to work on atleast one of the following projects:
1. Amplifiers 2. Oscillators 3. Receiver 4. any other project approved by the course teacher.

Course Number: PHW202, Course Title: ENTERTAINMENT ELECTRONICS II
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52

Various faults and their locations, precautions in trouble shooting, TV, use of pattern generator, fundamentals of color TV. Audio / video / recording.

Course Number: PHW203, Course Title: MICROSOFT OFFICE
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52

UNIT 1: Using the Microsoft Office environment, Microsoft Word 7.0, creating professional documents, printing, etc.
UNIT 2: Creating presentations with Power Point.
UNIT 3: Introduction to Spreadsheet management using Excel.
UNIT 4: Integration of Excel, Power Point and Word to create professional documents and presentations.
UNIT 5: File management in MS Office using the Office Binder, MS Schedule.

Course Number: PHM201, Course Title: OSCILLATIONS, WAVES & ACOUSTICS
Class: B.Sc., Status of the Course Number: MAJOR. Approved Since Session: 2005-06
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39

UNIT 1: SIMPLE HARMONIC
Simple Harmonic Motion, Rotating Vector Representation and Complex Numbers, Complex Exponential, Superimposed vibrations of same frequency: phase difference and interference, Superimposed vibrations of different frequency: beats, combination of perpendicular vibrations of same frequency and different frequency: Lissajous figures.
Mass-spring problem, Elasticity and Young's Modulus and mechanical vibrations, examples: floating objects, water in U-tube. Torsional oscillations and modulus of rigidity, Vibrating column of air and bulk modulus. Massive Springs. Damped Oscillations, Forced Oscillations and Resonance, power absorbed by a driven oscillator, transient phenomena, resonance
UNIT 2: Coupled Oscillations and Normal Modes
Normal Modes of two coupled pendulums, superposition of normal modes, Normal frequencies: general analytic approach, forced vibration and resonance for two coupled oscillators, Normal modes for *N* coupled oscillators, longitudinal oscillations, normal modes of a crystal lattice
UNIT 3: WAVES
Free vibrations of stretched strings, stationary waves, superposition of modes on a string, forced harmonic vibration of a stretched string, longitudinal vibrations of a rod, elasticity of a gas, normal modes of two and three dimensional systems..Reflection, Formation of stationary waves. Experimental verification of the laws of vibrating strings, Vibration of stretched membrane
UNIT 4: FOURIER ANALYSIS
Fourier analysis, normal modes and orthogonal functions. Fourier theorem, Evaluation of Fourier coefficient, Trigonometric Fourier series, Analysis of Square, Sawtooth, Triangular waves and half and full wave rectifier outputs
UNIT 5: Acoustics
Noise and Music, Musical Scale, Sonar, Acoustics impedance of a medium, Reverberation Time and Sabine's formula, intensity and loudness, decibels, Weber-Flechner law. Ultrasonics: production, detection and applications
Suggested Readings:
AP French, *Vibrations and Waves,* MIT Introductory Physics Series.
H J Pain, *Physics of Vibrations and Waves*
Feynman, *Feynman Lectures on Physics vol 1,2*, Pearson Education

Course Number: PHM202, Course Title: ELECTRICITY AND MAGNETISM
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39

UNIT 1: ELECTROSTATICS [8 pds]
Quantization, conservation and invariance of electric charge, Electric field: Coulomb's Law, continuous charge distributions. Divergence and curl of electrostatic fields: field lines, flux, Gauss's Law, divergence of E, applications of Gauss's law, curl of E.
UNIT 2: ELECTRIC POTENTIAL AND ENERGY [7 pds]
Poisson equation and Laplace's equation, potential of a localized charge distribution, electrostatic boundary conditions. Work and energy in electrostatics: work done to move a charge, energy of a point charge and continuous charge distribution. Conductors, induced charges, surface charge and force on a conductor, capacitors. Method of Images. Multipole expansion of scalar potential
UNIT 3: ELECTRIC FIELDS IN MATTER [8 pds]
Microscopic and Macroscopic fields, Polarization: dielectrics, induced dipoles, polarization. Field of a polarized object, electric displacement, Gauss's law in the presence of dielectrics, linear dielectrics, susceptibility, permittivity, dielectric constant, boundary value problems, boundary conditions at interface of dielectrics, energy in dielectric systems and forces on dielectrics.
UNIT 4: MAGNETOSTATICS AND INDUCTION [8 pds]
Lorentz force law,Biot-Savart law: magnetic field of a steady current. Divergence and curl of B, applications of Ampere's law, comparison of magnetostatics and electrostatics. Magnetic vector potential boundary conditions, multipole expansion of the vector potential. Absence of magnetic monopoles. Faraday's Law of induction; RLC circuits, displacement current and introduction to Maxwell's equations
UNIT 5: MAGNETIC FIELDS IN MATTER [8 pds]
Magnetization : diamagnets, paramagnets, ferromagnets, torques and forces on magnetic dipoles, effect of magnetic field on atomic orbits, magnetization. Field of a magnetized objecT:bound currents, physical interpretation, magnetic field inside matter, auxiliary field H, Ampere's law in magnetized materials, linear and nonlinear media: magnetic susceptibility and permeability, ferromagnetism.

Suggested Readings:
Edward Purcell, *Electricity and Magnetism,Berkeley Physics Course*
David Griffiths, Introduction to Electrodynamics, 3rd edition, (Benjamin Cummings, 1998)

Course Number: PHM203, Course Title: PHYSICS LAB
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4) Min. Periods/Sem.: 52

At least TEN experiments out of the following to be done during the semester
1. Discharge and charge of condenser through resistance
2. Comparison of capacities by De-Sauty method
3. L-C-R resonant circuiT:(i) Q of parallel resonant circuit (ii) Q of series resonant circuit
4. Ballistic galvanometer- charge sensitivity
5. Conversion of galvanometer into voltmeter
6. Conversion of galvanometer into ammeter
7. Study of two coupled oscillators
8. Dispersion Law for water waves
9. Tuning Forks: Beats from two tuning forks, overtones and radiation pattern of tuning fork
10. Impedance of LCR circuit
11. Self Inductance by Maxwell's Bridge
12. Study of superposition theorem
13. Comparison of capacitances of two condensers by means of a ballistic galvanometer
14. To determine the capacitance of a capacitor by Schering bridge
15. To determine the capacitance of a condenser by Wein's bridge
16. To determine the impedance and Power factor of an A.C. circuit

SUGGESTED READINGS:
Crawford, *Waves*, Berkeley Physics Course, Volume 3
Prakash, Indu&KrsishnaRam : A TEXT BOOK OF PRACTICAL PHYSICS VOL. II
Gupta, S. L..:PRACTICAL PHYSICS II
Kumar, V. Khandelwal, D. P. :A LABORATORY MANUAL OF PHYSICS FOR U.G. CLASSES

Course Number: PHM204, Course Title: SEMINAR & GROUP DISCUSSION
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 0.5,

Topic related to PHM201 & PHM202.

Course Number: PHM301, Course Title: OPTICS
Class: B.Sc., Status of the Course Number: MAJOR Approved Since Session: 2015-16
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39

UNIT 1: GEOMETRICAL OPTICS [8 pds]
Cardinal points of a co-axial lens system, coincidence of principal and nodal points, graphical construction of image using cardinal points, Newton's formula. Cardinal points of a co-axial optical system of two thin lenses, Nodal slide method for determination of cardinal points, Eye pieces - Huygen's and Ramsden's eye piece. Step and graded index fibers (definition only), single and multi-mode fibers (concept only).

UNIT 2: ELECTROMAGNETIC WAVES [8 pds]
Maxwell's Equations, Electromagnetic Waves, Energy and Momentum, Poynting Vector, Light in Bulk Matter, Index of Refraction, the Electromagnetic Spectrum; Rayleigh Scattering

UNIT 3: REFLECTION, REFRACTION AND POLARIZATION [8 pds]
Fermat's Principle, Reflection, Refraction, Total Internal Reflection, Fresnel's equations, Stokes Treatment of Reflection and Refraction. Polarized Light, Linear, Circular and Elliptically Polarized Light, Poincare Sphere, Scattering and Polarization, Polarization by Reflection. Quarter Wave and Half-Wave plates and their uses. Nicols Prism

UNIT 4: INTERFERENCE [8 pds]
Wavefront Splitting Interferometers, Young's Two Slit Experiment, Amplitude Splitting Interferometers, Michelson Interferometer, Multiple Beam Interference, Fabry-Perot Interferometer, Thin Films and Newton's Rings, Applications of Interferometry

UNIT 5: DIFFRACTION [7 pds]
Huygens-Fresnel Principle. Fraunhofer Diffraction -- Single Slit, Multiple Slits, Rectangular Aperture, Circular Aperture, Diffraction Gratings, Resolving Power, Fresnel Diffraction. Magnification and Resolution

Suggested Readings:
Textbook: Eugene Hecht, *Optics, 4th edition,* Pearson Education
Other: Feynman, *Feynman Lectures on Physics, vol 1,*Pearson Education

Course Number: PHM302, Course Title: THERMAL & STATISTICAL PHYSICS
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39

UNIT 1 [7 pds]
Concept of Statistical Equilibrium, Fluctuations and Irreversibility, definition of ideal gas, Statistical Ensembles, Elementary Relations among Probabilities, The Binomial Distribution, Mean Values, Standard Deviation, Calculation of Mean Values of a Spin System, Continuous Probability Distributions, Probability Density, Random Walk

UNIT 2 [8 pds]
Microscopic state of a system, Statistical Ensemble, Statistical Postulates, Number of States Accessible to a macroscopic system, Adiabatic interactions and thermal interactions, work done on a system and heat absorbed by a system. Distribution of energy between two macroscopic systems, definition of entropy, temperature, change in entropy due to small heat transfer, system in contact with a heat reservoir and Boltzmann distribution, mean energy and mean pressure of an ideal gas, Sackur Tetrode formula

UNIT 3 [8 pds]
Determination of Absolute Temperature, Work, Internal Energy and Heat, Heat Capacity, Macroscopic Determination of Entropy, intensive and extensive parameters, work done in an isothermal process, work done in an adiabatic process, examples. The Van der Waals' Equation, Critical pressure, temperature and volume for a Van der Waals' gas

UNIT 4 [8 pds]
Dependence of the number of states on external parameters, quasi-static and non quasi-static adiabatic and isothermal processes, thermodynamic relations, application to an ideal gas: entropy, adiabatic compression and expansion, laws of thermodynamics, equilibrium conditions, Gibbs Free Energy and Helmholtz free energy, equilibrium between phases, ClausiusClapyron Equation, Heat Engines, Efficiency of an Ideal Heat Engine, Carnot Cycle, C_p-C_v for an ideal gas

UNIT 5 [8 pds]
Canonical Gas in the Classical Limit, Maxwell Velocity Distribution, Effusion and Molecular Beams, Equipartition theorem, specific heat of monoatomic ideal gas, Brownian motion, specific heat of solids, Kinetic Theory: mean free path, viscosity, calculation of viscosity for a dilute gas, thermal conductivity, calculation of thermal conductivity for a dilute gas, self-diffusion and random walk problem, electrical conductivity

Suggested Readings:
Textbook: F. Reif, *Statistical Physics, Berkeley Physics Course Volume 5* McGraw Hill
Other: Feynman, *Feynman Lectures on Physics, vol 1,*Pearson Education.

Course Number: PHM303, Course Title: INTRODUCTION TO QUANTUM MECHANICS
Class: B.Sc., Status of the Course Number: MAJOR. Approved Since Session: 2015-2016
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39

UNIT 1: ORIGINS OF QUANTUM MECHANICS [7 pds]
Atomic spectrum and Wave-particle duality: Compton scattering, Franck-Hertz Experiment, Davisson-Germer experiment. X-rays, production, continuous and characteristic spectra, Moseley's law, x-ray diffraction, Bragg's condition. Blackbody radiation, Feynman's description of two-slit experiment. Uncertainty principle and complementarity

UNIT 2: SCHRODINGER'S WAVE MECHANICS AND OPERATOR FORMALISM [8 pds]
Schrodinger Equation, Statistical Interpretation of the wavefunction, Review of Probability -- mean, variance of a continuous distribution, expectation value and uncertainty of position, Dirac Delta function, Normalization of the wavefunction, measuring momentum and the momentum operator, expectation value and uncertainty of momentum, the uncertainty principle. Hilbert space, observables: hermitian operators, eigenfunctions and eigenvalues of hermitian operators, generalized uncertainty principle, Dirac notation

UNIT 3: TIME-INDEPENDENT SCHRODINGER EQUATION [8 pds]
Stationary states, the time independent Schrodinger equation, infinite square well and its solutions, the harmonic oscillator -- algebraic solution and analytical solution, free particles and wave-packets, dispersion of wavepackets, delta-function potential, finite square well, one-dimensional scattering.

UNIT 4: QUANTUM MECHANICS IN THREE DIMENSIONS [8 pds]
Schrodinger equation in spherical coordinates, separation of variables, angular equation and spherical harmonics, radial equation; the hydrogen atom, principal, orbital and magnetic quantum numbers of the hydrogen atom, Stern-Gerlach experiment, gyromagnetic ratio and Bohr magneton, angular momentum, spin

UNIT 5: IDENTICAL PARTICLES [8 pds]
Identical particles, symmetric and anti symmetricwave functions, Bosons and fermions, exchange forces, Intro to Quantum Statistical Mechanics: Bose-Einstein and Fermi-Dirac Statistics, Blackbody radiation. Helium atom, Periodic table and Hund's rules, spectral notation for atomic states, free electron gas, degeneracy pressure and Fermi energy, Dirac Comb and Band structure

Suggested Readings:
Textbook: Griffiths, *Introduction to Quantum Mechanics,* Prentice-Hall

Course Number: PHM304, Course Title: PHYSICS LAB
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 3, Periods (55 mts. each) per week: 6 (L:0 + T:0 + P:6) Min. Periods/Sem.: 78

At least TWELVE experiments out of the following to be performed during the semester

1. Nodal Slide - verification of lens combination formula
2. Newton's Rings - determination of wavelength of Sodium light
3. Fresnel's biprism - determination of wavelength of sodium light
4. Determination of wavelength of prominent lines of Hg source by plane transmission diffraction grating
5. Determination of resolving power of a plane transmission diffraction grating
6. Spectrometer - measurement of Uo and Ue for Calcite/quartz prism
7. Telescope - determination of resolving power
8. Magnetic field - study of variation of magnetic field with distance along the axis of a circular coil
9. Determination of the angle of dip in the lab by means of an earth inductor & ballistic galvanometer
10. Determination of the magnetic susceptibility
11. Determination of ballistic constant 'K' of a ballistic galvanometer
12. Hysteresis curve - using CRO
13. Determination of the mutual inductance of transformer coils using ballistic galvanometer
14. Determination of the mutual inductance of transformer coil using a/c source
15. Measurement of magnetic field between the pole pieces of an electro-magnet with the help of search coil and B. G.

SUGGESTED READINGS

Prakash, Indu and Krishna, Ram : A TEXT BOOK OF PRACTICAL PHYSICS. VOLUME II
Gupta,S.L. and :PRACTICAL PHYSICS II KUMAR,V.
Khandelwal, D. P. :A LABORATORY MANUAL OF PHYSICS FOR U.G. CLASSES

Course Number: PHM305, Course Title: SEMINAR & GROUP DISCUSSION
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 0.5,

Topic related to PHM301, PHM302 and PHM303.

Course Number: PHM401, Course Title: SOLID STATE PHYSICS
Class: B.Sc., Status of the Course Number: MAJOR. Approved Since Session: 2015-16
Credits: 3, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Periods/Sem.: 52

UNIT 1: CRYSTAL STRUCTURE [11 pds]
Bravais Lattice and Primitive Vectors; Simple, Body-Centered and Face-Centered Cubic Lattices; Primitive Unit Cell, Wigner Seitz Cell; Crystal Structures and Lattice with Bases, Hexagonal Close-Packed and Diamond Structures, Sodium Chloride, Cesium Chloride and Zincblende Structures; Definitions and Examples of Reciprocal Lattice, First Brillouin Zone, Lattice Planes and Miller Indices. X-ray Diffraction
UNIT 2: FREE ELECTRON THEORY [10 pds]
Drude Model, Sommerfeld Model, Fermi Dirac Distribution, Density of States, Fermi Momentum, Energy and Temperature, Ground State Energy and Bulk Modulus, Thermal Properties of a Free Electron Gas, Sommerfeld theory of Conduction, Wiedemann-Franz Law, Failures of Free Electron Model
UNIT 3: BAND THEORY [10 pds]
Electrons in a Periodic Potential, Bloch's Theorem, Crystal Momentum, Band Index and Velocity, The Fermi Surface, Perturbation Theory and Weak Periodic Potentials, Energy Levels Near a Single Bragg Plane, Energy Bands and Band Gap, Fermi Surface and Brillouin Zones
UNIT 4: METALS, INSULATORS AND SEMICONDUCTORS [10 pds]
Metals insulators and semiconductors, intrinsic and extrinsic semiconductors, carrier concentration, expression for Fermi level, conduction in semiconductors, electrons and holes, mobility, thermo-electric effects in semiconductors
UNIT 5: PHONONS [11 pds]
Phonons, Lattice specific heats, classical theory, Einstein's theory, debye's theory of specific heat, acoustic and optical phonons, anharmonicity thermal expansion, elementary ideas about point defects and dislocations.

Suggested Readings:
Kittel, *Introduction to Solid State Physics*
Ashcroft and Mermin, *Solid State Physics,* Brooks/Cole.

Course Number: PHM402, Course Title: SEMICONDUCTOR DEVICES AND CIRCUITS
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39
[SAME AS CSM402]
UNIT 1 [8 pds]
Review: Historical developments, active passive components. Discrete components circuits, IC's, Logic, Semiconductors, n, p type on the basis of band theory, Semiconductors diodes: characteristics, diode equation, rectifier, clipper and clamper circuits, Zener diodes, Breakdown mechanism, use as a voltage regulator, regulated power supply, filter circuits. Synthesis of simple AND, OR, NOT gates from diode resistor networks
UNIT 2 [9 pds]
Transistors: pnp, npn transistors and their characteristics, current relationships, applications as an amplifier. Different configurations, Biasing, DC & AC load lines, Gain calculation
UNIT 3 [9 pds]
Operational Amplifiers: Ideal operational amplifier characteristics, concept of feedback, open/closed loop gain, inverting, non-inverting amplifier, Zero crossing detector, Applications:- mathematical operations and oscillators
UNIT 4 [8 pds]
Field Effect Transistor: Working and fabrication of JFET,MOS-C. Introduction to MESFETS and MOSFETs, Advantages of FETs over BUTs
UNIT 5 [8 pds]
Introduction to VLSI: Moore's Law and evolution of integrated circuits from SSI to VLSI, Crystal Growth, next generation lithographic methods, CMOS fabrication, Layout design- Rules, model and CADs (CMOS inverter as an example).

SUGGESTED READINGS:
1. Malvino, A.P. and Leach, D.: DIGITAL PRINCIPLES AND APPLICATIONS
2. Boylestadt and Nashelsky: ELECTRONIC DEVICES AND CIRCUIT THEORY
3. Streetmen, B.G.: SOLID STATE ELECTRONIC DEVICES
4. Weste and Eshragian: BASIC VLSI DESIGN

Course Number: PHM403, Course Title: NUCLEAR PHYSICS
Class: B.Sc., Status of the Course Number: MAJOR Approved Since Session: 2015-16
Credits: 3, Periods (55 mts. each) per week: 3 (L:3 + T:0 + P:0) Min. Periods/Sem.: 39

UNIT 1: SPECIAL RELATIVITY [9 pds]
Review of special theory of relativity: invariant space-time interval, Lorentz Transformations (in three spatial dimensions), Simultaneity, Causality, Time Dilation, Length Contraction, Addition of Velocities, natural units. Relativistic kinematics: 4-velocity, relativistic energy and momentum (4-momentum), applications to particle decay and particle collisions.Discovery of anti-proton
UNIT 2:BASIC NUCLEAR STRUCTURE [8 pds]
Basic Terminology and Units, Nuclear Properties: Nuclear Radius and is measurement (including mirror nuclei, mesonic x-rays, scattering) Nuclear Mass and Mass spectrographs, Abundance. Electromagnetic moments of Nuclei, Excited States. Binding Energy and Binding Energy Per Nucleon, Coloumb effects and odd even effects, Semi-Empirical Mass Formula
UNIT 3: NUCLEAR MODELS [8 pds]
The Shell Model, Angular Momentum and Parity, Magic Numbers, Even-Z and Even-N Nuclei. Radioactive decay, secular equilibrium, Alpha Decay: Range-energy andGeiger-Nuttal relation and Gamow’s theory of Alpha decay, elementary discussion of beta decay and gamma decay. Discovery of neutron
UNIT 4: ACCELERATORS AND DETECTORS [8 pds]
Accelerators: linear accelerator, cyclotron, betatron, synchrotron. Detectors: ionization chambers, proportional counter, G.M. counter, cloud chamber, bubble chamber, scintillation counter, solid state detectors. Discovery of positron
UNIT 5: NUCLEAR REACTORS [8 pds]
Concept of Scattering Cross-Section, Nuclear Fission and nuclear reactions, basic nuclear reactors.Introduction to Cosmic Rays and elementary particles. Nuclear fusion and carbon cycle in stars.

SUGGESTED READINGS:
Krane, *Introductory Nuclear Physics,* Pearson Education
Taylor and Wheeler, *Spacetime Physics*

Course Number: PHM404, Course Title: PHYSICS LAB
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 3, Periods (55 mts. each) per week: 6 (L:0 + T:0 + P:6) Min. Periods/Sem.: 78
At least twelve experiments out of the following to be done during the semester.

1. Study of half-wave and full-wave rectifiers: determination of % ripple and voltage regulation.
2. Study of half-wave and full-wave rectifiers: variation of o/p voltage with load current for Pi, L type filters.
3. Hybrid parameters for common base configuration.
4. Hybrid parameters for (common emitter config.) npn transistor.
5. RC coupled amplifier: frequency response characteristics.
6. RC coupled amplifier with feedback: frequency response characteristics.
7. OP-AMP characteristics: frequency response.
8. Use of OP-AMP as adder and subtractor.
9. Study of OR gate and NOR gate.
10. Study of AND gate and NAND gate.
11. Study of XOR and XNOR gate.
12. Verification of De-Morgan's law.
13. Realization of boolean functions using logic gates.
14. Half adder and Full adder.
15. Tunnel diode characteristics. (V-I)

SUGGESTED READINGS:
Subrahmanyan,S.V. :EXPERIMENTS IN ELECTRONICS
Malvino, Leach :DIGITAL PRINCIPLES AND APPLICATIONS
Allen, Mottershead :ELECTRONIC DEVICES AND CIRCUITS: AN INTRODUCTION

Course Number: PHM405, Course Title: SEMINAR & GROUP DISCUSSION
Class: B.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 0.5,

Topics related to PHM401, PHM402 and PHM403.

Course Number: PHM501, Course Title: MATHEMATICAL METHODS II
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0), Min. Periods/Sem.: 52

UNIT 1: SIGNALS AND LINEAR TIME-INVARIANT SYSTEMS [11 pds]
Signals, Complex exponential and sinusoidal signals, Unit step function and unit impulse function (Dirac Delta function), Discrete time unit step and unit impulse sequences, Continuous and discrete time system, Representation of signals in terms of impulses, Discrete time, Linear Time Invariant (LTI) systems, Continuous time LTI systems, Properties of LTI systems, LTI systems with and without memory, Invertibility, Causality and Stability for LTI systems, Unit step response (Greene's Function) of an LTI system, Systems described by differential and difference equations, Linear constant coefficient differential equations and difference equations, Block diagram representations of LTI systems described by difference and differential equations, Singularity functions
UNIT 2: FOURIER ANALYSIS OF CONTINUOUS-TIME SIGNALS AND SYSTEMS [11 pds]
Response of Continuous-time LTI systems to complex exponentials, Continuous-time Fourier series, Approximation of Periodic signals, Convergence of Fourier series, Continuous-Time Fourier Transform and its convergence, Fourier transform for periodic signals, Properties of Continuous-time Fourier transform, Convolution property, Modulation property, Polar representation of Continuous-time Fourier transform, Frequency response of systems characterized by Linear-Constant Coefficient Differential Equations, First and second order systems
UNIT 3: FOURIER ANALYSIS OF DISCRETE-TIME SIGNALS AND SYSTEMS [10 pds]
Response of Discrete-time LTI systems to complex exponentials, Discrete-time Fourier series, Discrete-time Fourier transform and its convergence, Properties of Discrete-time Fourier Transform, Convolution property, Modulation property, Polar representation of Discrete-time Fourier transform, Frequency response of systems characterized by Linear-Constant Coefficient Difference Equations, First and second order systems. Laplace transforms: definition, examples and properties, Inverse Laplace transforms
UNIT 4: FILTERING AND MODULATION [10 pds]
Frequency and time domain characteristics of ideal frequency selective filter, Non ideal filters, RC Low pass and high pass filters, Recursive and Non-recursive discrete time filters, Butterworth filtersAsynchronous Demodulation, Frequency selective filtering, Frequency division multiplexing, Single-sideband amplitude modulation, Pulse amplitude modulation, Time-division multiplexing, Discrete-time amplitude modulation, Narrowband and Wideband frequency modulation, Square wave modulating signal
UNIT 5: SAMPLING [10 pds]
Sampling Theorem, Impulse train sampling, Sampling with zero order hold, Reconstructing signal using interpolation, Aliasing, Discrete-time processing of continuous-time signals, Digital differentiator, Half-Sample delay, Impulse train sampling of discrete time signals, Discrete time decimation and interpolation.

Suggested Readings:
AV Oppenheim, Alan Willsky, S. Hamid, Signals and systems, First Edition, Pearson Education Limited

Course Number: PHM502, Course Title: CLASSICAL MECHANICS
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0), Min. Periods/Sem.: 52

UNIT 1: LAGRANGIAN FORMULATION [10 pds]
Introduction; Newtonian mechanics for a single particle and many particles; The principle of least action; Changing coordinate systems; Holonomic and non-holonomic constraints, generalised coordinates; Noether's theorem and symmetries; Applications;
UNIT 2: HAMILTONIAN FORMULATION [10 pds]
Hamilton's equations; Liouville's theorem; Poincare recurrence theorem; Poisson brackets; Canonical transformations; Action-angle variables; Adiabatic invariants; Hamilton-Jacobi theory; Relationship to quantum mechanics; Qualitative discussion of chaos
UNIT 3: VIBRATIONS AND ROTATION I [12 pds]
Small oscillations and stability, Normal modes of vibrating molecules. Kinematics of Rotating Objects; Rotations, Orthogonal Matrices and SO(3), The inertia tensor, Angular Momentum and Angular Velocity, Principal Axis and Moments of Inertia, Parallel Axis Theorem, Examples
UNIT 4: ROTATION II [10 pds]
Euler's equation; Free tops -- symmetric and asymmetric top; Euler's angles; Euler’s Theorem; The heavy symmetric top; Application: The Earth’s Wobble, The Precession of the Equinox. Foucault’s pendulum
UNIT 5: RELATIVISTIC MECHANICS [10 pds]
Review of Special Relativity, Invariance of the Spacetime Interval, Lorentz Group, Vectors and the Metric Tensor, 1-forms and Tensors, Velocity Addition and Thomas Precession, Forces in Special Relativity and Electromagnetism, The Lagrangian Formulation of Relativistic Mechanics, Lagrangian and Hamiltonian of a charged particle in an external electric and magnetic field (relativistic and non-relativistic)

Suggested Readings:
Goldstein, Poole and Saafko, *Classical Mechanics 3rd edition,* Pearson Education.
David Tong, *Lectures on Classical Dynamics*, Cambridge University, http://www.damtp.cam.ac.uk/user/tong/dynamics.htm
Kibble and Berkshire, *Classical Mechanics* 5th edition.
Perceval and Richards, *Introduction to Dynamics*

Course Number: PHM503, Course Title: DIGITAL SYSTEMS & MICROPROCESSORS
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2006-07
Credits: 4, Periods (55 mts. each) per week: 5 (L:5 + T:0 + P:0), Min. Periods/Sem.: 65

UNIT 1
Review of number systems (decimal, binary, octal, hexadecimal, BCD), and inter-conversion. Gray, excess-3, ASCII and EBCDIC codes. Integer Representation (signed, unsigned, 1's and 2's complement), floating point representation. Computer arithmetic. Review of Boolean algebra (logic simplification, De Morgan's Theorems, Karnaugh Maps.) Tabulation method for determination of prime implicants and minimization. Combinational logic systems. Flip-Flops: RS, D, JK, master-slave and T.
UNIT 2
Synchronous sequential circuits: Introductory examples, finite state model, memory elements and excitation functions, synthesis of synchronous sequential networks, iterative networks, design problems. Counter techniques (ripple, ring, up/down, mod-n, presettable counters.) Registers: shift registers, controlled shift registers, tri-state switches. ALU - half and full adder and subtractor, controlled adder-subtractor. Multiplexer-demultiplexer, encoder, decoder.
UNIT 3
Computer evolution and performance, components and function, organization of control unit, micro-operations, hardwired implementation, microprogrammed control, microinstruction sequencing and execution.
UNIT 4
Instruction sets: characteristics and functions, addressing modes and formats (8085 (detailed) / Pentium (examples)). CPU structure and function: processor organization, register organization, instruction cycle, instruction pipelining.
UNIT 5
System buses, PCI. Memory: types (internal & external), Input/outpuT:programmed and interrupt driven I/O. External interface. DAC and ADC circuits.

Suggested reading:
Stallings, W.,: COMPUTER ORGANISATION AND ARCHITECTURE, 4TH ED., PHI, 1997.
Malvino,: DIGITAL COMPUTER ELECTRONICS, TATA MCGRAW HILL, 1989.
Mano, M.:, COMPUTER SYSTEM ARCHITECTURE, PRENTICE HALL OF INDIA, 1983.
Singh, B.P.,: MICRO PROCESSORS AND MICRO CONTROLLERS, GALGOTIA.
Raffiquzzaman,: MICROPROCESSORS: THEORY AND APPLICATIONS, PRENTICE HALL OF INDIA.
Jain, R.P.,: MODERN DIGITAL THEORY, TATA MCGRAW HILL.

Course Number: PHM504, Course Title: NETWORK THEORY
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 4, Periods (55 mts. each) per week: 5 (L:5 + T:0 + P:0), Min. Periods/Sem.: 65
[Same as CSM504]

UNIT 1 [13 pds]
Introduction: Review of ideal circuit elements, KVL, KCL, resistive networks, mesh and nodal analysis. Network Theorems: linearity and superposition, Thevenin and Norton theorems, maximum power transfer, Wye-delta transformation, Tellegens theorem.

UNIT 2 [13 pds]
Transient Analysis: Laplace transform approach to solution of networks, signals, transform impedances, first order systems, second order systems, state space techniques for formulation of equations and analysis.

UNIT 3 [13 pds]
Sinusoidal Steady state analysis: Phasers and phaser diagrams, voltage-current-phase calculations in RL, RC, and RLC networks, steady state power, Fourier approach to solution using superposition. Two Port Networks: Derivation of H, Y, Z, ABCD parameters, inter-parameter conversions.

UNIT 4 [13 pds]
Network Synthesis: Introduction to network synthesis, Test for positive real functions, Hurwitz polynomials, passive RL, RC, LC network synthesis: Cauer, Foster realizations.

UNIT 5 [13 pds]
Introductory graph theory, incidence matrix, f-cutset and f-circuit equations, sparse tableau analysis, modified nodal analysis.

SUGGESTED READINGS
Hayt and Kermerley: ENGINEERING CIRCUIT ANALYSIS
Chua, Desoer, Kuh : LINEAR AND NON-LINEAR CIRCUITS.
Van Valkenburg : NETWORK ANALYSIS
Van Valkenburg : INTRODUCTORY NETWORK SYNTHESIS

Course: PHM505, Title: ELECTROMAGNETIC THEORY
Class: B.Sc. Honours, Status of the Course: MAJOR, Approved Since Session: 2011-2012
Credits: 4, Periods (50 mts. each) per week: 4 (L: 4+ T: 0 + P:0), Min. Periods/Sem.: 52

UNIT 1
Overview of Vector Algebra, line, surface and volume integral, physical significance of Biot&Savart's law and Ampere's Law, Displacement Current, Laplace and Poisson's Equation.

UNIT 2
Maxwell's Equation in microscopic media, isotropic media, Boundary value problem, Continuity Equation, Characteristic plasma equation. Poynting's Theorem. EM waves in Vacuum, em waves in matter, boundary conditions at interfaces.

UNIT 3
Reflection and transmission of a plane interface between dielectrics. Fresnel formula, total internal reflection. Brewster's angle, waves in conducting mediawith normal and oblique incidence.

UNIT 4
Waveguides: Concept of TE and TM modes, planer optical waveguides, continuity at interface, propagation in rectangular waveguides, expression for cutoff frequency, guided wavelength, impedance and propagation constant, phase and group velocities of guided modes, pulse propagation in optical fibers.

UNIT 5
Transmission Lines and Antennas: Idea of distributed parameters, characteristic impedance and propagation constant. Basic Antenna parameters, directivity, gain, radiation intensity, beam width and dipole antenna and its radiation characteristics.

Suggested Readings:
A. Z. Capri & P. V. Panat: INTRODUCTION TO ELECTRODYNAMICS, New Delhi: Narosa, 2002.
Joseph A. Edminister: ELECTROMAGNETIC, 2nd Edition, Tata McGraw Hill 1992.
David J Griffiths: INTRODUCTION TO ELECTRODYNAMICS, Benjamin Cummings, 1998.
Ghatak and Thyagarajan: OPTICAL ELECTRONICS, Cambridge University Press, 1989

Course Number: PHM505, Course Title: ELECTROMAGNETIC THEORY
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 4, Periods (55 mts. each) per week: 4 (L:4+ T:0 + P:0), Min. Periods/Sem.: 52
[APPLICABLE FROM 2017-18]

UNIT 1: ELECTRODYNAMICS [10 pds]

Electromotive Force, Electromagnetic Induction and Faraday's Law, Inductance, Energy in Magnetic Fields, Maxwell's Equations, Maxwell's Equations in Matter, Charge and Energy, The Continuity Equation, Poynting's Theorem, Momentum in electrodynamics, Maxwell's Stress Tensor and Angular Momentum. Electrodynamics in SI and cgs units

UNIT 2: ELECTROMAGNETIC [10 pds]

Waves in one dimension, Boundary conditions, Polarization, Electromagnetic waves in vacuum, Electromagnetic waves in matter, Reflection and Transmission at normal and oblique incidence, Fresnel's equations, Absorption and dispersion, Electromagnetic waves in conductors, Reflection at a conducting surface, Frequency dependence of permittivity, Intro to Waveguides, TE waves in a rectangular waveguide, cutoff frequency, The coaxial transmission line

UNIT 3: POTENTIALS AND FIELDS [10 pds]

Scalar and vector potentials, Gauge transformations, Coulomb gauge and Lorenz gauge, Lorentz force law in potential form, retarded potentials, Lienard- Wiechert Potentials, fields of a moving point charge

UNIT 4: RADIATION [11 pds]

Electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, Larmor formula, power radiated by a point charge, radiation reaction, the physical basis of radiation reaction

UNIT 5: ELECTRODYNAMICS AND RELATIVITY [11 pds]

Special Theory of Relativity: Lorentz transformations, structure of space-time, Relativistic mechanics: time, relativistic energy and momentum, relativistic kinematics and dynamics, Relativistic Electrodynamics: magnetism as a relativistic phenomenon, transformation of fields, field tensor, electrodynamics in tensor notation, relativistic potentials

Suggested Readings:

Textbook: David Griffiths, *Introduction to Electrodynamics, 4th edition,* Pearson Education
AdditionaL:Jackson, *Electrodynamics*

Course Number: PHM506, Course Title: DIGITAL & MICROPROCESSOR LAB
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2011-12
Credits: 3, Periods (55 mts. each) per week: 4 (L:0+ T:0 + P:4), Min. Periods/Sem.: 52

A. DIGITAL SYSTEMS
1. To study the TTL IC's (AND,OR,NOT,NAND,NOR etc)
2. To verify laws and theorems of Boolean algebra
3. To study basic combinational circuits using AND, OR,NOT logic
4. To study and observe the operation of a 4 input multiplexer.
5. To study and observe the operation of a 1of 4 decoder.
6. To verify the operation of an 8 input priority encoder.
7. To study and connect a BCD to seven segment decoder driver to a seven segment LED display and verify experimentally the characteristics of a seven segment LED
8. To verify the operation of XOR gate and use XOR gate a) Parity check b) Binary to Gray code conversion c) Gray code to Binary conversion
9. To study the operation of 4 bit adder(IC 7483) and also perform subtraction operation using XOR gate along with 4 bit adder.
10. To verify the arithmetic and logical capabilities of an arithmetic logic unit
11. To build flip-flop circuits using elementary gates (RS, clocked RS, D-type and JK ff).
12. To verify the truth table of JK flip flop using IC 7476
13. To verify experimentally the operating characteristic of a 555 timer used in the astable mode.
14. To verify experimentally operations of a 4 bit presettable UP/DOWN binary counter (IC 74193)

Design a MOD 10 counter
1. To verify experimentally operations of a 4 bit shift register
2. To construct a ring counter using shift register

B. MICROPROCESSORS
1. Familiarization with the microprocessor kit.
2. Addition and Subtraction of numbers using direct and indirect addressing modes.
3. Addition and subtraction of 16 bit numbers
4. Addition of block of data
5. Multiplication by repeated addition.
6. Use of CALL and RETURN instructions.
7. Copy block of data to another location.
8. Finding the maximum number in the given data set.
9. Other exercises (division, sorting, parity check etc.)

Course Number: PHM507, Course Title: NETWORK & SYSTEMS LAB
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2011-12
Credits: 3, Periods (55 mts. each) per week: 4 (L:0+ T:0 + P:4), Min. Periods/Sem.: 52

1. Verification of Ohm's Law
2. Verification of Kirchoff's Voltage Law
3. Verification of Kirchoff's current Law
4. Verification of Thevenin's Equivalent
5. Verification of Norton's Equivalent
6. Verification of Superposition Theorem
7. Verification of Tellegen's Theorem
8. Determination of 2-port Network parameters
9. Determination of impedance and phase in AC circuits.

Course Number: PHM601, Course Title: QUANTUM MECHANICS

Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0), Min. Periods/Sem.: 52

UNIT 1: MATHEMATICAL FORMALISM [10 pds]
Delta function and Fourier Transform. Wave packeT:propagation and dispersion. Operators and states, Review of linear algebra -- vector spaces, linear transformations, Hermitian matrices, unitary matrices, commutators, eigenvectors and eigenvalues, function spaces, bra ket notation, Hilbert Space, momentum space wavefunctions, and proof of generalized uncertainty principle, energy-time uncertainty principle

UNIT 2: TIME INDEPENDENT PERTURBATION THEORY [12 pds]
General Formulation of time-independent perturbation theory, first order corrections to energy levels and wavefunctions, second order corrections to energies; degenerate perturbation theory, Application to hydrogen: fine structure -- relativistic corrections and spin-orbit coupling, weak field Zeeman effect and Paschen-Back Effect, Hyperfine Splitting, Stark Effect.

UNIT 3: VARIATIONAL PRINCIPLE AND WKB APPROXIMATION [10 pds]
The variational principle, application to Helium, Hydrogen molecule ion (Chandrasekhar's trial wavefunction), WKB approximation, tunnelling and Gamow's theory of alpha decay, Connection formulas and semi-classical limit (Wilson-Sommerfeld quantization)

UNIT 4 : TIME-DEPENDENT PERTURBATION THEORY [10 pds]
General formulation, application to two-level systems, transition probabilities, Fermi's Golden Rule, sinusoidal perturbations, Emission and Absorption of Radiation, Selection Rules

UNIT 5: SCATTERING [10 pds]
Concept of a Differential Scattering Cross-Section, Partial wave analysis, optical theorem, Born approximation. Examples

SUGGESTED READINGS:
R Shankar, *Principles of Quantum Mechanics*, Springer.
Griffiths, *Introduction to Quantum Mechanics*

Course Number: PHM602, Course Title: ATOMIC & MOLECULAR SPECTRA

Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2011-12
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0), Min. Periods/Sem.: 52

UNIT 1 [11 pds]
Atomic Spectra: Representation of spectra, basic elements of practical spectroscopy, signal-to-noise ratio, resolving power, width and intensity of spectral transitions, Many electron atoms : LS and JJ coupling, Lande's-factor, Anomalous Zeeman effect, idea of Hartree-Fock equations, spectra of two electron atoms: Sodium, Helium and Mercury.

Unit 2 [11 pds]
Molecular Spectra: different kinds of molecular spectroscopy with respect to regions in spectrum; Rotational energy levels of diatomic molecules, rigid and non-rigid rotator models, selection rules, intensity of spectral lines, effect of isotopic substitution, polyatomic molecules. Microwave spectrometer, Vibrational energy levels, harmonic and anharmonic oscillator models, vibration-rotation spectra, IR spectrometer.

UNIT 3 [10 pds]
Electronic Spectroscopy: Electronic structure of diatomic molecules, electronic spectra of diatomic molecules, Franck-Condon principle, rotational fine structure of electronic-vibration transitions, idea of symmetry elements and point groups for diatomic molecules.

UNIT 4 [10 pds]
Raman Effect: Classical and quantum theory of Raman effect, molecular polarizability, pure rotational Raman spectra for linear molecules, vibrational Raman spectra: water and carbon dioxide molecules, rule of mutual exclusion, structure determination from Raman and IR spectroscopy, Raman spectrometer. Principles of Electron Spin Resonance, NMR and Mossbauer spectroscopy.

UNIT5 [10 pds]
Lasers : Einstein's A and B coefficients, metastable states, spontaneous and stimulated emissions, pumping and population inversion, three-level and four-level lasers, Ruby, He-Ne and semiconductor lasers, laser spectroscopy.

SUGGESTED READING:
CONCEPTS OF MODERN PHYSICS: A. Beiser, McGraw Hill, 2003.
FUNDAMENTALS OF MOLECULAR SPECTROSCOPY (4th ed.): Banwell and McCash, McGraw Hill, 2003.
Optical ELECTRONICS : A.K. Ghatak and K. Thyagarajan, Cambridge University Press, 1989.
MOLECULAR SPECTRA AND MOLECULAR STRUCTURE (Vol.I) : G. Herzberg, Von Nostrand, 1950.
PHYSICS OF ATOMS AND MOLECULES, Bransden and Jochain, Pearson, 2003.
ATOMIC AND MOLECULAR SPECTROSCOPY (3rd ed.) : S. Svanberg, Springer-Verlag, 2008
LASER SPECTROSCOPY, Demtroder, 3ed, Springer-Verlag, 2003.

Course Number: PHM603, Course Title: SEMICONDUCTOR DEVICES
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2011-12
Credits: 4, Total Periods (55 mts. each) per week: 4 (L: + T:0 + P:0) Min. Pds/Term: 52

UNIT 1 [11 pds]
Basic concepts of semiconductor physics: doped semiconductors, density of states, Fermi Functions, energy distribution, degenerate and non-degenerate semiconductors, concept of drift, diffusion, mobility, resistivity, diffusion length, relaxation time, band bending, Einstein's relationship, Continuity Equation.
UNIT 2 [11 pds]
Junction Physics: Physics of metal –metal Junctions, metal semiconductor junctions. PN junctions: spatial variation of electric fields, potential etc., temperature dependence of reverse leakage current, deduction of diode equation, capacitance of pn-junction.
UNIT 3 [10 pds]
Bipolar Junction Transistor: Fabrication and operational regions of BJT, primary and secondary processes in BJT, different modes of operation in BJT:active, saturation and cut off. Expression for beta and gamma, temperature effects in BJT, depletion region and minority charge distribution in BJT.
UNIT 4 [10 pds]
Unipolar Devices: Classification. JFET-construction, principle and working, IV-characteristics. MESFET: construction, principle and working and hetero-junction MESFETs.
UNIT 5 [10 pds]
MOS-devices, energy band diagram, regions of operations, parameters of MOSC, Gate voltage, C-V characteristics. MOSFET-principle, theory of operation, ID-VD relationships and square law theory. D-RAM, Non-volatile NMOS, Ferroelectric semiconductor, optical memories, magnetic memories, CCD.

SUGGESTED READING:
SM Sze: SMICONDUCTOR DEVICES, Wiley.
Modular Series on Solid State Devices (Vol-I to Vol IV), Pub: Addison Wesley Publishing Company.
Ben Streetman, Solid State Electronic Devices.

Course Number: PHM604, Course Title: MIXED SIGNAL CIRCUIT DESIGN
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0), Min. Periods/Sem.: 52

UNIT 1 [10 pds]
Semiconductor review, current equation of PN diode, BJT, operation of Transistor, CE,CB and CC configuration, active cutoff, saturation analysis of transistor circuits, AC,DC load lines, Q-point, JFET and its applications as amplifier.
UNIT 2 [10 pds.]
Biasing and stabilization, temperature effect on Q point, diode compensation. Power amplifiers, transformers, coupled amplifiers, class A and B operation, power calculations and efficiency. Darlington amplifiers.
UNIT 3 [10 pds.]
H-parameters, small signal analysis, Bode plots, frequency response, effect of bypass and coupling capacitor, Miller capacitance, high frequency analysis of a transistor , tuned circuits.
UNIT 4 [10 pds.]
Operational amplifiers, linear and nonlinear applications of op-amps, common mode, difference mode, CMRR, offset. Feedback in amplifiers, Berkhausen criterion, phase-shift, Wein Bridge, Colpitts, Harley, Tuned collector and crystal oscillator.
UNIT 5 [10 pds.]
Logic families and their comparison. Bipolar logic families RTL, DTL, DCTL, current hogging, propagation delay, wired AND connection, HTL, input-output characteristics, fan-out, ECL transfer characteristics, speed. IIL. Different TTL families, application of TTL.

SUGGESTED READINGS
ELECTRONIC CIRCUITS, Schilling, L. and Belove.
INTEGRATED ELECTRONICS, J. Millman and C. C. Halkins
DIGITAL INTEGRATED ELECTRONICS, Taub and Schilling
DESIGNING WITH TTL INTEGRATED CIRCUITS, Morris and Miller
MONOGRAPH ON DIGITAL ICS AND APPLICATIONS, Soude (IISc Bangalore)

Course Number: PHM605, Course Title: COMPUTATIONAL SCIENCE AND PROGRAMMING
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0), Min. Periods/Sem.: 52
[SAME AS CSM511]

UNIT 1 [12 pds]
MATLAB M-files, debugging, and profiling tools. MATLAB applications, polynomials, interpolation, integration, differentiation, ODE. Graphics, 2-D, 3-D, Graphical User Interface (GUI). Advanced graphics in MATLAB, 3-D representation and exportable animations

UNIT 2 [10 pds]
Accuracy, stability and convergence of numerical algorithms, error analysis of operations, interpolation for numerical differentiation and integration, stable solution algorithm for ordinary and partial differential equations [Exercises in MATLAB in all units]

UNIT 3 [10 pds]
Key ideas of linear algebra, special matrices, differential and difference equations, solving linear systems, inverses, delta function, eigenvalues, eigenvectors, positive definite matrices

UNIT 4 [10 pds]
Oscillations by Newton's law, least squares, finite differences in time, graph models, networks. Boundary conditions, splines, gradient, divergence, Laplace's equation

UNIT 5 [10 pds]
Fourier series, Chebyshev, Legendre, Bessel, Green's functions, discrete Fourier series, fast Fourier transform, convolution, filtering, sampling

Suggested Readings

Gilbert Strang: Computational Science and Engineering, Wellesley-Cambridge Press, 2007.
SS Sastry: Introductory Methods of Numerical Analysis, PHI
Burden Richard, L. and Douglas Faires: Numerical Analysis, 7th ed, Belmont, CA, Brooks Cole, 2000.
Cleve Moler: Numerical Computing with MATLAB, Mathworks, 2004.
Patrick Marchand and O. Thomas Holland: Graphics and GUIs with MATLAB, Chapman and Hall/CRC Press

Course Number: PHM606, Course Title: ELECTRONICS LAB.
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 3, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 52

1. Design of power supply using discrete components.
2. Design of power supply using IC723 current sensing and fold back current limiting.
3. Study of OP-AMP as invertor, summer, integrator and differentiator.
4. Study of OP-AMP parameters.
5. Study of RC coupled amplifier.
6. Study of complementary symmetry type push-pull amplifier.
7. Measurement of h-parameters.
8. Study of phase-shift oscillator.
9. Study of Wien-Bridge oscillator.
10. Design and study of tuned amplifier.

Course Number: PHM607, Course Title: PROGRAMMING LAB
Class: B.Sc. Honours, Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 3, Periods (55 mts. each) per week: 3 (L:0 + T:0 + P:3), Min. Periods/Sem.: 52

Experiments

1. Implement the list abstract data type using an array representation of a list, including development of an iteration scheme that allows you to move through a list data item by data item. It should include insert, delete and search etc.
2. Implement a logbook in calendar form. User should be able to create a log on a particular date and see old logs also.
3. Implement a binary tree to with doubly linked nodes. It should have the capability of inserting, deleting and moving data items and recursive implementation of traversing the tree.
4. Create an implementation of weighted graph abstract data type using a vertex list and an adjacency matrix. Develop a routine that finds the least cost path between each pair of vertices in a graph.
5. Write a program to reduce a coefficient matrix into: (i) Lower triangle matrix (ii) Upper triangle matrix (iii) Write a routine to solve simultaneous linear equations by Gauss elimination method using back substitution.
6. Write a program that has routines for: (i) Finding out inverse of a given square matrix (ii) Finding out the solution to a linear transformation system of the type Ax = b.
7. Implement Newton's and Lagrange's interpolation of n points in MATLAB.
8. Implement first and second derivative differentiation using Newton's method in MATLAB.
9. Implement Trapezoidal and Simpson's methods of integration in MATLAB.
10. Implement Range-Kutta 4^{th} order method and Milne's Predictor-Corrector methods of solving ODE in MATLAB.
11. Write a simple master slave program in LAM/MPI which does the following: The master allocates 2 tasks to 5 slaves in a round robin manner. The slaves then compute the task and return the results back to the master. The tasks can be as simple as an addition of two numbers. Perform this using a simple send-receive functions. Also illustrate the use of MPI_Reduce for the above mentioned task.
12. Write a parallel program in LAM/MPI which takes A, B and C three vectors of length n and parallelly computes root of n quadratic equations. (A[0], B[0] and C[0] are a, b, c coefficients of the first quadratic equation.)

Course Number: PHM701, Course Title: CONDENSED MATTER PHYSICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2006-07
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1: BAND THEORY OF SOLIDS
Motion of Electron in periodic potentials, Bloch Theorem, Nearly Free Electron theory, Tight binding approximation. Kronig-Penny Model, Fermi surface and Brillouin Zones, Characteristics of Fermi surfaces, reduced, zone scheme, effective mass of electron. Elementary idea of crystal defects & dislocation.
UNIT 2: DIELECTRIC PROPERTIES OF MATERIALS
Polarization, local electric field at an atom, i lorentz field of dipole inside a cavity, dielectric constant and polarizability, Claussius-Mossoti equation, complex dielectric constant, dielectric loss and relaxation time, Debye equation, piezoelectricity, ferroelectricity.
UNIT 3: MAGNETIC PROPERTIES OF MATERIALS
Response to magnetic field, exchange interaction, quantum theory of para, dia, ferro, antiferro and ferrimagnetism, ferrites, Magnetic resonance phenomenon: EPR, NMR.
UNIT 4: SUPERCONDUCTIVITY
Experimental properties, Messiner effect, type-I and II superconductors, London equation, thermodynamics of superconducting transition, penetration depth, Cooper pairs, flux quantization, Josephson's tunneling effect, BCS theory (qualitative). Elementary ideas of high-T superconductivity.
UNIT 5: INTRODUCTION TO NANO-ELECTRONICS
Definition of Mesoscopic region, Landauer-Buttiker formalism, Quantum Hall Effect, Coulomb blockade, single electron transistors, Carbon Nanotubes.

Suggested Reading:
CM Kachhava, TMH: SOLID STATE PHYSICS
AJ Dekkar: SOLID STATE PHYSICS
C KitteL:INTRODUCTION TO SOLID STATE PHYSICS
C. Hamaguchi: BASIC OF SEMICONDUCTOR PHYSICS, Springer'04
David Ferry: TRANSPORT IN NANOSTRUCTURES, Cambridge Univ. Press
S Datta: ELECTRONICS TRANSPORT IN MESOSCOPIC SYSTEMS, Cambridge Univ. Press'95

Course Number: PHM702, Course Title: STATISTICAL MECHANICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1: THERMODYNAMICS
Extensive and Intensive Variables, Entropy and Temperature, Review of Thermodynamic Potentials, Maxwell Relations, and Phase Transitions, Phase diagrams and critical points, Stability of Phases, Van der Waals Gas and Curie-Weiss Magnet, Critical Exponents and scaling relations
UNIT 2: STATISTICAL MECHANICS: RULES OF CALCULATION
Isolated systems: Boltzmann's Hypothesis, Entropy of Mixing and Gibbs Paradox, Equipartition of Energy; Closed systems: The Partition Function and connection with Thermodynamics, Open systems: Grand Partition Function and connection with thermodynamics, Microcanonical, Canonical and Grand Canonical Ensemble. Fluctuations, Correlations and Response, Fluctuation-Response Theorem, Scattering and Correlation. Above concepts to be illustrated through the Ideal Classical Ising Magnet and Ideal Classical Monatomic Gas
UNIT 3: IDEAL CLASSICAL AND QUANTUM GASES
Statistical Physics of Monoatomic and Diatomic Classical Gas, Maxwell Boltzmann, Fermi-Dirac and Bose-einstein distributions, Quantum Gases: Concept of Density of States, Ideal Fermi Gas at T=0, Ideal Fermi Gas at small non-zero temperatures, specific heat and magnetic properties of ideal fermi gas, Ideal Bose Gas, Bose Einstein Condensation
UNIT 4: INTERACTING SYSTEMS
Models of Interacting Fluids, Lattice Spin Systems -- ClassicalIsing Models, Exact solution of 1-d Interacting Ising ModeL:Partition function, Thermodynamics and Correlations, Phase Transitions
UNIT 5: ADVANCED TOPICS
Van der Waals-Weiss Formulation of Mean Field Approximation, Mean-Field Approximation for the d-dimensional Ising Model, Mean-Field Approximation for the d-dimensional fluid and Van der Waals gas, Validity and accuracy of mean-field approximation. Diffusion equation, Random walks, Brownian motion and non-equilbrium processes

Suggested Readings:
DebashishChowdhury and Dietrich Stauffer, *Principles of Equilibrium Statistical Mechanics*, Wiley-Vch, 2000.
K Huang: STATISTICAL MECHANICS
RK Pathria: STATISTICAL MECHANICS
F Reif: STATISTICAL AND THERMAL PHYSICS

Course Number: PHM703, Course Title: ADVANCED QUANTUM MECHANICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1: QUANTUM CORRELATIONS AND INTERPRETATIONS OF QUANTUM MECHANIC [11 pds]
Review of quantum mechanics; elementary discussion of: Entanglement and the Einstein-Podolski-Rosen paradox, the measurement problem, Concept of Density Matrix and partial trace, quantum correlations- the Bell and Bell-Kochen-Specker inequalities (Mermin-Peres Magic square).Experimental tests of Bell's inequalities, Interpretations of quantum mechanics. Aspect's experiment
UNIT 2: RELATIVISTIC QUANTUM MECHANICS [11 pds]
The Klein-Gordon equation, Dirac equation and its solutions. Probability current density, plane wave solutions, electron in an electromagnetic field, spin-orbit interaction, central potential, energy levels of the hydrogen atom, covariance of Dirac equations, hole theory and positrons.
UNIT 3**:** PATH INTEGRAL FORMULATION [10 pds]
Classical action, quantum mechanical amplitude, classical limit, sum over paths, events occurring in succession, free particle, diffraction through a slit. Motion in a potential field, path integral as a functional, evaluation of path integral by Fourier series.
UNIT 4**:** QUANTUM THEORY OF INTERACTION OF RADIATION FIELD WITH MATTER [10 pds]
Semi-classical theory of radiation: quantum mechanics of a charged particle in an external electric and magnetic field, Einstein coefficients, atom-field interaction, probability for stimulated emission, spontaneous emission rate, dipole approximation and selection rules
UNIT 5**:** APPLICATIONS OF QUANTUM MECHANICS [10 pds]
Quantum Optics: Quantization of the electromagnetic field, eigenkets of the Hamiltonian, coherent and squeezed states, transition rates, phase operator, photons incident on a beam splitter. Additional applications at discretion of instructor.
Suggested Readings:
J.J. Sakurai, J. Napolitano, Modern Quantum Mechanics, 2nd ed., Pearson, 2013
R. P. Feynman, A.R. Hibbs, Quantum Mechanics and Path Integrals, Dover, 2010.
F. Gross, Relativistic Quantum Mechanics and Field Theory, Wiley, 1993

Course Number: PHM704, Course Title: NUCLEAR AND PARTICLE PHYSICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2017-18
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1
Nuclear forces, deuteron systems, square well solution for deuteron, N-P and P-P scattering at low energies, high energy N-P and P-P scattering, exchange forces, isotropic spin formalism, meson theory of nuclear forces.
UNIT 2
Single particle shell model, square well of infinite depth, harmonic oscillator potential, spin-orbit potential, Nordheim rules, stripping reaction, nuclear isomerism, magnetic moment, configuration mixing, independent particle model, unified model.
UNIT 3
Theories of alpha and beta decay, nuclear reactions' classification, Q-equation, solution of Q-equation, endoergic and exoergic reactions, centre of mass frame, kinematics of stripping and pick-up reactions.
UNIT 4
Nuclear cross-section, resonance, Breit-Wigner dispersion formula for L=0 and other values of L, compound nucleus, continuum theory of cross section, statistical theory of nuclear reactions, experimental results, reciprocity theorem.
UNIT 5
Elementary particle classification, interactions and conservation laws, charge conservation, spin inversion, C-P inversion, CPT inversion, electron, positron, proton, antiproton, neutron and antineutron, neutrino and anti neutrino, mesons, hyperons, particle symmetries, SU-2, SU-3, quark theory.

SUGGESTED READING:
BLATT & WEISKOPF: NUCLEAR PHYSICS
ELTON, L.R.B.: NUCLEAR THEORY
SEGRE: NUCLEI AND PARTICLES
EVANS,R.D.: ATOMIC NUCLEUS
ENGE,H.A.: INTRODUCTION TO NUCLEAR PHYSICS.
ROY & NIGAM: NUCLEAR PHYSICS

Course Number: PHM705, Course Title: MATHEMATICAL PHYSICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1: COMPLEX VARIABLE THEORY [12 pds]
Complex Variables and Functions, multivalued functions, Cauchy-Riemann Conditions, Contour Integrals, Cauchy's Integral Theorem, Cauchy's Integral Formula, Laurent Expansion, Singularities: Poles, Branch cuts and Branch Points.Calculus of Residues, Improper integrals, Principal value of a definite integral, Evaluation of Definite Integrals using Contour Techniques, Jordan's Lemma, Examples involving indented contours and functions with branch cuts.
UNIT 2: PARTIAL DIFFERENTIAL EQUATIONS [10 pds]
Examples of PDEs, First order PDE's: characteristic curves, Second Order PDE's, Boundary Conditions, Separation of Variables: Laplace and Poisson Equation, Wave Equation, Heat Flow Equation. Solutions using fourier analysis
UNIT 3**:** GROUP THEORY [10 pds]
Definition of a group, Subgroups, coset decomposition, direct product of groups; Matrix representations of a group, equivalent and inequivalent representations, reducible and irreducible representations, class structure of a group and characters, applications to symmetry in quantum mechanics. Continuous groups – O(N), SU(N), summary of representations of SU(2) and SO(3)
UNIT 4**:** VECTORS AND TENSORS [10 pds]
Tensor Analysis, Covariant and Contravariant tensors, Einstein's summation convention, Pseudotensors, Dual Tensors, Jacobians, Vector Spaces, Vectors in function spaces, Gram-Schmidt orthogonalization, Linear operators and their Adjoint, Self Adjoint operators, Unitary operators, Matrix Eigen value problems, Hermitian Eigen value problems, Hermitian matrix diagonalization, Normal matrices
UNIT 5: SPECIAL FUNCTIONS [10 pds]
Bessel Functions of the first kind, Neumann functions, Hankel functions, Modified Bessel Functions: Qualitative Behaviour, Recurrence Relations and Asymptotic Expansions, Spherical Bessel functions, Legendre functions, Spherical harmonics. Hermite functions and Laguerre Functions

Suggested Readings:
Arfken, Weber and Harris, *Mathematical Methods for Physicists,* 7th edition, Elsevier 2013,
Saff and Snider, *Funamentals of Complex Analysis with Applications to Science and Engineering*, 3rd edition, Pearson Education.

Course Number: PHM706, Course Title: 'C' AND DATA STRUCTURES
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2012-13
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[Same as MAM504]
UNIT 1 [10 pds]
Programming Fundamentals: Algorithms, Flow Charts. C Programming Language: Fundamentals, operators, expressions, Data Input and Output, Control Statements, functions, recursion.
UNIT 2 [10 pds]
C Programming Language: Arrays, pointers, structures and unions, data files
UNIT 3 [10 pds]
Data Structures: Introduction to Analysis of Algorithms, Arrays, Stacks, Queues, Static Implementations via Arrays, Linked Implementation involving Single Linking, Double Linking, and Circular Structures.
UNIT 4 [10 pds]
Trees: Binary Trees and their Applications; Searching Algorithms; Sorting: Internal sorting.
UNIT 5 [10 pds]
Symbol Tables: Binary Search Trees, Height Balanced Binary Trees, Hash Tables.

SUGGESTED READING:
Schildt HC: A REFERENCE MANUAL
Gottfried B: PROGRAMMING WITH C, SCHAUM'S OUTLINE SERIES
Weiss N: DATA STRUCTURES USING C
Dromey G: HOW TO SOLVE IT BY COMPUTERS
Horowitz E & Sahani S: AN INTRODUCTION TO DATA STRUCTURES USING PASCAL
Kernighan B & Richie D: C

Course Number: PHM707, Course Title: COMPUTER SYSTEMS ARCHITECTURE
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2008-09
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[Same as CSM503/ MAM707]

UNIT 1

Number Systems, Radix Conversion, Fixed and Floating point Arithmetic, Logic Gates, Boolean Algebra, Combinational Logic, Minimization, Implementation Examples- arithmetic/logic circuits. Sequential logic, flips-flops, finite state machines, registers, counters.

UNIT 2

General Purpose Machine, History, Programming–Architecture–Logic design Viewpoints, Machine Classifications, Instruction Formats, Computer Instruction Sets (Data Movement, ALU, Branch Instructions) Addressing Modes, Simple RISC Computers (SRC), Formal Description using Register Transfer Notation (RTN) Data path, Control Path.

UNIT 3

Processor Design, register transfers, single bus SRC microarchitecture, Data Path Implementation, Logic Design, Control Sequences, Control Unit, Clocks, Timing, multi-bus microarchitecture, exceptions.

UNIT 4

Pipelining, microprogramming, examples of CISC/RISC processors.

UNIT 5

Memory system design, RAM Structure, SRAM, DRAM, ROM, Memory hierarchy, cache design, cache policies. I/O Programmed, I/O Interrupts, DMA, Error Control, Peripheral Devices.

SUGGESTED READING:

Heuring & Jordan: COMPUTER SYSTEMS ARCHITECTURE
R.P. Jain: DIGITAL ELECTRONICS
M. Mano: DIGITAL ELECTRONICS AND COMPUTER DESIGN

Course Number: PHM708, Course Title: LABORATORY
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 4, Total Periods (55 mts. each) per week : 12 (L:0 + T:0 + P:12) Min. Pds/Term: 168

Experiments supporting the courses: PHM 701, PHM 704, PHM 705 and Programming in C

Course Number: PHM802, Course Title: NEURAL NETWORKS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2006-07
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
UNIT 1
Brain style computing, origins, issues; biological neurons, artificial neuron abstraction, activations and signals, neuron signal functions, neural networks, architectures, salient- properties and application domains. Geometry of binary threshold neurons, pattern classification, linear separability, pattern dichotomizers, TLN capacity, layering, XOR problem.
UNIT 2: SUPERVISED LEARNING
Pattern and weight space, Perceptron learning, convergence, alpha and mu LMS algorithm and convergence issues, MSE error surface. Multilayered networks, back-propagation learning algorithm, hand worked examples, applications, universal approximation.
UNIT 3: ATTRACTOR NEURAL NETWORKS
Additive and multiplicative activation models, Cohen-Grossberg Dynamics, Lyapunov analysis. OLAM, Hopfield networks: dynamics, stability issues, continuous and discrete time operation, electronic interpretation, CAM, error correction, applications, and spurious attractors. Bidirectional associative memory: stability issues, bivalent BAM theorem, examples, error correction, signal Hebbian learning.
UNIT 4: UNSUPERVISED LEARNING I
Adaptive Resonance Theory, noise- saturation dilemma, on-center off surround shunting networks, competitive learning. ART overview, STM and LTM equations, ART 1 classification, comparison, search, learning algorithm, applications.
UNIT 5: UNSUPERVISED LEARNING II
Maximal eigen vector filtering, generalized learning laws, vector quantization, Mexican hat networks, self-organizing feature maps, applications. Research discussions.

SUGGESTED READING:
S Haykin: NEURAL NETWORKS-A COMPREHENSIVE FOUNDATION
S Kumar: NEURAL NETWORKS-A CLASSROOM APPROACH, McGraw Hill Educational, 2004

Course Number: PHM803, Course Title: PHYSICS AT NANOSCALE
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2011-12
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1 [11 pds]
Introduction to nanoscience and nanotechnology, Quantum confined system: quantum confinement and its consequences, quantum wells, quantum wires and quantum dots. Electronic structure from bulk to quantum dot.Electronic structure calculations by ab initio, tight binding, empirical potential and density functional methods. Electron states in direct and indirect gap semiconductors, nanocrystals.

UNIT 2 [11 pds]
Dielectric constant of nanostructures, Quasi-particles and excitons, Optical properties: General formulation-absorption, emission, and luminescence. Optical properties of nanostructures and heterostructures.

UNIT 3 [10 pds]
Growth and characterization of nanostructures: Self–assembled nanostructure growth–MBE and MOCVD methods, specific features of nanoscale growth, control of size, nucleation, growth and aggregation. Synthesis of nanopowders, chemical and colloidal methods, mechanical milling, dispersion in solids-doped glasses and sol gel method, nanoporous media.Processing and consolidation of nanoparticles. Synthesis of metal, semiconductor Nanomaterials. Structural, morphological, optical and chemical characterization–XRD, SEM, TEM, AFM, XPS, UV-Vis Spectrophotometer.

UNIT 4 [10 pds]
Special Materials and properties: Various allotropes of Carbon-Carbon nanotubes, MWCNT, SWCNT, Graphene: Various methods of Synthesis, Mechanical, Thermal, Optical, Electrical and electronic Properties.

UNIT 5 [10 pds]
Applications of Nanostructures: Electronic and Electromagnetics- ceramic capacitors and magnetic recording, Spintronics, Optics-nanophosphor and photonic crystals, All Optical Switching, Nanomaterials Devices, Applications in Electronics, Energy production, Energy Storage.

SUGGESTED READING:
C. Delerue and M. Lannoo: NANOSTRUCTURES- THEORY & MODELING, (Springer,2004)
V.A. Shchukin: NANOSTRUCTURE, N.N. Ledentson and Bimberg (springer,2004)
CHARACTERIZATION OF NANOPHASE MATERIALS by Z.L. Wang(Ed.)(Wiley-VCH,2000)
Semiconductor Nanocrystal Quantum Dots by A.L. Rogach (Ed.)(Springer Wien NY , 2008)
C.P. Poole Jr.& F.J. Owens: INTRODUCTION TO NANOTECHNOLOGY, (Wiley-InterScience,2003)
H.S. Nalwa: NANOSTRUCTURED MATERIALS AND NANOTECHNOLOGY, (Ed.) (Academic Press,2002)
C. Brechignac, P. Houdy and M. Lahmani: NANOMATERIALS AND NANOTECHNOLOGY, (Springer ,2006)
S. Reich, C Thomsen & J Maultzsch: CARBON NANOTUBES, (wiley-VCH,2004)

Course Number: PHM804, Course Title: MICROWAVE TECHNIQUES
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2011-12
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS EEM817]

UNIT 1 [11 pds]

Transmission Lines: Introduction, transmission line equation, interpretation of solution, characteristic impedance, propagation constants, condition for distortionless transmission, with minimum attenuation, loss free transmission lines, low loss transmission line ,terminated transmission line, input impedance, reflection coefficient, resonant and anti-resonant lines, VSWR, Smith Chart calculation with Smith Chart.

UNIT 2 [11 pds]

Wave Guides: Concept of TE and TM modes, propagation in rectangular wave guide, expression of cut off frequency, guided wavelength, impedance and propagation constant dominant modes, introduction to resonators.

UNIT 3 [10 pds]

Microwave Signal Generation: Re-entrant cavity, klystron, reflex klystron, velocity modulation process, bunching process, 2 cavity klystron, principles of slow wave structure, TWT, magnetron, Gunn oscillator.

UNIT 4 [10 pds]

S-matrix and microwave componenT:Scattering matrix, properties of scattering matrix, S-parameter description of E-plane, and hybrid tee. Directional couplers, phase shifter, single flow graph, decomposition of single flow graph.

UNIT 5 [10 pds]

Propagation of EM Waves in Ferrites: Propagation of microwaves in ferrites, Faraday Rotation ferrites devices like isolator gyrator, circulator microstriplines, formula for effective dielectric constants, characteristics impedance and attenuation, microstrip resonators and filters.

SUGGESTED READING:
David M Pozar: Microwave Engineering, 3ed, Wiley.
MICROWAVE DEVICES, CIRCUITS AND SUBSYSTEM, I.A. Grover, S.R. Pennock, P.R. Shephard, Wiley.

Course Number: PHM805, Course Title: LASER PHYSICS & APPLICATIONS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2009-10
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1 [11 pds.]
Linear Interaction of Light with Matter: Einstein's theory and semi-classical theory of stimulated emission, Einstein's coefficients, optical pumping, light amplification, threshold condition, laser rate equations: two-level, three-level, four-level laser systems, pumping processes: incoherent light source, laser pumping, electrical discharge, pump rate and pump efficiency, variation in laser power around threshold, optimum output coupling, line broadening mechanisms- inhomogeneous and homogeneous broadening: Natural, Collision and Doppler broadening.
UNIT 2 [11 pds.]
Laser Resonators: Modes of a rectangular cavity and open planar resonator, quality factor, ultimate line width of a laser, transverse and longitudinal modes of a laser cavity, mode selection, Q-switching, techniques for Q-switching: electro-optic, acousto-optic, saturable absorber; Mode-Locking: active and passive, pulse compression, Gaussian beam and its properties, Fraunhofer and Fresnel diffraction, modes of a confocal resonator system, general spherical resonator, higher-order modes, stability criterion.
UNIT 3 [10 pds.]
Properties of Laser beams and Lasers Systems: Intensity, Monochromaticity, Coherence: spatial and temporal, Directionality of laser beams, Solid-state lasers: Ruby, Nd-YAG, Nd-Glass, Ti: Sapphire; Gas lasers: He-Ne, CO_2, Ar-ion, Nitrogen, Excimer; Dye lasers, Semiconductor lasers: homo-junction, hetero-junction lasers, quantum-well, free-electron and X-ray lasers; ultra-short and ultra-high power pulsed laser systems. Laser beam measurements, propagation and laser safety.
UNIT 4 [10 pds.]
Applications of Lasers in Science & Engineering: Spatial Frequency Filtering, lens as a Fourier transforming element, Holography: basic principle, Fourier transform and volume holograms and their applications, Qualitative treatment of laser applications in information processing Optical communication, computing, data storage, sensors; Principle of Slow and Fast Light. Elements of Quantum Optics: Field quantization, coherent states, atom-field interactions, entanglement and applications in quantum information processing.
UNIT 5 [10 pds.]
Applications of Lasers: Nonlinear Interaction of Light with Matter: nonlinear electron oscillator model, nonlinear polarization, Nonlinear interactions without absorption: second order phenomena: second harmonic generation, sum-difference of frequency generation, two-photon absorption, Pocket's effect, optical rectification, third order phenomena: Kerr effect, Intensity- dependent refractive index, self-focusing, self-diffraction, optical bistability, optical solitons, phase conjugation (qualitative); Nonlinear interaction with absorption: nonlinear transmission, bleaching, spectral hole burning, rate equations, elements of nonlinear laser spectroscopy: pump-probe measurements, z-scan etc. (qualitative), Basic elements of Nano-Photonics and its applications.

SUGGESTED READING:
O. Svelto: PRINCIPLES OF LASERS, Plenum, New York, 1998.
Ghatak and Thyagarajan: OPTICAL ELECTRONICS, Cambridge University Press, 1989.
Thyagarajan and Ghatak: LASER THEORY AND APPLICATIONS, Macmillan, India, 1986.
A.E. Siegman: LASERS, Oxford University Press, 1986.
Milonni and Eberly: LASERS, John Wiley,1991.
W.T. SilfvasT:LASER FUNDAMENTALS, Cambridge Univ. Press, 1998.
A. Yariv: OPTICAL ELECTRONICS, John Wiley, 3rd ed., 1989. 8. R. MenzeL:Photonics, Springer, 2001
W. Demtroder: LASER SPECTROSCOPY (3rd ed.), Springer, 2003.
R. W. Boyd: NONLINEAR OPTICS, Academic Press, 2003.

Course No. PHM806, Course Course Title: DESIGN AND ANALYSIS OF ALGORITHMS
Class: M.Sc. Status of the Course Number: MAJOR, Approved Since Session: 2012-13
Credits: 04, Periods (50 mts.) per week: 04 (L:4 + T:0 + P:0), Min. periods per semester: 52

UNIT 1
Introduction: Algorithms, analysis of algorithms, Growth of Functions, Master Theorem. Sorting and order Statistics: Heap sort, Quick sort, Sorting in Linear time, Medians and order Statistics.
UNIT 2
Advanced Data Structures: Red-Black Trees, Augmenting Data Structures. B-Trees, Binomial Heaps, Fibonacci Heaps, Data Structure for Disjoint Sets.
UNIT 3
Advanced Design and Analysis Techniques: Dynamic Programming, Greedy Algorithms, Amortized Analysis.
UNIT 4
Graph Algorithms: Elementary Graphs Algorithms, Minimum Spanning Trees, Single-source Shortest paths, All-Pairs Shortest Paths, Maximum Flow, travelling Saleman Problem.
UNIT 5
Selected Topics: Randomized Algorithms, String Matching, NP Completeness, Approximation Algorithms.

SUGGESTED READING
Cormen, Leiserson, RivesT:"INTRODUCTION TO ALGORITHMS", PHI.
Basse, S.: "COMPUTER ALGORITHMS: INTRODUCTION TO DESIGN & ANALYSIS", Addison Wesley.
Horowitz & Sahani, "FUNDAMENTAL OF COMPUTER ALGORITHMS", Galgotia.

Course Number: PHM807, Course Title: SOFTWARE ENGINEERING
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2010-11
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[Same as CSM601 & CSD222]
UNIT 1
Introduction: Software and Software Engineering, Phases in Software Engineering, Software Engineering Life-Cycle Paradigms; Software: its Nature and Qualities. Software Engineering Principles.
UNIT 2
Software Project ManagemenT:The Software Management Process; Software MeasuremenT:Function Points and Code Size Estimation, Software Cost Estimation - COCOMO and Putnam models; Staffing and Personnel Planning; Team Structure; Risk Management - an overview; Software Configuration Management; Quality Assurance Planning; Project Monitoring Planning; Case Study.
UNIT 3
Software Requirements Specification: Analysis principles, Structured Analysis: Modelling Tools, Structured Analysis Methodology - Classical and Modern; Requirements Specification: Characteristics, and Components; Case Study.
UNIT 4
System Design: Objectives, Principles, Modular Design, Structured Design - Structure Charts, Transform Analysis, Transaction Analysis, Design Heuristics; Module Specification; Detailed Design; Case Study.
UNIT 5
Coding: Structured Programming, Programming Style; Validation; Verification: Static Analysis (Reviews and Inspections), Testing - Goals, Theoretical Foundations, Testing in the Small, Testing in the Large; Metrics: Metrics in Requirements Analysis and Design, Complexity Metrics-Halstead's Theory, and Cyclomatic Complexity.

SUGGESTED READINGS:
Jalote, P., AN INTEGRATED APPROACH TO SOFTWARE ENGINEERING, NAROSA.
Pressman, R.S., SOFTWARE ENGINEERING: A PRACTITIONER'S APPROACH, MCGRAW HILL.
Somerville, I., SOFTWARE ENGINEERING, ADDISON WESELEY.

Course Number: PHM808, Course Title: ANALOG INTEGRATED CIRCUITS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2011-12
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1
CMOS Processing Technology: Wafer Processing, Photolithography, Oxidation, Ion-implantation, Deposition, Etching, Interconnections. Basics of MOS Device Physics: MOSFET structure, symbol. MOS Threshold voltage, I/V characteristics, Device Capacitances, Small signal model, NMOS v/s PMOS.
UNIT 2
Single Stage Amplifiers: Common-Source, Common-Gate, Common Drain, CS-with source degeneration, Cascode. Differential Amplifier: Qualitative & quantitative analysis, Common-mode, differential mode response, CMRR.Passive and active current mirrors: Large and small-signal analysis, common-mode properties.
UNIT 3
Frequency response of an amplifier: Common source, Gain, drain, Cascode, differential pair. Miller Effect Feedback: properties of feedback circuits, VV, CV,VC, CC feedback, Effect of feedback on Noise.
UNIT 4
Operational amplifier: Performance parameters, One-stage, two stage op amps, gain boosting, slew rate, power supply rejection. Bandgap reference: Supply-independent biasing, Negative-TC, positive TS, Bandgap reference, PTAT current generation.
UNIT 5
Oscillators: LC Oscillators, VCO, Phase-lock Loops: Phase detector, Basic PLL topology, Dynamics of simple PLL. Introduction to DLL.

SUGGESTED READING:
B. Razavi: DESIGN OF ANALOG CMOS INTEGRATED CIRCUITS, McGrawHill
ANALYSIS & DESIGN OF ANALOG INTEGRATED CIRCUITS: Paul R. Gray: Wiley; 5 ed., '09
CMOS CIRCUIT DESIGN, Layout, and Simulation, R. Jacob Baker: IEEE
MICROELECTRONIC CIRCUIT DESIGN, Jaeger & Blalock, McGrawHill

Course Number: PHM809, Course Title: LABORATORY
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 4, Total Periods (55 mts. each) per week: 12 (L:0 + T:0 + P:12) Min. Pds/Term: 156

Experiments supporting Theory courses.

Course No. PHM810, Course Course Title: OPERATING SYSTEMS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2009-10
Credits: 04, Periods (50 mts.) per week: 04 (L:4 + T:0 + P:0), Min. periods per semester: 52
[SAME AS CSM604]

UNIT 1: BASICS

Functions of operating systems. Computer hardware review: processor and model of execution, interrupts and interrupt processing, storage structure, I/O structure, dual mode operation, clocks and timers. Evolution of operating systems, components. System calls, types of system calls (Linux system calls as examples). Operating system design and implementation.

UNIT 2: PROCESS MANAGEMENT

Process, Threads, IPC with shared memory and message passing. CPU scheduling: scheduling criteria, algorithms. Synchronisation: critical section problem, Peterson's solution, synchronization hardware, semaphores. Solving classic synchronization problems with semaphores. Monitors.

UNIT 3: DEADLOCKS AND MEMORY MANAGEMENT

Deadlocks: characterization, prevention and avoidance. Memory ManagemenT:contiguous allocation, paging, segmentation, demand paging, page replacement, frame allocation.

UNIT 4: FILE AND I/O MANAGEMENT

File ManagemenT:Files, directory structure, protection, file system structure, implementation, allocation methods, disk scheduling. I/O ManagemenT:Hardware, principles of I/O software, I/O software layers.

UNIT 5: LINUX OPERATING SYSTEM

Structure, scheduling, memory management and file system, shell and shell programming, signals and signal handling, pthreads, IPC: shared memory and pipes.

SUGGESTED READINGS:

Silberschatz A, Gagne G. and Galvin P.B.: OPERATING SYSTEM CONCEPTS, ADDISON - WESLEY PUBLISHING COMPANY, 7E,2005.

Tanenbaum A.S.: MODERN OPERATING SYSTEMS, 2E, PEARSON EDUCATION, 2001.

Linux Handouts

Course Number: PHM811, Course Title: QUANTUM COMPUTING
Class: M.Sc. Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52
[SAME AS PHM956 & PEE415]

UNIT 1

Principles of quantum mechanics and information science: postulates, state space, evolution, quantum measurement, distinguishing quantum states, density operator, photon polarization, Einstein Podolsky and Rosen (EPR) and Bell's inequality. Principles of information science : models for computation: turing machines, circuits, analysis of computational problems: quantification of computational resources, computational complexity, decision problems and the P and NP complexity classes, energy and computation.

UNIT 2

Manipulating Qubits: quantum superposition, quantum qubits, single qubit gates and operations, controlled operations, measurement, universal quantum gates, two-level unitary gates, CNOT gates, discrete set of unitary operations, Hadamard gate and multiple qubit gates, entanglement, measurement in bases other than the computational basis, decoherence, quantum circuits, example: Bell states, quantum teleportation, quantum computational complexity; simulation of quantum systems.

UNIT 3

Quantum Computation : quantum algorithms : classical computations on a quantum computer, quantum parallelism, Deutsch's algorithm, Deutsch-Jozsa algorithm, generalization to n + m qubits, Grover's search algorithm, quantum fourier transform, period of a function, differences between classical and quantum algorithms.

UNIT 4

Quantum Computers: physical realization, guiding principles, conditions for quantum computation: representation of quantum information, performance of unitary transformations, Nuclear magnetic resonance (NMR), trapped ions, superconducting qubits, quantum dots, optical quantum computer.

UNIT 5

Quantum Information: quantum noise and quantum operations, classical noise, examples, distance measures for quantum information, teleportation, Entropy and quantum information: Shannon entropy, von Neumann entropy, elements of quantum error-correction and quantum cryptography.

SUGGESTED READINGS:

M.L. Bellac, A Short Introduction to Quantum Information and Quantum Computing, Cambridge Univ. Press 2006.
M.A. Nielson and I.L. Chuang, Quantum Computation and Quantum Information, Cambridge Univ. Press 2002.
D. Bouwmeester, A. Ekert and A. Zeilinger (Eds.), The Physics of Quantum Information, Springer Verlag 2001.

Course Number: PHM001, Course Title: BASIC RES. METH., SC.COMPUT.& ANAL.
Class: M.Sc., Status of Course: CORE COURSE, Approved since session: 2013-14
Total Credits:4

UNIT 1: INTRODUCTION
Meaning of research, types of research, research process, problem formulation and techniques, literature review. Research design, principles and types of experimental designs, controls in an experiment, types of controls.
UNIT 2: MEASUREMENT & DATA COLLECTION
Measurement & Scaling: Measurement in research, scales of measurement, sources of errors, tests of sound measurement, development of measurement tools, scaling, scale construction techniques. Methods of data collection: observation, interviews, questionnaire, rating scales, content analysis, case study, schedules.
UNIT 3: ANALYSIS
Quantitative analysis, Errors in Quantitative analysis- random and systematic errors, handling systematic errors, presentation of results, Quality Control and Quality Assurance, Figures of merit-accuracy, precision, limit of detection, limit of quantification, method of standard additions, internal and external standards, comparison of analytical methods.
UNIT 4: INTERPRETATION & REPORTING
Interpretation, techniques of Interpretation, precautions in Interpretation. Report writing: synopsis, project/dissertation report, abstract; reading and writing a research paper.
UNIT 5: SEARCH, REASONING & IPR
Part A: Patents, copyrights, trademarks, trade secrets, IPR. Ethical, legal and social issues associated with research. Research and the Internet: World Wide Web, search engines, search strategy, subject categories, specialized databases.
Part B: Mathematical and Logical Reasoning.

SUGGESTED READINGS:
Kothari C.R. & Gaurav Garg : RESEARCH METHODOLOGY-METHODS AND TECHNIQUES, 3RD Edition, New Age International
Chawla D. and Neena Sondhi : RESEARCH METHODOLOGY CONCEPTS AND CASES, Vikas Publishing House Pvt. Ltd.
Agarwal A.K.: MODERN APPROACH TO LOGICAL REASONING, 2012, S. Chand & Co. Delhi
R. Panneerselvam : RESEARCH METHODOLOGY, PHI, 2004

Course Number: PHM002, Course Title: PRE-DISSERTATION
Class: M.Sc., Status of Course Number: Summer Term Course, Approved since session: 1998-1999
Total Credits: 4

Pre-dissertation will include preparation and improvement of synopsis in consultation with concerning supervisor.

Course Number: PHM901, Course Title: DISSERTATION
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
CrediT: 12

Students will be required to select a topic of their choice in various fields of expertise available in the Institute: do extensive literature survey on the selected topic, and study and explore the possibility of some research oriented results.

Course Number: PHM902, Course Title: OPTO-ELECTRONICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2004-05
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1 [12 pds.]
Introduction to guided wave optics, Maxwell's equation in inhomogeneous media; TE, TM modes, Planer symmetric waveguide, symmetric and anti- symmetric modes, eigen value equation, V-number, Cutoff value, single and multimode waveguide.
Integrated Optical components and Devices: (Mathematical details not required) Prism Coupler, Grating coupler, Directional Coupler, Geodesic lens, Electro-optic modulator, RF Spectrum Analyzer.
UNIT 2 [10 pds.]
Fiber-optic Waveguides: Introduction, optic fiber Waveguides, SIN fibres, Concept of mode, Single mode and multi-mode fibers. GRIN fibers, PAIN fiber as a special case of GRIN fibers, Zero dispersion fibers, dispersion losses: profile dispersion loss, material dispersion, intermodal dispersion, Rayleigh scattering loss, Stimulated Brillouin scattering loss and stimulated Raman scattering loss.
UNIT 3 [10 pds.]
Optoelectronic modulators: Electro-optic effect, EO modulators, Pockel and Kerr effects, Pockel and Kerr modulators, relative merits and demerits, Magneto-optic effect, Raman- Nath diffraction, Bragg diffraction (Elementary ideas only), A-O modulators.
UNIT 4 [10 pds.]
Photo-detectors, Display devices and Optical Couplers: Photo emissive devices, Vacuum photo devices, Photo multipliers, Noise in photo multipliers, Schottky effect and Shot noise effect, photo-conducive devices, Noise in photo conductive detectors, Junction detectors, Detector performance parameters, Optical Characteristics of photo detectors, Liquid Crystal Displays, Opto electronic couplers, Basic considerations, Optical coupling medium, Types of Opto-couplers, Opto-coupler parameters.
UNIT 5 [10 pds.]
Optical Communication Systems: Analog modulation, Digital modulation (Basic ideas only) Optical windows, Emitter design, Detector design, Fiber choice, System design considerations.

SUGGESTED READING:
Wilson & JFB Hawkes: OPTOELECTRONICS - AN INTRODUCTION
L Sharupich, N Tugov: OPTOELECTRONICS
SN Biswas: OPTOELECTRONIC ENGINEERING
AK Ghatak & Thyagarajan: OPTICAL ELECTRONICS
G Keiser: OPTICAL FIBER COMMUNICATIONS
AK Ghatak, A Sharma & R Tiwary: FIBER OPTICS ON A PC

Course Number: PHM903, Course Title: PLASMA PHYSICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2000-01
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1
Nature and occurrence of plasmas, concept of temperature, Debye shielding-Debye length, principles of electrodynamics, motion of charged particles in static uniform and non-uniform E and B fields, motion in time varying electric and magnetic fields, magnetic mirror.
UNIT 2
Plasmas as fluids: introduction, relation of plasma physics to ordinary electromagnetics, fluid equations, fluid drifts parallel and perpendicular to B, plasma approximation.
UNIT 3
Waves in plasmas: representation of waves, group velocity, plasma oscillations, electron plasma waves, ion- acoustic waves, ion-waves, validity of plasma approximation, comparison of ion & electron waves, electrostatic oscillation, lower and upper hybrid waves.
UNIT 4
Propagation of e.m. waves in plasma, dielectric constant of plasma, e.m. waves perpendicular to B, cutoff and resonances, e.m. waves parallel to B, hydromagnetic waves. Diffusion in plasma: diffusion and mobility in weakly ionized gases, decay of plasma by diffusion, classification of instabilities, two stream instability, gravitational and drift instability.
UNIT 5
Inertial and magnetic confinement, Tokamak, Pinch and mirror devices, Elmo Bumpy Torus, laser induced fusion.
SUGGESTED READING:
F F Chen: INTRODUCION TO PLASMA PHYSICS & CONTROLLED FUSION
R Cairns: PLASMA PHYSICS
Krall & Travelpiece: PLASMA PHYSICS

Course Number: PHM904, Course Title: COMPUTER NETWORKS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2010-11
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS CSM502 & CSD112]
UNIT 1 [12 pds]
Introduction to computer networks, internet, telephone network. Network edge, core, access and physical media: Transmission media: twisted pair, coaxial cables, optical fiber, terrestrial and satellite microwave radio. Concepts of data transmission, delay and loss, protocol layers and service models.
UNIT 2 [10 pds]
Application Layer: Principles of application layer, Web, HTTP, FTP, Email (SMTP), DNS, etc. Socket programming with TCP/UDP, client-server implementation, simple web server implementation.
UNIT 3 [10 pds]
Transport Layer: Transport layer services, multiplexing/demultiplexing, UDP. Principles of reliable data transfer (stop and wait, sliding window: go-back-N, selective repeat.). TCP:Connection management, segment structure, flow control, RTT estimation. Congestion controL:Causes and approaches to control, TCP congestion control. Numerical examples.
UNIT 4 [10 pds]
Network Layer: Network service models, routing principles (distance vector, link state), hierarchical routing, IP, fragmentation, ICMP, routing in the Internet (RIP, OSPF, BGP), IPV6.
UNIT 5 [10 pds]
Link Layer & Security: services, error detection and correction, multiple access protocols, LAN, ARP, ethernet, bridging, wireless LAN. Security issues in networks, tunneling VPNs, Ipsec.
SUGGESTED READING:
Kurose JF, Ross KW: A TOP DOWNAPPROACH FEATURING THE INERNET, PEARSON EDUCATON, 2ND EDITION, 2002

Peterson LL, Davie B: COMPUTER NETWORKS; A SYSTEMS APPROACH, MORGAN-KAUFMANN

Tanenbaum AS: COMPUTER NETWORKS, PRENTICE HALL OF INDIA.
Stallings William: LOCAL NETWORKS; AN INTRODUCTION, MACMILLAN PUB. CO.
Stallings W: DATA AND COMPUTER COMMUNICATIONS, PRENTICE HALL OF INDIA.
Keiser: LOCAL AREA NETWORKS, TATA MCGRAW HILL.
Keshav S: AN ENGINEERING APPROACH TO COMPUTER NETWORKING, ADDISON WESLEY.

Course Number: PHM905, Course Title: DIGITAL SIGNAL PROCESSING
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1999-2000
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1
Discrete Time Signals, Properties, Discrete Time Systems, Block Diagram Representation, Difference equations, Convolution & Correlation.
UNIT 2
Z-transform & Inverse Z-transform, One-sided Z-transform, Frequency Analysis, Power Density Spectrum, Convergence, Relation between Z-transform & fourier transform.
UNIT 3
DFT:Properties & Application, FFT Algorithms, Goertzel Algorithm, Chip-Z transform.
UNIT 4
Discrete time systems, Structures of FIR & IIR systems, State space analysis, Representation of numbers, Quantization of Filter Coefficiences-Sensitivity.
UNIT 5
Digital Filters: FIR Filters, Linear Phase characteristics, Design using Windows & Frequency Sampling techniques. IIR filter design from Analog filters using approximation of Derivatives & Impulse invariance.

SUGGESTED READING:
Proakis John G & Manolakis: DIGITAL SIGNAL PROCESSING, PHI
Opperheim & Schafer: DIGITAL SIGNAL PROCESSING, PHI

Course Number: PHM906, Course Title: OPERATING SYSTEMS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2008-09
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1
Functions of operating systems. Computer hardware review: processor and model of execution, interrupts and interrupt processing, storage structure, I/O structure, dual mode operation, clocks and timers. Evolution of operating systems, components. System calls, types *of* system calls (Linux system calls as examples). Operating system design and implementation.
UNIT 2
Process, Threads, IPC with shared memory and message passing. CPU scheduling: scheduling criteria, algorithms. Synchronisation: critical section problem, Peterson's solution, synchronization hardware, semaphores. Solving classic synchronization problems with semaphores. Monitors. Case study - Windows XP and Linux.
UNIT 3
Deadlocks: characterization, prevention and avoidance. Memory ManagemenT:contiguous allocation, paging, segmentation, demand paging, page replacement, frame allocation. Case study - Windows XP and Linux.
UNIT 4
File ManagemenT:Files, directory structure, protection, file system structure, implementation, allocation methods, disk scheduling. I/O ManagemenT:Hardware, principles *of* I/O software, I/O software layers. Case study- Windows XP and Linux.
UNIT 5
Structure, scheduling, memory management and file system, shell and shell programming, signals and signal handling, pthreads, IPC: shared memory and pipes.

SUGGESTED READING:
A Silberschatz, G Gagne & PB Galvin: OPERATING SYSTEM CONCEPTS, Addison-Wesley Publishing Co., 7E,2005.
AS Tanenbaum: MODERN OPERATING SYSTEMS, 2E, Pearson Education, 2001. LINUX HANDOUTS

Course Number: PHM907, Course Title: ACOUSTICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 1998-1999
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

Mechanics of wave motion and sound, vibrating systems, wave propagation in gases, liquids, and solids including elements of hydrodynamics and elasticity; reflection, refraction, diffraction and scattering of waves in fluids, attenuation mechanisms in fluids, propagation in non-homogeneous fluids and in moving fluids, radiation pressure, acoustic streaming, and attenuation in large amplitude sound fields, propagation of sound in liquid Helium, mechanisms resulting in attenuation for elastic waves in solids, applications in ultrasonics, low temperature physics, solid state physics, and architectural acoustics; interaction of light and sound, acousto-optic effect, photo-acoustic effect.

Course Number: PHM908, Course Title: ASTROPHYSICS & GENERAL RELATIVITY
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2009-10
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1: THE STANDARD MODEL & ELEMENTARY PARTICLES
Quarks and Leptons, Fermions and bosons, Super symmetry, Antiparticles, Fundamental Interactions, Boson coupling to Fermions, Quark-gluon plasma. Kinematics and Cross-sections: Threshold energies, four vectors, Lorentz Transformations, Cross-sections.
UNIT 2: CONSERVATION RULES & SYMMETRIES
Introduction, rotations, The Parity operation, Parity conservation and Intrinsic Parity, Parity violation in Weak interactions, Helicity and helicity conservation, Charge conjugation invariance, Gauge transformations and gauge invariance, Gauge invariance in the electroweak theory, Higgs Mechanism of spontaneous symmetry breaking, Running Coupling constants, Grand Unified Theories (GUTs) and super symmetry, CPT theorem and CP and T symmetry, CP violation in neutral Kaon decay and CP violation in the Standard model.
UNIT 3: PHYSICS OF PARTICLE & RADIATION DETECTION, ACCELERATION MECHANISM
Interaction of Astroparticles, Interaction processes used for particle detection, Photon detection, Cyclotron Mechanism, Acceleration by sunspot pairs, Shock acceleration, Fermi acceleration, Pulsars, Binaries.
UNIT 4: PRIMARY AND SECONDARY COSMIC RAYS
Charged Components of Primary Cosmic rays, Neutrino Astronomy: Atmospheric neutrinos, Solar neutrinos, Supernova Neutrinos. Gamma Astronomy: Introduction, Production mechanism for gamma rays, Observation of gamma rays, Measurement of gamma rays. X-ray Astronomy: Introduction, Production Mechanism of X-rays, Detection of X-rays.
Secondary Cosmic Rays: Propagation in the atmosphere, Cosmic rays at sea level, Cosmic rays underground, Extensive air showers, Nature and Origin of the Highest energy Cosmic rays.
UNIT 5: COSMOLOGY & THE EARLY UNIVERSE
The Hubble Expansion, Isotropic and Homogeneous Universe, The Friedman Equation from Newtonian Gravity, The Friedmann Equation from General Relativity, The Fluid and acceleration equation, Nature of solutions to the Friedmann equation.
Planck Scale, Thermodynamics of the early Universer, Solving the Friedmann equation, Baryon Asymmetry of the Universe. Basic String theory- Theory of Everything.

SUGGESTED READINGS:
COSMIC RAYS AND PARTICLE PHYSICS: Thomas K Gaisser, Cambridge Univ. Press, Cambridge 1990.
THE ORIGIN OF COSMIC RAYS: PL Biermann, astro-ph/9501003
INTRODUCTION TO HIGH ENERGY PHYSICS, Cambridge Univ. Press, Cambridge 2001.
SPECIAL CENTENARY ISSUE OF REVIEWS OF MODERN PHYSICS, 71(1999) S 145-197.

Course Number: PHM909, Course Title: NONLINEAR DYNAMICS
Class: MSc, Status of the Course Number: MAJOR. Approved from session: 2011-2012
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P/S: 0), Min. periods/Sem.: 52

UNIT 1 [11 pds]
Introduction to ordinary differential equation (ODEs): linear nonlinear, systems of ODEs, existence and uniqueness theorems, conservative versus dissipative system, invariant curves and quasi-periodicity review of KAM theorem, integrable and non-integrable system.

UNIT 2 [10 pds]
Phase space analysis: phase portrait, linear stability, potential fixed points, periodic orbits, limit cycles, Poincare–Bendixson theorem, Lyapunov function, gradient system.

UNIT 3 [10 pds]
Bifurcation: saddle-node, transcritical pitchfork, Hopf, period doubling, intermittency, local and global bifurcation, center manifold and normal forms, structural stability.

UNIT 4 [10 pds]
Discrete system: Poincare cross-sections, linear stability and cobweb analysis; universality and renormalization, logistic and Henon maps.

UNIT 5 [11 pds]
Strange attractors: unstable periodic orbits, chaotic motions; characterization of strange motions: fractal dimension, entropy and Lyapunov exponents; Cantor set and Koch curve. Coupled system: synchronization and riddilng, multistability, introduction to pattern formation.

SUGGESTED READING

NONLINEAR DYNAMICS AND CHAOS: WITH APPLICATIONS TO PHYSICS, BIOLOGY, CHEMISTRY AND ENGINEERING, S.H.Strogatz, Westview Press, 2001.
Chaos: AN INTRODUCTION TO DYNAMICAL SYSTEMS, K.Alligood,T. Sauer, J.A.Yorke, Springer 1996.
NONLINEAR SCIENCE, Scott, Oxford Univ. Press, 1999.
NONLINEAR DYNAMICS: INTEGRABILITY, CHAOS AND PATTERNS, M.Lakshmananand S.Rajasekar, Springer- Verlag,2003.

Course Number: PHM910, Course Title: COMPLEX SYSTEMS AND NETWORKS
Class: MSc, Status of the Course Number: MAJOR. Approved from session: 2011-12
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P/S: 0), Min. periods/Sem.: 52

UNIT 1 [12 pds]
Example of Complex Systems: organisms, ecosystems, brains, societies, the internet. Explaining how each of these systems is more than some of its parts. Descriptions of the components of these systems: molecules, cells, species, agents, computers. Description of complex collective phenomena exhibited by these systems. Contrast with other collective phenomena in physics such as phase transitions. Adaptive nature of these systems.

UNIT 2 [10 pds]
Description of complex systems: Networks and graph theory. Complex networks of interaction as a unifying theme underlying complex systems. A graph with nodes and edges as a description of a network. Adjacency matrix of a graph. Undirected, directed, unipartite and bipartite graphs, hypergraphs. Measures of graph structure: degree distribution, path length, clustering coefficient, distributions of cycles, modularity and community structure, eigenvalues, graph Laplacian, etc. Random graph ensembles, small world, scale free, hierarchical and autocatalytic graphs. Network motifs. Nature of graphs appearing in various complex systems.

UNIT 3 [10 pds]
Dynamics of complex systems: Dynamics of a fixed network. The influence of network structure on dynamics. Discrete and continuous dynamical systems, including Boolean networks, cellular automata, coupled maps, differential equations of networks. Attractors of a dynamical system: fixed points and cycles. Chaos. Deterministic and stochastic dynamics. The role of positive and negative feedback. Examples to be taken from various complex systems, such as flux analysis of metabolic networks, rate equations for chemical networks, ecological food web dynamics, dynamics of genetic regulatory circuits, neural networks, spreading of disease on social networks, economic dynamics.

UNIT 4 [10 pds]
Evolution of complex systems: Dynamics of network. A dynamical system whose set of variables is itself a variable. Preferential attachment model of scale free networks. The origin of life puzzle. Model of autocatalytic network evolution and self-organization of a complex network. Emergencies of system level coherence and order from a random initial condition. Community assembly models in ecology. Natural selection and evolution of life on earth.Evolution of biological networks.

UNIT 5 [10 pds]
Some open questions in complex systems: The problem of defining complexity, attempts from computer science, information theory and dynamical systems, the " edge of chaos" hypothesis. Complexity arising from multiple length and time scale. The problem of robustness, fragility and evolvability; their relationship with network architecture. Crashes and recoveries in complex systems. Characterizing the fragility of the biosphere. Characterizing "innovation" in complex systems.

SUGGESTED READINGS:
Stuart Kauffman: ORIGINS OF ORDER (Oxford University Press, 1993)
S. Bornholdt and H.-G. Schuster: HANDBOOK OF GRAPHS AND NETWORKS: FROM THE GENOME TO THE INTERNET (Wiley – VCH, 2003)

Course Number: PHM911, Course Title: VLSI DESIGN TECHNIQUES
Class: M.Sc., Status of the Course Number: MAJOR. Approved from session: 2000-01
Credits: 4, Periods (55 mts. each) per week = 4 (L:4 + T:0 + P/S: 0), Min. periods/Sem.: 52
(SAME AS EEM719)
UNIT 1: MOSFET DESIGN FUNDAMENTALS
MOS Transistor fundamentals: MOS structure and operation, C-V characteristics, scaling and small geometry effects, capacitances. SPICE Modeling of MOS transistors and their comparisons.
Fabrication of MOS: Fabrication Process flow, CMOS n-well process, Layout design rules, Full custom Mask layout design.
CMOS inverters: Static characteristics. Switching characteristics and interconnect effects. Power dissipation. Super buffer design. Low power design fundamentals.
UNIT 2: STATIC CMOS DESIGN
Static CMOS logic: Combinational complex logic circuits, transmission gate logic. Sequential logic circuits, bistable elements, SR latch, clocked flip flops.
Input-Output circuits: ESD protection, Latch and its prevention, Design of bi-directional I/O pads. Clock generation and distribution.
UNIT 3: DYNAMIC CMOS DESIGN
Dynamic CMOS logic: Pass transistor principles, voltage bootstrapping, charge sharing, synchronous dynamic circuits, high performance dynamic CMOS circuits.
Semiconductor memories: SRAM, DRAM(6-T, 3-T, 1-T), operation principles, read write cycles, sense amplifiers.
UNIT 4: VLSI DESIGN METHODOLOGIES
VLSI Design flow (Y-chart), hierarchy, regularity, modularity and locality.
VLSI design styples: Standard Cell, PLA, MUX-based, Sea of Gates and Gate Array, PLD, FPGA.
CAD tools: Layout tools, Simulation and verification tools. Synthesis tools.
Introduction to HDL: Instruction set of HDL and exercises for programming ASIC/FPGA/CPLDs.
UNIT 5: DESIGN FOR TESTABILITY
Design quality: testing yield, manufacturability, reliability. Manufacturing test faults, Fault models, Observability, controllability. Scan based techniques, BIST techniques, IDDQ technique.

SUGGESTED READING:
NHE Weste & K Eshraghian: PRINCIPLES OF CMOS VLSI DESIGN
SM Kang & Y Leblebici: CMOS DIGITAL INTEGRATED CIRCUITS
RJ Baker, HW Li & D Boyce: CMOS-CIRCUIT DESIGN, LAYOUT AND SIMULATION
J Rabaey: DIGITAL INTEGRATED CIRCUITS-A DESIGN PERSPECTIVE
M Abramovici, MA Breuer & AD Friedman: DIGITAL SYSTEMS TESTING & TESTABLE DEISGN
J Bhaskar: VHDL PRIMER
Sameer Palnitkar: VERILOG HDL

Course Number: PHM912, Course Title: STATISTICAL MECHANICS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week : 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS PHM702]

UNIT 1: THERMODYNAMICS

Extensive and Intensive Variables, Entropy and Temperature, Review of Thermodynamic Potentials, Maxwell Relations, and Phase Transitions, Phase diagrams and critical points, Stability of Phases, Van der Waals Gas and Curie-Weiss Magnet, Critical Exponents and scaling relations

UNIT 2: STATISTICAL MECHANICS: RULES OF CALCULATION

Isolated systems: Boltzmann's Hypothesis, Entropy of Mixing and Gibbs Paradox, Equipartition of Energy; Closed systems: The Partition Function and connection with Thermodynamics, Open systems: Grand Partition Function and connection with thermodynamics, Microcanonical, Canonical and Grand Canonical Ensemble. Fluctuations, Correlations and Response, Fluctuation-Response Theorem, Scattering and Correlation. Above concepts to be illustrated through the Ideal Classical Ising Magnet and Ideal Classical Monatomic Gas

UNIT 3: IDEAL CLASSICAL AND QUANTUM GASES

Statistical Physics of Monoatomic and Diatomic Classical Gas, Maxwell Boltzmann, Fermi-Dirac and Bose-einstein distributions, Quantum Gases: Concept of Density of States, Ideal Fermi Gas at T=0, Ideal Fermi Gas at small non-zero temperatures, specific heat and magnetic properties of ideal fermi gas, Ideal Bose Gas, Bose Einstein Condensation

UNIT 4: INTERACTING SYSTEMS

Models of Interacting Fluids, Lattice Spin Systems -- ClassicalIsing Models, Exact solution of 1-d Interacting Ising ModeL:Partition function, Thermodynamics and Correlations, Phase Transitions

UNIT 5: ADVANCED TOPICS

Van der Waals-Weiss Formulation of Mean Field Approximation, Mean-Field Approximation for the d-dimensional Ising Model, Mean-Field Approximation for the d-dimensional fluid and Van der Waals gas, Validity and accuracy of mean-field approximation. Diffusion equation, Random walks, Brownian motion and non-equilbrium processes.

Suggested Readings:

DebashishChowdhury and Dietrich Stauffer, *Principles of Equilibrium Statistical Mechanics*, Wiley-Vch, 2000.
K Huang: STATISTICAL MECHANICS
RK Pathria: STATISTICAL MECHANICS
F Reif: STATISTICAL AND THERMAL PHYSICS

Course Number: PHM913, Course Title: BIOPHYSICS

Class: MSc, Status of the Course Number: MAJOR. Approved from session: 2011-12

Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P/S: 0), Min. periods/Sem.: 52

UNIT 1 [10 pds]

Building blocks and Living State Interactions: Molecules essential for life: water, proteins, lipids, carbohydrates, cholesterol, nucleic acid, requirements for life, characteristics and structure of living cells, forces and molecular bonds, electric and thermal interactions, Casimir interaction, heat transfer in biomaterials. Thermodynamic equilibrium, entropy, physics of many particle systems in biology-ensembles.

UNIT 2 [10 pds]

Living State Thermodynamics: Casimir contribution to free energy, Protein folding and unfolding, open systems and chemical thermodynamics, chemical reactions, activation energy and rate constants, enzymatic reactions, ATP hydrolysis and synthesis, entropy of mixing. Diffusion and TransporT:Maxwell-Boltzmann statistics, Fick's laws of diffusion, quantum diffusion, Navier-Stokes equation, Reynolds number, Active and passive membrane transport, fluid dynamics of circulatory systems.

UNIT 3 [10 pds]

Bioenergetics and molecular motors, Brownian motors, ATP synthesis in mitochondria, photosynthesis in chloroplasts-Photosystems I and II, light absorption in biomolecules and their vibrational spectra. Passive Electrical Properties of Living Cells: Poisson-Boltzmann equation, Membrane potentials, bioimpedance, nerve conduction and impulses, neurotransmitters and synapses, Hodgkin-Huxley equations, simplified models of individual neurons, passive transport in dendrites, bio-electromagnetism, magnetotactic bacteria, Squid magnetometry, magneto-cardiography.

UNIT 4 [10 pds]

Nonlinearity and Chaos in Biological Systems: Chaotic dynamics, population dynamics, fractals and complexity in life sciences, self-organized criticality, problems and approaches of system analysis, models of evolution, growth, neural processes. Principles of Bioelectronics and Biophotonics, emission of photons from biosystems.

UNIT 5 [10 pds]

Biophysics of Computation: Elements of Unconventional computing, molecular flip-flop, programming with peptides, computing with neurons, biomolecular computing, DNA computing. Principles of Quantum Biology: entanglement, quantum properties in ion-channel proteins, microtubules and transfer of information in biological systems.

SUGGESTED READING:

Roland Glaser: Biophysics, Springer, 2001

Philip Nelson: BIOLOGICAL PHYSICS: ENERGY, INFORMATION AND LIFE; Freeman, 2004

INTRODUCTORY BIOPHYSICS: PERSPECTIVES OF THE LIVING STATE: J. Claycomb & J.Q.P. Tran, Jones and Bartlett, 2011

INTEGRATIVE BIOPHYSICS: F.A. Popp and L. Beloussov, Kluwer, 2003.

BIOPHOTONICS: P.N. Prasad, Wiley, 2004.

Course Number: PHM914, Course Title: INTRODUCTION TO EMBEDDED SYSTEMS
Class: M.Sc., Status of the Course Number: MAJOR. Approved from session: 2011-12
Credits: 4, Periods (55 mts. each) per week: 4 (L:4 + T:0 + P/S: 0), Min. periods/Sem.: 52

UNIT 1: INTRODUCTION TO EMBEDDED SYSTEMS [10 pds]
Embedded Systems Vs General Computing Systems, Classification of Embedded Systems, Major application areas of Embedded Systems, Purpose of Embedded systems, Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded firmware, PCB and Passive Components, Characteristics and Quality attributes of an Embedded System.

UNIT 2: DESIGN OF EMBEDDED SYSTEMS [10 pds]
Factors for considering in selecting a Controller, Designing with 8051 microcontroller, Different addressing modes supported by 8051, Instruction set for 8051 microcontroller. Fundamental issues in Hardware Software Co-Design, Computational models in Embedded Design.

UNIT 3: REAL-TIME OPERATING SYSTEM (RTOS) BASED EMBEDDED SYSTEM DESIGN [10 pds]
Operating system basics, Kernel Features, Tasks, Process, Threads, Multiprocessing and Multitasking, Task scheduling, Task Communication, Task Synchronization, I/O operations, Synchronous/Asynchronous, Interrupt Handling, Device Drivers, Real Time transactions and files, Examples of Real Time OS, Power Optimisation Strategies for Processes.

UNIT 4: EMBEDDED SYSTEM DEVELOPMENT ENVIRONMENT [10 pds]
Integrated Development Environment (IDE), Types of files Generated on Cross-Compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Boundary Scan

UNIT 5: EMBEDDED PRODUCT DEVELOPMENT LIFECYCLE (EDLC) AND TRENDS IN EMBEDDED INDUSTRY [10 pds]
What is EDLC, Objectives of EDLC, Different phases of EDLC, EDLC Approaches-Linear or waterfall model, Iterative Model, Prototyping/Evolutionary Model, Spiral Model. Processor trends in Industry, Embedded OS Trends, Development Language trends, Open Standards, Frameworks and Alliances, Bottlenecks. Case Studies.

SUGGESTED READING:
KV Shibu: INTRODUCTION TO EMBEDDED SYSTEM, Tata McGraw Hill, 2009
Steven F Barrett and Daniel J Pack: EMBEDDED SYSTEMS: DESIGN AND APPLICATIONS, Pearson Education
RajkamaL:EMBEDED SYSTEM: ARCHITECTURE, PROGRAMMING AND DESIGN, Tata McGraw Hill, 2008
James K. PeckoL:EMBEDDED SYSTEM- A CONTEMPORARY DESIGN TOOL, Willey India, 2009
Balbno: EMBEDDED MICRO COMPUTER SYSTEM, Cengage Learning
SiewerT:REAL TIME EMBEDDED SYSTEM & COMPONENTS, Cengage Learning, 2007

Course Number: PHM915, Course Title: LASER PHYSICS AND APPLICATIONS
Class: M.Sc., Status of the Course Number: MAJOR, Approved Since Session: 2009-10
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52

UNIT 1 [12 pds.]
Linear Interaction of Light with Matter: Einstein's theory and semi-classical theory of stimulated emission, Einstein's coefficients, optical pumping, light amplification, threshold condition, laser rate equations: two-level, three-level, four-level laser systems, pumping processes: incoherent light source, laser pumping, electrical discharge, pump rate and pump efficiency, variation in laser power around threshold, optimum output coupling, line broadening mechanisms- inhomogeneous and homogeneous broadening: Natural, Collision and Doppler broadening.

UNIT 2 [11 pds.]
Laser Resonators: Modes of a rectangular cavity and open planar resonator, quality factor, ultimate line width of a laser, transverse and longitudinal modes of a laser cavity, mode selection, Q-switching, techniques for Q-switching: electro-optic, acousto-optic, saturable absorber; Mode-Locking: active and passive, pulse compression, Gaussian beam and its properties, Fraunhofer and Fresnel diffraction, modes of a confocal resonator system, general spherical resonator, higher-order modes, stability criterion.

UNIT 3 [11 pds.]
Properties of Laser beams and Lasers Systems: Intensity, Monochromaticity, Coherence: spatial and temporal, Directionality of laser beams, Solid-state lasers: Ruby, Nd-YAG, Nd-Glass, Ti: Sapphire; Gas lasers: He-Ne, CO_2, Ar-ion, Nitrogen, Excimer; Dye lasers, Semiconductor lasers: homo-junction, hetero-junction lasers, quantum-well, free-electron and X-ray lasers; ultra-short and ultra-high power pulsed laser systems. Laser beam measurements, propagation and laser safety.

UNIT 4 [11 pds.]
Applications of Lasers in Science & Engineering: Spatial Frequency Filtering, lens as a Fourier transforming element, Holography: basic principle, Fourier transform and volume holograms and their applications, Qualitative treatment of laser applications in information processing Optical communication, computing, data storage, sensors; Principle of Slow and Fast Light. Elements of Quantum Optics: Field quantization, coherent states, atom-field interactions, entanglement and applications in quantum information processing.

UNIT 5 [11 pds.]
Applications of Lasers: Nonlinear Interaction of Light with Matter: nonlinear electron oscillator model, nonlinear polarization, Nonlinear interactions without absorption: second order phenomena: second harmonic generation, sum-difference of frequency generation, two-photon absorption, Pocket's effect, optical rectification, third order phenomena: Kerr effect, Intensity- dependent refractive index, self-focusing, self-diffraction, optical bistability, optical solitons, phase conjugation (qualitative); Nonlinear interaction with absorption: nonlinear transmission, bleaching, spectral hole burning, rate equations, elements of nonlinear laser spectroscopy: pump-probe measurements, z-scan etc. (qualitative), Basic elements of Nano-Photonics and its applications.

SUGGESTED READING:
O. Svelto: PRINCIPLES OF LASERS, Plenum, New York, 1998.
Ghatak and Thyagarajan: OPTICAL ELECTRONICS, Cambridge University Press, 1989.
Thyagarajan and Ghatak: LASER THEORY AND APPLICATIONS, Macmillan, India, 1986.
A.E. Siegman: LASERS, Oxford University Press, 1986.
Milonni and Eberly: LASERS, John Wiley,1991.
W.T. SilfvasT:LASER FUNDAMENTALS, Cambridge Univ. Press, 1998.
A. Yariv: OPTICAL ELECTRONICS, John Wiley, 3rd ed., 1989. 8. R. MenzeL:Photonics, Springer, 2001
W. Demtroder: LASER SPECTROSCOPY (3rd ed.), Springer, 2003.
R. W. Boyd: NONLINEAR OPTICS, Academic Press, 2003.

Course Number: PHM916, Course Title: GENERAL RELATIVITY
Class: M.Sc./M.Phil., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS PHM967]
UNIT 1: SPECIAL RELATIVITY AND TENSORS
Special Relativity, invariance of the interval, Lorentz transformations, invariant hyperbolae; vector algebra; four-velocity and four-momentum, scalar product, metric tensor, one-forms, (m,n) tensors, index raising and lowering; perfect fluids in special relativity.
UNIT 2: CURVATURE
Tensor algebra/calculus in polar coordinates, Christoffel symbols and the metric, noncoordinate bases, differentiable manifolds and tensors, Riemannian manifolds, covariant differentiation, parallel-transport, geodesics and curvature, curvature tensor, bianchi identities; Ricci and Einstein tensors,
UNIT 3: PHYSICS IN CURVED SPACE-TIME AND EINSTEIN FIELD EQUATIONS
Differential geometry and gravity, Physics in slightly curved spacetimes, physical derivations of Einstein field equations, Einstein's equations, Einstein's equations for weak gravitational fields, Newtonian gravitational fields.
UNIT 4: GRAVITATIONAL RADIATION AND STARS
Gravitational Waves, energy in Gravitational Waves, Coordinates for spherically symmetric spacetimes, static spherically symmetric spacetimes, static perfect fluid Einstein equations, exterior geometry, interior geometry, realistic stars and gravitational collapse
UNIT 5: BLACK HOLES
Trajectories in the Schwarzschild spacetime, nature of the event horizon, charged and rotating black holes (elementary description), Penrose Diagrams and causal structure, Penrose diagram for black holes in minkowski space; AdS space; Penrose diagram for AdS space and black holes in AdS space.

Reference:
Bernard Schutz, *A first course in general relativity,* Cambridge University Press.

Course Number: PHM917, Course Title: QUANTUM FIELD THEORY
Class: M.Sc./M.Phil., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS PHM965]
UNIT 1: PATH INTEGRAL FORMULATION AND FREE FIELD THEORY
Path Integral Formulation of Quantum Physics, Gaussian Integrals and Wick Contraction, Lattice and Continuum limit, Free scalar field theory, free scalar propagator, attractive and repulsive forces and quantum fields, anharmonic oscillator in path integral formulation, Feynman diagrams, Wick contraction and perturbative quantum field theory; canonical quantization, casimir effect, symmetries and Noether's theorem
UNIT 2: SPINORS
Dirac Equation, Lorentz Transformations of the Dirac Matrices, Majorona fermions; Quantizing dirac field and anti-commutation relations, Lorentz Group and WeylSpinors, Spin Statistics Theorem, Grassmann numbers, path integrals and Feynman rules for fermions.
UNIT 3: RENORMALIZATION AND GAUGE INVARIANCE
Electron scattering and gauge invariance, diagrammatic proof of gauge invariance, cutoff-regularization, renormalizable and non-renormalizable field theories; counterterms and physical perturbation theory; gauge invariance; non-relativistic field theory, magnetic moment of the electron, polarization of the vacuum and charge renormalization (qualitative)
UNIT 4: SYMMETRY AND SYMMETRY BREAKING
Symmetry and symmetry breaking, pion as a Nambu Goldstone Boson, Effective Potential, introduction to non-abelian gauge theory, higgs mechanism; chiral anomaly, magnetic monopoles.
UNIT 5: FIELD THEORY AND COLLECTIVE PHENOMENA
Superfluids, Euclidean path integrals and field theory at finite temperature, introduction to Landau Ginzberg theory of critical phenomena, superconductivity, peierls instability, solitons, vortices monopoles and instantons. Fractional statistics, ChernSimons terms and quantum hall fluids.

Suggested Readings:
Anthony Zee, *Quantum Field Theory in a Nutshell,* Princeton University Press.
Mark Srednicki, *Quantum Field Theory,* Cambridge University Press.

Course Number: PHM918, Course Title: STRING THEORY AND M-THEORY
Class: M.Sc.& M.Phil., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS PHM966]
Unit 1
Introduction and historical overview of string theory, String sigma-model action: the classical theory, Canonical quantization, light-cone gauge quantization
Unit 2
Conformal field theory, Representations of Conformal Group, BRST quantization, Background fields, Vertex operators, The structure of string perturbation theory, The linear-dilaton vacuum and noncritical strings,
Unit 3
Ramond-Neveu-Schwarz strings, Global world-sheet supersymmetry, Constraint equations and conformal invariance, Boundary conditions and mode expansions, Light-cone gauge quantization of the RNS string, SCFT and BRST, Strings with space-time supersymmetry, The D0-brane action, The supersymmetric string action, Quantization of the Green-Schwarz action, Gauge anomalies and their cancellation
Unit 4
The bosonic string and Dp-branes, D-branes in type II superstring theories, type I superstring theory, T-duality in the presence of background fields, World-volume actions for D-branes, The heterotic string, Nonabelian gauge symmetry in string, Fermionic construction of the heterotic, Toroidalcompactification, Bosonic construction of the heterotic string
Unit 5
Low-energy effective actions, S-duality, M-theory, M-theory dualities, String geometry, Orbifolds, CalabiYau manifolds: mathematical properties, Examples of CalabiYau manifolds, Calabi-Yaucompactifications of the heterotic string

Suggested Readings
K Becker, M Becker, J Schwarz, *String theory and M-Theory,* Cambridge University Press

Course Number: PHM951, Course Title: DISSERTATION I Credits: 8

Course Number: PHM952, Course Title: DISSERTATION II Credits: 16
Class: MPhil, Status of the Course Number: MAJOR. Approved from session: 2007-08

Dissertation courses.

Course Number: PHM953, Course Title: SELF STUDY COURSE
Class: MPhil, Status of the Course Number: MAJOR. Approved from session: 2007-08
Credits: 4

1. SOFT COMPUTING: Hybrid neuro-fuzzy-evolutionary computation, parallel implementations, rough-fuzzy integration, applications in bioinformatics.
2. ADVANCED MICROWAVE TECHNIQUES: Planar microwave devices, electronic band gap structures, negative refractive index structures, Smart antennas, MEMS
3. PHYSICS OF CONSCIOUSNESS: Concepts of consciousness, mind and matter, dualism, implications of new physics, interpretations, explaining biological phenomena through physics. Basic elements of emergence, chaos, complexity, and evolution, systems perspective, quantum consciousness theories, integral world view, unified theory of reality.
4. ADVANCES IN VLSI DESIGN: Adaptive electronics, physics of floating gate transistors, adaptive circuit design using FGMOS, field programmable architectures, neuromorphic circuits
5. SOLAR HYDROGEN PRODUCTION SYSTEMS: Hydrogen as a fuel, techniques of solar generation of hydrogen, role of materials in solar generation of hydrogen, applications of nano materials and nano structured thin films in PEC generation of hydrogen.
6. PHOTONICS: Nonlinear optical phenomena, characterization of optical properties of organic and bio-molecules, elements of biophotonics, nano photonics, photonics of components and devices, applications in communications, computing and sensing.
7. INTERNET TECHNOLOGIES AND PROGRAMMING WITH JAVA: Topics in Java relevant to Internet programming: JSP, Java Standard Tag Library, Custom tags, Database integration with web pages, Internationalization, Java Beans with JSP, XMLs sessions, servlets and other Java based technologies.
8. ADVANCED THEORETICAL PHYSICS: Advanced topics in quantum field theory, general relativity, string theory; quantum information theory, fault tolerant quantum computing and quantum error correction; topics in high-energy particle physics and nuclear physics.

Course No.: PHM954, Course Course Title: ADV. SCIENTIFIC METHODOLOGY & ANAL.
Class: M.Phil., Status of Course Number: Major Course, Approved since session: 2013-14
Total Credits: 4, Periods(55 mts. each)/week:5(L-5+T-0+P/S-0), Min.pds./sem.:65
[Same as MAM954]
UNIT 1
Part A: Introduction, matrix-vector approach (MATLAB), vectors and plotting, vectorization of scalar computations, evaluation of functions, scaling and superposition, approximations and error, floating point numbers, properties of floating point systems, machine precision, subnormals and underflow, floating point arithmetic, condition number, stability, writing MATLAB functions, examples.
Part B: Mathematical and Logical Reasoning to Cover Part I of UGC NET Syllabus. Literature review, report writing and ethics in research.
UNIT 2
The polynomial interpolation problem, Vandermonde approach, special and general case, piecewise interpolation – Hermit, cubic and spline, nested multiplication, Newton representation, properties, accuracy, MATLAB implementations.
UNIT 3
Newton-Cotes integration and implementation, error, composite rules, Composite quadrature, adaptive quadrature, Gauss quadrature, MATLAB implementation examples.
UNIT 4
Matrix computations, simple i-j recipes, band and block structures, matrix-vector multiplications, matrix-matrix multiplications, errors and norms, recursive matrix operations, distributed memory matrix multiplication, discrete Fourier transform, fast Fourier transform, Introduction to MPI.
UNIT 5
Triangular problems, banded problems, full problems, stability, error, sensitivity, QR and Cholesky factorizations, system of linear equations, LU decomposition.

SUGGESTED READINGS:
Michael Heath, Scientific Computing: An Introductory Survey, McGraw Hill.
CF Van Loan, Introduction to Scientific Computing: A Matrix-Vector Approach Using MATLAB, 2nd Edition.

Course Number: PHM955, Course Title: NANOTECHNOLOGY
Class: M.Phil. Electronics/Computer Science
Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52

UNIT 1
Principles of molecular structure, molecular spectra and processes. What are nanostructures? Review of quantum mechanics of low-dimensional systems: potential well, wire and dot, solid state physics and surface science review: electronic state in a perfect crystal, Defects and impurities, General properties of solid surface/interface, atomic processes in growth of crystal and thin film, length, energy and time scales.
UNIT 2
Scattering probes, Scanning electron microscopy and transmission electron microscopy, Scanning probe microscopy (SPM), Scanning tunneling microscopy (STM), Atomic force microscopy (AFM), Variants of STM/AFM, Near-field scanning optical microscopy (NSOM), Electrical transport probes, modern laser techniques.
UNIT 3
Lithography and nano-imprint technologies, Manipulation and lithography with SPM, Molecular beam epitaxy (MBE) and Self-assembly. 2D electron gas (2DEG), Coherent quantum transport, 2D EG in a magnetic field and quantum Hall effect, Quantum dots: Coulomb blockade and resonant tunneling.
UNIT 4
Role of nanoscale dimensions in dictating device functionality, nanoscale semiconductor electronic devices, solid-state devices: Josephson junctions, quantum dots, carbon nanotubes etc., Magnetic nanostructures, Spintronic devices.
UNIT 5
Optoelectronics of nanostructures: quantum wells, superlattices, quantum dot systems, photonic bandgap materials, Organic molecular electronics: polymer based LEDs, photovoltaic devices, photo-electrochemical splitting to generate hydrogen, molecular electronic devices etc

SUGGESTED READINGS:
Y. Imry, Introduction to Mesoscopic Physics, Oxford University Press.
Hari Singh Nalwa (ed.), Nanostructured Materials and Nanotechnology, Academic Press, London, 2002.
G. Timp (ed.), Nanotechnology, Springer, New York, 1999.

Course Number: PHM956, Course Title: QUANTUM COMPUTING
Class: M.Phil. Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52

UNIT 1
Principles of quantum mechanics and information science: postulates, state space, evolution, quantum measurement, distinguishing quantum states, density operator, photon polarization, Einstein Podolsky and Rosen (EPR) and Bell's inequality. Principles of information science : models for computation: turing machines, circuits, analysis of computational problems: quantification of computational resources, computational complexity, decision problems and the P and NP complexity classes, energy and computation.
UNIT 2
Manipulating Qubits: quantum superposition, quantum qubits, single qubit gates and operations, controlled operations, measurement, universal quantum gates, two-level unitary gates, CNOT gates, discrete set of unitary operations, Hadamard gate and multiple qubit gates, entanglement, measurement in bases other than the computational basis, decoherence, quantum circuits, example: Bell states, quantum teleportation, quantum computational complexity; simulation of quantum systems.
UNIT 3
Quantum Computation : quantum algorithms : classical computations on a quantum computer, quantum parallelism, Deutsch's algorithm, Deutsch-Jozsa algorithm, generalization to n + m qubits, Grover's search algorithm, quantum fourier transform, period of a function, differences between classical and quantum algorithms.
UNIT 4
Quantum Computers: physical realization, guiding principles, conditions for quantum computation: representation of quantum information, performance of unitary transformations, Nuclear magnetic resonance (NMR), trapped ions, superconducting qubits, quantum dots, optical quantum computer.
UNIT 5
Quantum Information: quantum noise and quantum operations, classical noise, examples, distance measures for quantum information, teleportation, Entropy and quantum information: Shannon entropy, von Neumann entropy, elements of quantum error-correction and quantum cryptography.

SUGGESTED READINGS:
M.L. Bellac, A Short Introduction to Quantum Information and Quantum Computing, Cambridge Univ. Press 2006.
M.A. Nielson and I.L. Chuang, Quantum Computation and Quantum Information, Cambridge Univ. Press 2002.
D. Bouwmeester, A. Ekert and A. Zeilinger (Eds.), The Physics of Quantum Information, Springer Verlag 2001.

Course Number: PHM957, Course Title: INFORMATION CENTRIC SYSTEMS DESIGN
Class: M.Phil. Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52
(University of Maryland, USA: CMSC 818Z)
UNIT 1
Introduction, information dynamics, outline of the system of information, role of time.
UNIT 2
Context aware computing, location determination technologies, time synchronization, pinpoint technology, cyclone technology, Context-Aware Computing Overview and Case Studies, Location Privacy in Vehicular Networks.
UNIT 3
802.16e Mobile WiMAX, Comparison of 3G and WiMAX, protocols, applications.
UNIT 4 & UNIT 5: INVITED TALKS
Special Topics through Guest Lectures: Spam, computational intelligence, parallel algorithms, electronic storage and distribution, semantic web ontologies, virtual worlds, peer-to-peer streaming systems, wireless sensor networks, data mining.

SUGGESTED READINGS:
Material available from web sites.

Course Number: PHM958, Course Title: OPERATING SYSTEMS
Class: M.Phil. Electronics/Computer Science
Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52
(UNIVERSITY OF MARYLAND, USA: CMSC 417)

UNIT 1
Introduction to Operating Systems, Process Management, Threads, Kernel implementation techniques, CPU scheduling.
UNIT 2
Process Synchronization, Deadlocks.
UNIT 3
Memory Management, File Systems.
UNIT 4
I/O Systems, Security and Protection, Networking and Distributed Systems.
UNIT 5
Linux, Windows Operating System, System Performance and Operational Analysis.

SUGGESTED READINGS:
Operating Systems, Silberschatz.

Course Number: PHM959, Course Title: COMPUTER NETWORKS
Class: M.Phil. Electronics/Computer Science
Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52
(UNIVERSITY OF MARYLAND, USA: CMSC 412)

UNIT 1
Basic principles of networking, protocols, implementations, issues specific to the Internet. protocol layering. Internet protocols and some application layer protocols such as http, ftp, and DNS, and a few peer-to-peer systems/protocols such as Gnutella and Chord. Limitations of the current Internet and its service model.
UNIT 2
Transport protocols, socket programming, basic methods for alleviating congestion, congestion control.
UNIT 3
Addressing, routing, transport, and internetworking protocols, Internet family of protocols.
UNIT 4
Network services programming component, basic medium access including wireless protocols.
UNIT 5
Design, implementation, testing of network protocols.

SUGGESTED READINGS:
Computer Networks: A Systems Approach by Larry Peterson and Bruce Davie, MorganKaufman, 4rd Edition, 2007.
TCP/IP Sockets in C: A Practical Guide for Programmers by Jeff Donahoo and KenCalvert, Morgan Kaufmann, 2000.
Computer Networking: A Top Down Approach Featuring the Internet by Jim Kurose and Keith Ross, Addison-Wesley, 2000.
An Engineering Approach to Computer Networking, by S. Keshav. Addison-Wesley,1997.
High-speed Networks: TCP/IP and ATM design principles by William Stallings,Prentice-Hall, 1998.
TCP/IP Illustrated volume 1 by W. Richard Stevens. Addison-Wesley.

Course Number: PHM960, Course Title: INTELLIGENT INFORMATION PROCESSING
Class: M.Phil. Electronics/Computer Science
Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52
(INDIAN INSTITUTE OF TECHNOLOGY, DELHI: SIV 875)

UNIT 1
Soft Computing: neural networks, fuzzy logic, evolutionary computation, applications of soft computing technologies, simulation software.
UNIT 2
Pattern recognition, Bayesian Techniques, Bayes Theorem, Bayes classifier, neural network implementations, supervised learning with expectation maximization.
UNIT 3
Data Mining, models, methodologies, and processes. The KDD process. Generic tasks. Broad themes (search, induction, querying, approximation, and compression). Application areas.
UNIT 4 & UNIT 5
Special Topics (Invited lectures): Intelligent Software Agents, Multi-objective Evolutionary Optimization, Applications (Networks), Applications (Imaging), Hybrid Soft Computing Systems

SUGGESTED READINGS:
Material available from web sites.

Course Number: PHM961, Course Title: MEDIA PROCESSING
Class: M.Phil. Electronics/Computer Science
Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52
(INDIAN INSTITUTE OF TECHNOLOGY, DELHI: SIV 864)

UNIT 1
Introduction to Multimedia and Data Compression: Digital representation of different media (Audio/Image/Video/Graphics), Tools and File formats for different media, Fundamentals of data compression: Compression ratio, Data redundancy, Lossy and Loss-less compression.
UNIT 2
Image and Video Compression: Variable length coding (Huffman coding), Run length coding, Predicitive coding, Transform coding, JPEG (Base Line). Motion JPEG, Temporal redundancy, Motion Compensation based prediction, Basics of video compresion in MPEG-1.
UNIT 3
Multimedia Communication: Real time media applications, An overview of multimedia communication and its protocols. Session Initiation Protocol (SIP).
UNIT 4
Multimedia Streaming: Streaming performance requirement, Real-time Transport Protocol (RTP), RTP-Control Protocol (RTCP),Real Time Streaming Protocol (RTSP).
UNIT 5
Special Topics through Guest Lectures in the related areas such as Speech processing, Mobile streaming, Video on Demand, etc.

SUGGESTED READINGS:
Material available from web sites.

Course Number: PHM962, Course Title: EXPERIMENTAL TECHNQ. & DATA ANAL.
Class: M.Phil. Status of the Course Number: MAJOR, Approved Since Session: 2011-2012
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52

UNIT 1 [10 pds]
Functional characteristics of instruments. Static characteristics: accuracy, precision, linearity, sensitivity. Dynamic characteristics, transfer functions of first and second order systems and their responses.
UNIT 2 [10 pds]
Block diagram reduction, frequency domain analysis, Bode Plot, effect of poles on stability, Nyquist stability, Routh-Hurwitz stability criterion.
UNIT 3 [10 pds]
Data interpretation and analysis; Precision and accuracy, error analysis, propagation of errors, least square fitting, linear and nonlinear curve fitting, Chi-square test.
UNIT 4 [10 pds]
Transducers(temperature, pressure/vacuum,, magnetic field, vibration, optical, and particle detectors), measurement and control; signal conditioning and recovery, impedance matching, amplification (op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding.
UNIT 5 [10 pds]
Gamma Spectroscopy Ultrafast phenomena: Femtosecond laser systems and dynamics, Nonlinear optical properties of organic molecules: nonlinear absorption and refraction, pump-probe spectroscopy, Magnetically tuneable microwave devices and their applications, Microwave Biosensors and Electromagnetic bandgap structures.

Course Number: PHM964, Course Title: QUANTUM SYSTEM MODELING
Class: M.Sc. Status of the Course Number: MAJOR, Approved Since Session: 2015-2016
Credits: 04, Periods (55 mts. each) per week: 4 (L:4+T:0+P/S:0), Min. Periods/Sem:52

UNIT 1
Circuit Theory as lumped abstraction, relation to Maxwell’s equations, lumped circuits and Kirchhoff’s laws, series and parallel connections, Circuit elements, Principles of Graph Theory: loop and cut set analysis, network laws. Applications of circuit and network theory to various systems, including socio-economic systems.
UNIT 2
Quantum Information – quantum bits, quantum states and dynamics, quantum entanglement and Bell states, qudits, quantum gates and quantum circuits, Shannon entropy and von Neumann entropy, information, communication channels, correlations between two systems, density matrices and mixed states.
UNIT 3
Quantum Hopfield Networks – definition and basic properties, simulation of quantum Hopfield networks, comparison with classical neural networks.
UNIT 4
Graph theoretic representations of qubits and qudits. Graph theoretic representation of Quantum teleportation – two particle and multi-particle,
UNIT 5
Conditions for Quantum Information Processing, Decoherence, Quantum error correction, Fault tolerant quantum computing and magic state distillation, Contextuality as a necessary resource for quantum computation.

Suggested Readings:
Sahni, Lakshminarayan and Srivastava, *Quantum Information Systems*
Desoer and Kuh, *Basic Circuit Theory*
Seshu and Reed*, Linear Graph Theory and Electrical Networks.*

Course Number: PHM965, Course Title: QUANTUM FIELD THEORY
Class: M.Sc./M.Phil., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS PHM917]
UNIT 1: PATH INTEGRAL FORMULATION AND FREE FIELD THEORY
Path Integral Formulation of Quantum Physics, Gaussian Integrals and Wick Contraction, Lattice and Continuum limit, Free scalar field theory, free scalar propagator, attractive and repulsive forces and quantum fields, anharmonic oscillator in path integral formulation, Feynman diagrams, Wick contraction and perturbative quantum field theory; canonical quantization, casimir effect, symmetries and Noether's theorem
UNIT 2: SPINORS
Dirac Equation, Lorentz Transformations of the Dirac Matrices, Majorona fermions; Quantizing dirac field and anti-commutation relations, Lorentz Group and WeylSpinors, Spin Statistics Theorem, Grassmann numbers, path integrals and Feynman rules for fermions.
UNIT 3: RENORMALIZATION AND GAUGE INVARIANCE
Electron scattering and gauge invariance, diagrammatic proof of gauge invariance, cutoff-regularization, renormalizable and non-renormalizable field theories; counterterms and physical perturbation theory; gauge invariance; non-relativistic field theory, magnetic moment of the electron, polarization of the vacuum and charge renormalization (qualitative)
UNIT 4: SYMMETRY AND SYMMETRY BREAKING
Symmetry and symmetry breaking, pion as a Nambu Goldstone Boson, Effective Potential, introduction to non-abelian gauge theory, higgs mechanism; chiral anomaly, magnetic monopoles.
UNIT 5: FIELD THEORY AND COLLECTIVE PHENOMENA
Superfluids, Euclidean path integrals and field theory at finite temperature, introduction to Landau Ginzberg theory of critical phenomena, superconductivity, peierls instability, solitons, vortices monopoles and instantons. Fractional statistics, ChernSimons terms and quantum hall fluids.

Suggested Readings:
Anthony Zee, *Quantum Field Theory in a Nutshell,* Princeton University Press.
Mark Srednicki, *Quantum Field Theory,* Cambridge University Press.

Course Number: PHM966, Course Title: STRING THEORY AND M-THEORY
Class: M.Sc.& M.Phil., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS PHM918]
Unit 1
Introduction and historical overview of string theory, String sigma-model action: the classical theory, Canonical quantization, light-cone gauge quantization
Unit 2
Conformal field theory, Representations of Conformal Group, BRST quantization, Background fields, Vertex operators, The structure of string perturbation theory, The linear-dilaton vacuum and noncritical strings,
Unit 3
Ramond-Neveu-Schwarz strings, Global world-sheet supersymmetry, Constraint equations and conformal invariance, Boundary conditions and mode expansions, Light-cone gauge quantization of the RNS string, SCFT and BRST, Strings with space-time supersymmetry, The D0-brane action, The supersymmetric string action, Quantization of the Green-Schwarz action, Gauge anomalies and their cancellation
Unit 4
The bosonic string and Dp-branes, D-branes in type II superstring theories, type I superstring theory, T-duality in the presence of background fields, World-volume actions for D-branes, The heterotic string, Nonabelian gauge symmetry in string, Fermionic construction of the heterotic, Toroidalcompactification, Bosonic construction of the heterotic string
Unit 5
Low-energy effective actions, S-duality, M-theory, M-theory dualities, String geometry, Orbifolds, CalabiYau manifolds: mathematical properties, Examples of CalabiYau manifolds, Calabi-Yaucompactifications of the heterotic string

Suggested Readings
K Becker, M Becker, J Schwarz, *String theory and M-Theory,* Cambridge University Press

Course Number: PHM967, Course Title: GENERAL RELATIVITY
Class: M.Sc./M.Phil., Status of the Course Number: MAJOR, Approved Since Session: 2015-16
Credits: 4, Total Periods (55 mts. each) per week: 4 (L:4 + T:0 + P:0) Min. Pds/Term: 52
[SAME AS PHM916]
UNIT 1: SPECIAL RELATIVITY AND TENSORS
Special Relativity, invariance of the interval, Lorentz transformations, invariant hyperbolae; vector algebra; four-velocity and four-momentum, scalar product, metric tensor, one-forms, (m,n) tensors, index raising and lowering; perfect fluids in special relativity.
UNIT 2: CURVATURE
Tensor algebra/calculus in polar coordinates, Christoffel symbols and the metric, noncoordinate bases, differentiable manifolds and tensors, Riemannian manifolds, covariant differentiation, parallel-transport, geodesics and curvature, curvature tensor, bianchi identities; Ricci and Einstein tensors.
UNIT 3: PHYSICS IN CURVED SPACE-TIME AND EINSTEIN FIELD EQUATIONS
Differential geometry and gravity, Physics in slightly curved spacetimes, physical derivations of Einstein field equations, Einstein's equations, Einstein's equations for weak gravitational fields, Newtonian gravitational fields.
UNIT 4: GRAVITATIONAL RADIATION AND STARS
Gravitational Waves, energy in Gravitational Waves, Coordinates for spherically symmetric spacetimes, static spherically symmetric spacetimes, static perfect fluid Einstein equations, exterior geometry, interior geometry, realistic stars and gravitational collapse
UNIT 5: BLACK HOLES
Trajectories in the Schwarzschild spacetime, nature of the event horizon, charged and rotating black holes (elementary description), Penrose Diagrams and causal structure, Penrose diagram for black holes in minkowski space; AdS space; Penrose diagram for AdS space and black holes in AdS space.

Reference:
Bernard Schutz, *A first course in general relativity,* Cambridge University Press.

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Course Number: PHM181, Course Title: APPLIED PHYSICS I
Class: B.Tech., Status of the Course Number: MAJOR, Approved Since Session: 2012-13
Credits: 3, Periods (55 mins. each) per week:3 (L:3+T:0+P:0), Min. Periods/Sem.:39
UNIT 1: WAVE MOTION
One dimensional waves, harmonic waves, phase and phase velocity, the superposition principle, the complex representation, phasors and the addition of waves, plane waves, the addition of waves of the same frequency, the addition of waves of different frequency. Acoustics: sound waves, intensity of sound waves, decibels and Weber-Fechner law; characteristics of a musical sound versus noise.
UNIT 2: ELECTROMAGNETIC THEORY, PHOTONS AND LIGHT
Basic laws of electromagnetic theory – Maxwell's equations, electromagnetic waves, energy and momentum in electromagnetic waves, the electromagnetic-photon spectrum, Rayleigh scattering, reflection, refraction, Fermat's principle, total internal reflection
UNIT 3: INTERFERENCE AND DIFFRACTION
Conditions for interference, wavefront-splitting interferometers, amplitude-splitting interferometers, types and localization of interference fringes, Fraunhofer diffraction, Fresnel diffraction.
UNIT 4: POLARIZATION:
The nature of polarized light, polarizers, dichroism, birefringence, scattering and polarization, polarization by reflection, retarders, circular polarizers, polarizations of polychromatic light, optical activity.
UNIT 5: LASER AND FIBER OPTICS
Radiant energy and matter in equilibrium, Stefan-Boltzman law, Wien displacement law, Planck's radiation law, the Einstein A and B coefficients, Ruby laser, Helium-neon laser, semiconductor laser, fiber optics, numerical aperture, types of fiber, fiber optic communication.
SUGGESTED READINGS:
Optics: by *Eugene Hecht*. Addison-Wesley, 2002

Course Number: PHM182, Course Title: APPLIED PHYSICS LAB
Class: B.Tech., Status of the Course Number: MAJOR, Approved Since Session: 2012-13
Credits: 1, Periods (55 mins. each) per week:2 (L:0+T:0+P:2), Min. Periods/Sem.:26
Based on Theory Course.

Course Number: PHM281, Course Title: APPLIED PHYSICS II
Class: B.Sc. Engg., Status of the Course Number: MAJOR, Approved Since Session: 2012-13
Credits: 3, Periods (55 mts. each) per week: 4 (L:3 + T:1+ P:0), Min. Periods/Sem.: 52

UNIT 1: SPECIAL THEORY OF RELATIVITY
Special relativity, time dilation, Doppler effect, length contraction, twin paradox, relativity momentum, mass and energy, energy and momentum, Lorentz transformations, velocity addition.
UNIT 2: PARTICLE AND WAVES
Electromagnetic waves, blackbody radiation, photoelectric effect, x-ray diffraction, compton effect, pair production, photons and gravity, de-Broglie waves, phase and group velocities, particle diffraction, uncertainty principle , applying the uncertainty principle.
UNIT 3: ATOMIC STRUCTURE
The nuclear atom, electron orbits, atomic spectra, the bohr atom, energy levels and spectra, correspondence principle, nuclear motion, atomic excitation,
UNIT 4: QUANTUM MECHANICS
Quantum mechanics, the wave equation, Schrödinger equation: time-dependent form, linearity and superposition, expectation values, operators, Schrödinger's equation: steady-state form, particle in a box, finite potential well, tunneling, harmonic oscillator.
UNIT 5: THE SOLID STATE
Statistical distributions, Maxwell-Boltzmann statistics, molecular energies in an ideal gas, quantum statistics, specific heats of solids, free electrons in a metal, electron-energy distribution, crystalline and amorphous solids, ionic crystals, covalent crystals, van der Waals bond,metallic bond, band theory of solids, semiconductor devices, energy bands, superconductivity.
Suggested Readings:
Arthur Beiser : Concepts of Modern Physics(sixth edition, 2003). McGraw-Hill

Course Number: PHM282, Course Title: APPLIED PHYSICS LAB
Class: B.Sc.Engg., Status of the Course Number: MAJOR, Approved Since Session: 2012-13
Credits: 1, Periods (55 mins. each) per week:3 (L:3 + T:1 + P:0), Min. Periods/Sem.:39
Based on Theory Course.

ADVANCED WORK EXPERIENCE COURSE

Course Number: PHW301, Course Title: COMPUTER PROGRAMMING IN 'C'
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 56

UNIT 1: Computer Programming fundamentals.
UNIT 2: Overview of C, variables, constants, etc.
UNIT 3: Program control, arrays, functions.
UNIT 4: Input-output.
UNIT 5: Pointers, structures, preprocessor commands.

Course Number: PHW401, Course Title: DATABASE MANAGEMENT SYSTEMS
Class: B.Sc., Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 56

UNIT 1
Introduction to DBMS, data processing, records and files, data collection, preparation and verification, editing and checking.
UNIT 2
File systems.
UNIT 3
Database systems, data independence, data administration, database architecture.
UNIT 4
Using FOXPRO.
UNIT 5
FOXPRO programming for DBMS.

Course Number: PHW501, Course Title: COMPUTER NETWORKS
Class: B.Sc. Honours, Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 56

UNIT 1
Basics of Computer Networks.
UNIT 2
Setting up a computer network: Hardware.
UNIT 3
Setting up a network: Software.
UNIT 4
Networking in Windows 95
UNIT 5
Networking with Novell Netware.

Course Number: PHW601, Course Title: INTERNET PROGRAMMING
Class: B.Sc. Honours, Status of the Course Number: WORK EXPERIENCE, Approved Since Session: 1998-1999
Credits: 2, Periods (55 mts. each) per week: 4 (L:0 + T:0 + P:4), Min. Periods/Sem.: 56

UNIT 1
The Windows NT system.
UNIT 2
Network security.
UNIT 3
INTERNET:e-mail, ftp, telnet, browsing, gopher, archie, veronica, etc.
UNIT 4
Introducing Java.
UNIT 5
Creating Java applets.

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