Academic Council: Date 26 / 04 / 2010, R. No.: (2)
Executive Council: Date 07 / 05 / 2010, R. No.: (3)

BHAVNAGAR UNIVERSITY

BHAVNAGAR

(NACC Accreditation Grade "B")

CREDIT AND SEMESTER SYSTEM SYLLABUS

MASTER OF SCIENCE (M.Sc.)

PHYSICS

(In Force From Academic Year: 2010-2011)

Bhavnagar University

Syllabus

for

M.Sc. Physics Degree

Effective from 2010-2011

Bhavnagar University
Gaurishankar Lake Road
Bhavnagar 364002

"Take charge of your life"

Philosophy and vision

"You" should learn by "your choice" what is "good for you".

Highlights

Each theory paper is divided in 5 units.

Each unit is of 10 - 12 hours duration.

Each Unit has a weightage of approximately of 20 marks in a paper of 100 marks

Each paper has a corresponding paper code
The papers having 'C' in the code are Core / compulsory and the papers with an 'E' in the code are Electives

Some papers are of Interdisciplinary nature and can be opted by students pursuing post graduate degree in other subjects, as per the rules of the choice based system

An elective / option will be offered based on the availability of faculty and other resources in the University

Admission criteria for selection, marking scheme and paper style are to be followed as per rules framed and effective from time to time

The distribution of continuous internal evaluation marks (30%) would be decided by respective teachers.

Semester -1

Laboratory [Phys-C101]

Credits: 9 - 200 Marks (Semester end exam 140 + continuous internal evaluation 60)

[Lab Teaching 9 hours/week]

Experiments related to Physics and Electronics as appropriate to theory taught at Graduate Level and Post Graduate Level. The Experiments should be selected and designed to enhance the basic understanding of the subject and to provide hands on training to prepare the students for Research, Industry and teaching careers.

A journal showing the record of the experiments carried out should be maintained by the students.

Semester -1

Classical Mechanics [Phys-C102]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I Lagrangian Formulation: Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity—dependent forces and the dissipation function, Applications of Lagrangian formulation. [Teaching Hours 15, Marks ~20]

II Hamilton's Principles: Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to non-holonomic systems advantages of variational principle formulation, symmetry properties of space and time and conservation theorems. [Teaching Hours 15, Marks ~20]

III Rigid Body Motion: Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top. [Teaching Hours 15, Marks ~20]

IV Small Oscillations: Eigenvalue equation, Free vibrations, Normal Coordinates, Vibrations of a tritomic molecule. Hamilton's Equations: - Legendre Transformation, Hamilton's equations of motion, Cyclic-co-ordinates, Hamilton's equations from variational principle, Principle of least action. [Teaching Hours 15, Marks ~20]

V Canonical Transformation and Hamilton-Jacobi Theory: Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton-Jacobi equations for principal and characteristic functions Action-angle variables for systems with one-degree of freedom [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems given at the end of each chapter in reference books.

Reference Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1. Classical Mechanics: H. Goldstein (Narosa)
2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi).
3. Mechanics: L.D. Landau and E.M. Lifshitz (Pergamon, Oxford).
4. Classical Mechanics: N.C. Rana and P.J. Joag (Tata McGraw Hill, New Delhi)

Semester -1

Mathematical Methods in Physics [Phys-C103]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I Curvilinear Coordinates**:** Orthogonal Curvilinear Coordinates, Gradient, Divergence and Curl, ∇^2 in spherical and cylindrical coordinates, Expression for angular momentum L and L^2 in spherical polar coordinates. Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, Beta function. [Teaching Hours 15, Marks ~20]

II Complex Variables**:** Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation. [Teaching Hours 15, Marks ~20]

III Differential Equations and Special Functions**:** Partial differential equations of theoretical physics, separation of variables, singular points, Second order liner One dimensional equations with variable coefficients, series solutions, Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. [Teaching Hours 15, Marks ~20]

IV Legendre functions: generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynomials. Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions [Teaching Hours 15, Marks ~20]

V Fourier Series and Integral Transforms: Fourier series, Dirichlet conditions, General properties, Advantages and applications. Fourier transforms, Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives; Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems given at the end of each section in Book 1.

Ref. Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed

1. Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, San Diego).
2. Mathematical Methods in the Physical Sciences – M.L. Boas (Wiley, New York).
3. Special Functions: E.D. Rainville (MacMillan, New York).
4. Advanced Engineering Mathematics, Erwin Kreyszig, (Wiley Eastern Limited)

Semester -1

Computer Programming [Phys-C104]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

Aim:

1 To train students in the discipline of Computer Programming. The choice of the programming language would depend on the availability of teacher as well as needs of the students.

2 To train students in the basics of numerical methods and applying these techniques using computers for solving Physics problems.

<u>Special Note for teachers:</u> The special features of the language being taught may be included at appropriate places in syllabus.

I Review of principles of programming, Problem solving techniques – Algorithms, Flowcharts, Programming logic, Sequential, Conditional and Repetitive flows, Program testing. [Teaching Hours 15, Marks ~20]

II Data types, Assignment and Arithmetic/Logical expressions, Hierarchy of operations. Various functions available in the programming language [Teaching Hours 15, Marks ~20]

III Conditional and Looping instructions [Teaching Hours 15, Marks ~20]

IV I/O Methods, Arrays and Array Operations, Repetitive operations and procedures [Teaching Hours 15, Marks ~20]

V Subprograms: Some Classic procedures e.g. Sorting, Searching, Pushdown Stacks, Linked Lists, Trees, data structures [Teaching Hours 15, Marks ~20]

Tutorials: Physics and Mathematics related problems, Simulation of some Physical systems (depending on the availability of Physical resources and Logistics.)

Reference Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed

As appropriate to the programming language taught.

Semester -1

Digital Electronics [Phys-C105]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I Binary and Hexadecimal Number Systems, Logic gates,Theorems of Boolean Algebra, Boolean functions, Algebraic manipulations and simplifications, Karnaugh's map specifications, Basic combinatorial circuits, Boolean function implementation using universal gates. [Teaching Hours 15, Marks ~20]

II Multiplexers and de-multiplexers: BCD-Decimal decoders, Seven Segment decoders, Encoders, Exclusive OR Gates, Parity Generators and Checkers, Magnitude Comparator [Teaching Hours 15, Marks ~20]

III Binary Arithmetic circuits for Addition and Subtraction, Parallel adder circuits, Adder-Subtracter combination Circuits. [Teaching Hours 15, Marks ~20]

IV RS, D, Flip-flops. Switch Debouncing, Edge and Level Triggering, Reset and Preset inputs, master slave JK Flip-Flops [Teaching Hours 15, Marks ~20]

V Shift-registers, left and right shift registers, Parallel-to-serial-to-parallel converters. Binary 4 bit, ripple and synchronous Counters, mod-n counters, Examples of 74 series counters. Logic Families [Teaching Hours 15, Marks ~20]

Tutorials: On design problems.

Reference Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1. Digital Principles and Applications – DP Leach, AP Malvino and G Saha, (TMH)
2. Fundamentals of Digital Circuits – A Anand Kumar, (PHI)
3. Digital Electronics-Principles & Practice - Kapoor & Maheshwari, (TMH)
4. Digital Electronics - (Tokheim)

Semester -2

Laboratory [Phys-C201]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

[Lab Teaching 9 hours/week]

Experiments related to Physics and Electronics as appropriate to theory taught at Graduate Level and Post Graduate Level. The Experiments should be selected and designed to enhance the basic understanding of the subject and to provide hands on training to prepare the students for Research, Industry and teaching careers.

A journal showing the record of the experiments carried out should be maintained by the students.

Semester -2

Quantum Mechanics [Phys-C202]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I Inadequacy of classical theory, De-Broglie hypothesis of matter waves, Heisenberg's uncertainty relation, Schroedinger's wave equation, physical interpretation and conditions on wave function, eigenvalues and eigenfunctions, particle in a square-well potential, potential barrier, linear operator, orthogonal systems and Hilbert space, expansion in eigenfunctions, hermitian operators , fundamental commutation rule, commutations and uncertainty principle. Dirac's bra and ket notation, commutators, postulates of quantum mechanics, uncertainty relation, harmonic oscillator in matrix mechanics, and operators, Heisenberg and Schröedinger representations. [Teaching Hours 15, Marks ~20]

II Angular momentum**:** Angular part of the Schrödinger equation for a spherically symmetric potential, orbital angular momentum operator, eigenvalues and eigenvectors of L^2 and L_z, spin angular momentum, general angular momentum, eigenvalues and eigenvectors of J^2 and J_z, representation of general angular momentum operator, addition of angular momenta, C.G. co-efficients. [Teaching Hours 15, Marks ~20]

III Stationary state approximate methods: Non-degenerate and degenerate perturbation theory and its applications, variational method with applications to the ground states of harmonic oscillator, hydrogen, helium atoms, etc. [Teaching Hours 15, Marks ~20]

IV Time dependent perturbation: General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, selection rules for emission and absorption of light. [Teaching Hours 15, Marks ~20]

V Scattering theory**:** Scattering cross-section and scattering amplitude, partial wave analysis, low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems given in the text and reference books.

Reference Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1. Quantum Mechanics: L.I. Schiff (Mcgraw –Hill International Editions)
2. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi).
3. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley).

Semester -2

Computational Physics [Phys-C203]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I Introduction to computational physics: Computer algorithms, solution of algebraic and transcendental equations, interpolations – cubic spline fitting, numerical differentiation - Lagrange interpolation, numerical integration by trapezoidal and Simpson rules, numerical solution of differential equations by Euler, predictor-corrector and Runge-Kutta methods, eigen-value problems. [Teaching Hours 15, Marks ~20]

II Oscillatory motion**:** Numerical and computer simulation of simple harmonic oscillator, damped oscillator motion, forced harmonic oscillator, chaotic dynamics, LCR Circuit. [Teaching Hours 15, Marks ~20]

III Scattering**:** Classical Scattering of particle by central potential, stationary solution of 1 D Schrodinger equation. [Teaching Hours 15, Marks ~20]

IV Trajectories**:** Coffee cooling problem, back ground, Euler algorithm, computer program, motion of falling objects. [Teaching Hours 15, Marks ~20]

V Computer simulations: Random number generators, Monte Carlo simulations for nuclear radioactivity, basics of molecular dynamics [Teaching Hours 15, Marks ~20]

Tutorials**:** Relevant problems given in the text and reference books.

Reference Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1. A First Course in Computational Physics - P.L. DeVries (Wiley).
2. Applied Numerical Methods for Digital Computation with FORTRAN and CSMP - M.L. James, G.M. Smith and J.C. Wolford (Harper).
3. An introduction to Computational Physics - Tao Pang (Cambridge University Press).
4. Computer Applications in Physics - S.Chandra (Narosa)
5. Computational Physics - R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age)
6. A Guide to Monte Carlo Simulations in Statistical Physics - D.P. Landau and K. Binder, (Cambridge University Press (2000)
7. Numerical Recipes - B.P.Flannery, S.A. Teukolsky and W.T. Vetterling, (Cambridge University Press (1986)

Semester -2

Electrodynamics & Plasma Physics [Phys-C204]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Electrodynamics: Poisson's and Laplace's equations for scalar potential, multipole expansion dipole and quadrapole fields, magnetostatics: basics macroscopic magnetostatics magnetization, M and H vectors boundary conditions on M & H, Farady law, energy in magnetic field, Poynting vector, Maxwell's displacement current. [Teaching Hours 15, Marks ~20]

II. Electromagnetic field tensor in four dimensions and Maxwell's equations, dual field tensor, wave equation for vector and scalar potential and solution, retarded potential and Lienard Wie'chert potential, electric and magnetic fields due to a uniformly moving charge and an accelerated charge, linear and circular acceleration and angular distribution of power radiated, Bremsstrahlung, synchrotron radiation and Cerenkov radiation, reaction force of radiation, electromagnetic mass of the electron, motion of charged particles in electromagnetic field, uniform E and B fields, non-uniform fields, diffusion across magnetic fields, time varying E and B fields, first, second, and third adiabatic invariants. [Teaching Hours 15, Marks ~20]

III. Plasma Physics - elementary concepts: plasma oscillations, Debye shielding, plasma parameters, magnetoplasma, plasma confinement (pinch effect, magnetic mirrors), formation of Van Allen belt, hydrodynamical description of plasma, fundamental equations. [Teaching Hours 15, Marks ~20]

IV. Hydromagnetic waves*:* Magnetosonic and Alfven waves, magnetoconvection and Sun spots, bipolar magnetic regions and magnetic buoyancy, magnetised winds (Solar wind), wave phenomena in magnetoplasma, polarisation, phase velocity, group velocity, cut-offs, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field. [Teaching Hours 15, Marks ~20]

V. Kinetic theory of plasma: Boltzmann-Vlasov equation, Fokker-Planck equation, transport equation, Landau damping, collision damping, wave amplification. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems given in the text and reference books.

Reference Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1. Plasma Physics and Controlled Fusion - F.F.Chen (Plenum Press, New York)
2. Classical Electrodynamics - J.D. Jackson(John Wiley & Sons, New York)
3. Introduction to Electrodynamics – D.J. Griffith (Prentice Hall))

Semester -2

Operational Amplifiers [Phys-C205]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I Introduction and basics, data sheet interpretation, ideal op-amp, equivalent circuit, ideal transfer curve, negative feedback, voltage series and shunt feedbacks, differential amplifier, input offset voltage, bias current, offset current, output offset voltage, thermal drift, effects of power supply variations, time effects. [Teaching Hours 15, Marks ~20]

II Frequency response of op-amps with internal and no compensations, open and closed loop responses, slew rate, applications of op-amps in DC and AC amplifiers, single supply operation, peaking amplifier, summing, scaling and averaging amplifiers, instrumentation amplifier, differential input and output amplifier, voltage-to-current and current-to-voltage converter and their applications, very high input impedance amplifiers, integrator and differentiators. [Teaching Hours 15, Marks ~20]

III Filters – first and second order low pass, high pass, band pass and band reject filters, all pass filter, oscillators – phase shift, Wein bridge and quadrature oscillators, square, triangle and sawtooth generators, voltage controlled oscillators. [Teaching Hours 15, Marks ~20]

IV Comparators – basic, zero crossing and Schmitt trigger comparators, characteristics and limitations, voltage limiters, high speed and precision comparators, window detectors, voltage-to-frequency and frequency-to-voltage Converters, analog-to-igital and digital-to-analog converters, clippers and clampers, absolute value output circuit, peak detector, sample and hold circuit. [Teaching Hours 15, Marks ~20]

V Study of IC 555 and its applications, phase-locked-loops and its applications, voltage regulators – fixed, variable and switching regulators. [Teaching Hours 15, Marks ~20]

Tutorials**:** Relevant problems given in the text and reference books.

Ref. Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1. Op-Amps and Linear Integrated Circuits- R.Gayakwad (Prentice Hall of India)
2. Operational Amplifiers - Design and Applications - Tobey, Graeme, Huelsman (Mc Graw Hill)

Semester -3

Laboratory [Phys-C301]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

[Lab Teaching 9 hours/week]

Experiments related to electives, general physics and electronics as appropriate to theory taught at Graduate Level and Post Graduate Level. The Experiments should be selected and designed to enhance the basic understanding of the subject and to provide hands on training to prepare the students for Research, Industry and teaching careers.

A journal showing the record of the experiments carried out should be maintained by the students.

Semester -3

Statistical Mechanics [Phys-C302]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. The Statistical basis of thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution. [Teaching Hours 15, Marks ~20]

II. Ensemble theory: Phase space and Liouville's Theorem, The microcanonical ensemble theory and its application to ideal gas of mono-atomic particles, the canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and Virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism, the grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations. [Teaching Hours 15, Marks ~20]

III. Ideal Bose systems: Basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field), liquid helium and superfluidity. [Teaching Hours 15, Marks ~20]

IV. Ideal Fermi systems: Basic Concepts and Thermodynamic behaviour of an ideal fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism, statistical equilibrium of white dwarf stars. [Teaching Hours 15, Marks ~20]

IV. Elements of phase transitions: Introduction, van der Waals equation and coexistence of phases, Landau theory of phase transition, a dynamical model for phase transition, one dimensional Ising model. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems given in the end of each chapter in the text book.

Ref. Books:

1. Statistical Mechanics: R.K. Pathria (Butterworth-Heinemann, Oxford).
2. Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi).
3. Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi).
4. Elementary Statistical Physics: C. Kittel (Wiley, New York).
5. Statistical Mechanics: S.K. Sinha (Tata McGraw Hill, New Delhi).
6. Statistical Mechanics: ESR Gopal

Semester -3

Condensed Matter and Materials Physics - I [Phys-C303]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Crystal Structure and X-ray diffraction: Interaction of X-rays with matter, absorption of X-rays, scattering cross section, elastic scattering from a perfect lattice, the reciprocal lattice and its applications to diffraction techniques, the Laue, powder and rotating crystal methods, crystal structure factor and intensity of diffraction maxima, extinctions due to lattice centering. [Teaching Hours 15, Marks ~20]

II. Elastic constants, lattice dynamics and thermal properties: Resume of binding in solids, stress components, stiffness constant, elastic constants, elastic waves in crystals, lattice vibrations, normal modes, density of states, thermodynamic properties of crystal, anharmonic effects, thermal expansion, phonon quantization, scattering of X-rays (Phonons), neutrons and light by phonons. [Teaching Hours 15, Marks ~20]

III. Energy band theory: Review of electrons in a periodic potential, nearly free electron model, Bloch theorem, band theory, Brillouin zones, Fermi surface, tight binding method, electronic specific heat, thermionic emission. [Teaching Hours 15, Marks ~20]

IV. Transport theory: Electronic transport from classical kinetic theory, introduction to Boltzmann transport equation, calculation of relaxation time in metals; thermal conductivity of metals and insulators, thermoelectric effects, Hall effect and magnetoresistance, transport in semiconductors. [Teaching Hours 15, Marks ~20]

V. Dielectric properties of materials: Polarization mechanisms, dielectric function from oscillator strength, Clausius-Mosotti relation, piezo, pyro- and ferro-electricity. Superconductors, Meissner effect, critical field BCS pairing mechanism, theory of superconductivity, tunneling and Josephson effect, high temperature superconductivity [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems given in the end of each chapter in the text book.

Reference Books:

1 Solid State Physics: C. Kittel
2 Solid State Physics: Aschroff and Mermin
3 Elementary Solid State Physics: MA Omar
4 Solid State Physics: AJ Dekker
5 Solid State Physics: Levey

Semester -3

Microcontroller-hardware,software and Embedded System Basics

[Phys-E301]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Architecture of 8051 microcontroller – Blocks of generic 8051 microcontroller, Registers, Data Memory, Multiplexed Port System, Internal and External Memory use, Interrupt and interrupt flags, Assembly language for 8051 – Levels of Programming languages, Assembler directives, Assembly language command formats, Execution of Assembly language programs. [Teaching Hours 15, Marks ~20]

II. Data move instructions, Addressing methods in 8051, Arithmetical instructions and operations (Add, Subtract, unsigned multiply and divide, increment and decrement), Branching and Looping instructions (short, absolute and long jumps, conditional jumps), Logical Instructions and operations – Logical AND, OR, XOR instructions, Programming with Loops, Rotate instructions, Subroutines, Clear, Complement and Swap instructions, Practical Programming examples. [Teaching Hours 15, Marks ~20]

III. Interrupt System – Interrupt and its applications, 8051 Interrupt system, Setting Interrupt jump table, Enabling and Disabling interrupts, Internal Interrupts, External Interrupts, Interrupt handling. [Teaching Hours 15, Marks ~20]

IV. Counter / Timer Subsystems of 8051 – Counter / Timer Modes of Operations, Counter / Timer Interrupts, Counter for external events, PWM with timer, DC motor control with PWM. Serial data communication – RS232 standard, UART control registers, Communication modes, Null Modem. [Teaching Hours 15, Marks ~20]

V. Ports and the Memory – Data transfer from/to microcontroller, 8051 ports, Simple I/O devices, LCD displays, 8255 interfacing, External RAM and ROM, 8255 with ADC.
Concepts of Embedded System – Multitasking, Real time Operating Systems, Task Scheduling,Tasks in RTOS, Data and Resource Protection, Synchronization.
Microcontroller project building concepts – I/O functions, Temperature Monitor Example, Typical Projects. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems from Text books and real life system examples.

Ref. Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1. 8051 Microcontroller and Embedded Systems – Dr Rajiv Kapadia, Jaico Publishing House.
2. The 8051 Microcontroller, Architecture, Programming and Applications – KJ Ayala, Penram International.
3. The 8051 and Embedded Systems using Assembly & C – MA Mazidi, JG Mazidi and RD McKalay,

Semester -3

Instrumentation and Optical Fiber [Phys-E302]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Basic concepts of measurements, transducer classification, performance characteristics displacement transducers – variable resistance, variable inductance transducers – LVDT, angular displacement, variable reluctance – induction potentiometer, synchros and resolvers, variable capacitance transducer, Hall effect proximity device, digital transducers, level measurements. [Teaching Hours 15, Marks ~20]

II. Strain measurement – basic concepts, types of strain gauges, theory of resistance strain gauge, electrical strain gauges – wire, unbonded foil, semiconductor thin film gauges, material for strain gauge, gauging techniques, circuits, temperature compensation, applications. [Teaching Hours 15, Marks ~20]

III. Pressure measurement – diaphragms, other elastic elements, transduction methods – potentiometric, strain gauge, variable reluctance, LVDT and variable capacitance sensors, solid sate devices, thin film transducers, digital transducer, piezoelectric transducer, vibrating element sensor, pressure multiplexer, pressure calibration. [Teaching Hours 15, Marks ~20]

IV. Temperature measurement – scales, mechanical sensors – liquid in glass, vapour pressure thermometer, resistance sensors, platinum resistance thermometer, thermistor, thermocouple, solid state, quartz sensors, radiation sensors – optical pyrometer, thermometer calibration. [Teaching Hours 15, Marks ~20]

V. Optical fibers - typical communication system, principles of light transmission in a fibre, losses in fibres, dispersion, light sources for fibre optics, photodetectors, connectors and splices fibre optic communication link. [Teaching Hours 15, Marks ~20]

TUTORIALS: Relevant problems from Text books and real life examples.

Ref. Books: The books indicated below are suggestive of the level of coverage. However, any other book may be followed.

1 Instrumentation Systems by: Rangan, Sarma & Mani - TMH
2 Communication Systems – Roody & Collen

Semester -3

Physics of Nanomaterials [Phys-E303]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Introduction**:** Importance and emergence of nanotechnology, challenges, current and future research, characteristic scale for quantum phenomena, nanoparticles, nano-clusters nano clusters, clusters of rare gases, clusters of alkali metals , nanoscale architecture, fundamental structure, chemistry, size dependent property relationships in nanomaterials and nanomaterial systems, characteristic scale for quantum phenomena, nanoparticles. laws of thermodynamics applied to nanoscale systems. [Teaching Hours 15, Marks ~20]

II. Electronic structure: Review of quantum mechanics in context of nanostructures, electron confinement, density of states, quantum wells quantum dots, quantum wires ,size effects in metal or semiconductor nanoparticles, conduction electrons and dimensionality, surface to volume ratio, coulomb blockade in quantum dot, transport properties: quantization of conductance, Hall, quantum Hall, fractional quantum Hall effects, spintronic: spin injection, spin valve effect, spin valves and MRAM devices, vibrational and thermal properties, phonons, quantization of phonon modes, heat capacity and thermal transport. [Teaching Hours 15, Marks ~20]

III. Propeties and applications of nanomaterials: Introduction, mechanical, structural, melting, electrical, optical and magnetic properties dependent on density of states, semiconductor quantum dots, metal nanoclusters, nanostructured multilayers, nanocomposite, applications of nanomaterials , processing of nanoparticles - binding mechanisms in nanoparticles, dispersion of nanoparticles, stabilization of nanoparticles [Teaching Hours 15, Marks ~20]

IV Carbon nanostructures: Carbon nanotubes: structure, single and multi walled carbon nanotubes, symmetry of single walled carbon nanotubes, symmetry based quantum numbers, phonon symmetries in CNTs. synthesis and purification of carbon nanotubes, structure-property relationships, physical properties, chemistry & biology of nanotubes, filled & heterogeneous nanotubes, nature of carbon bond, new carbon structure, discovery of C_{60}, C_{80} and C_{240} nanostructures, alkali doped C_{60}, superconductivity in C_{60}, Fullerene structure and bonding, other buckyballs, electronic, transport, optical, thermal, vibration and mechanical properties of nanotubes, application of nanomaterials. [Teaching Hours 15, Marks ~20]

V Bio-nano materials: Biomimetic processing, powder formation, particle growth in liposomes, other synthesis routes to powders, bacterial fermentation, in-situ mineralization of polymers, controller mineralization, utilization of DNA as construction material in nanotechnology, medical applications, health hazards of nanopartciles. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

Reference Books:

1. Introduction to Nanotechnology: CP Poole and FJ Owens
2. Quantum Dots: I Jacak, P Hawrylak and A Wojs,
3. Handbook of Nanostructured Materials and Nanotechnology HS Nalva ed., Vol.1-5,

Semester -3

Preparation Techniques and Characterization of Nanomaterials [Phys-E304]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Fabrication of nanomaterials by physical methods: Inert gas condensation, arc discharge, RF-plasma, plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, ball milling, molecular beam epitaxy, chemical vapour deposition method and electro deposition. [Teaching Hours 15, Marks ~20]

II. Chemical routes for synthesis of nanomaterials: Chemical precipitation and co-precipitation, metal nanocrystals by reduction, sol-gel synthesis, microemulsions or reverse micelles, myle formation, solvothermal synthesis, thermolysis routes, microwave heating synthesis; sonochemical synthesis, electrochemical synthesis, photochemical synthesis, synthesis in supercritical fluids. [Teaching Hours 15, Marks ~20]

III. Biological methods of synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, magnetotactic bacteria for natural synthesis of magnetic nanoparticles, mechanism of formation; viruses as components for the formation of nanostructured materials, synthesis process and application, role of plants in nanoparticle synthesis, lithographic techniques: AFM based nanolithography and nanomanipulation, E-beam lithography. [Teaching Hours 15, Marks ~20]

IV. Scanning electron microscopy (SEM), scanning probe microscopy (SPM), TEM and EDAX, analysis, X-ray diffraction, STM, VSM, SQUID [Teaching Hours 15, Marks ~20]

V . Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR spectrophotometers, principle of operation and application for band gap measurement, AFM, DSC, TGA [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

References:

1. Fabrication of fine pitch gratings by holography, electron beam lithography and nano-imprint lithography, (Proceedings Paper) Author(s): Darren Goodchild; Alexei Bogdanov; Simon Wingar; Bill Benyon; Nak Kim;Frank Shepherd
2. Microfabrication and Nanomanufacturing- Mark James Jackson
3. A Three Beam Approach to TEM Preparation Using In-situ Low Voltage Argon Ion Final Milling in a FIBSEM Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831 Cambridge University Press.
4. Processing & properties of structural naonmaterials - Leon L. Shaw (editor)

Semester -3

Basic Astronomy and Instrumentation [Phys-E305]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

Introductory Astrophysics

I. The meaning and scope of astronomy and astrophysics, Types of objects in the sky, Celestial coordinates. [Teaching Hours 15, Marks ~20]

II. Systems of flux measurements, stellar magnitudes, colours, Interstellar absorption and Reddening, Hertzsprung Russell diagrams. [Teaching Hours 15, Marks ~20]

III. Stellar distances, radii, masses, luminosities, Stellar populations, Introductory spectroscopy, Binary stars, Astronomical statistics. [Teaching Hours 15, Marks ~20]

Instruments and techniques

IV. Optical telescopes – reflecting and refracting models, Radio telescopes, Telescopes for high energy radiations, Detectors – photographic, photometric and high energy, Charge Coupled Devices. [Teaching Hours 15, Marks ~20]

V. Spectrographs, Counting statistics, Image processing, Interferometers, Polarimetry. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

References: Other relevant books may also be added

1. Astrophysics Stars and Galaxies, K D Abhyankar
2. The Origin of the Solar System, Thornton Page
3. A Textbook in Planetary Science Schaefer
4. The Origins of the Solar System Dermott – Wiley
5. Astronomical Instrumentation
6. Introduction to Astronomical Photometry, Edwin Budding and Osman Denircan, Cambridge
7. Practical Statistics for Astronomer, J. V. Wall and C. R. Jenkins

Semester -3

Sun, Solar System, Stellar Structure and Evolution [Phys-E306]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

The Sun

I. The Sun as a star, Solar Observations, Solar interior, photosphere, chromosphere, corona, Solar oscillations, Solar activity, Flares. [Teaching Hours 15, Marks ~20]

The Solar System

II. Meteorites, Asteroids, Comets, Planets, Satellites and Rings. [Teaching Hours 15, Marks ~20]

III. Celestial mechanics, Tides, Origin of the Solar system. [Teaching Hours 15, Marks ~20]

Stellar structure and evolution

IV. Stellar structure, Simple stellar models, Radiative and non – radiative energy transport, Stellar atmosphere. [Teaching Hours 15, Marks ~20]

V. Nuclear energy generation, Stellar evolution and nucleosynthesis. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

References: Other relevant books may be added

1. Origins of life - Planetary Astronomy, Lynn Morgulis, Springer – Verlag
2. Observational Astrophysics, Robert C. Smith, Cambridge
3. The Origins of the Solar System Dermott – Wiley
4. The Origin of the Solar System, Thornton Page
5. Celestial Mechanics,
6. Astrophysics Stars and Galaxies, K D Abhyankar
7. A Textbook in Planetary Science, Schaefer

Semester -4

Laboratory [Phys-C401]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

[Lab Teaching 9 hours/week]

Experiments related to electives, general physics and electronics as appropriate to theory taught at Graduate Level and Post Graduate Level . The Experiments should be selected and designed to enhance the basic understanding of the subject and to provide hands on training to prepare the students for Research, Industry and teaching careers.

A journal showing the record of the experiments carried out should be maintained by the students.

Semester -4

Sub Atomic Physics [Phys-C402]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Basic ideas about nucleus: Nuclear masses, radius, magntic moments, measurement of masses, charges and moments, binding energy. Classification of particles: Fermions and Bosons, leptons and hadrons, measons and baryons, exicted state and resonance. [Teaching Hours 15, Marks ~20]

II. Two nuclear problems at low energies**:** Deuteron low energy np and pp scattering, spin dependence of nuclear forces, noncentral forces, charge independence and isospin, meason and Yukawa theory of nuclear forces. [Teaching Hours 15, Marks ~20]

III. Nuclear Energy**:** Introduction, nuclear fission, spontaneous fission and potential barrier, emission of neutron in fission, selfsustaining chain reaction: nuclear reactor, neutron balance in reactor, uncontrolled chain reaction bomb, nuclear fusion, controlled fusion. [Teaching Hours 15, Marks ~20]

IV. Elementary particle physics**:** Baryon spectrum, meson spectrum, conservation of isospin, strangeness, charm, baryon numbers, quarks. hadron spectroscopy, necessity of color, mesons as quarkantiquark pairs, elementary ideas of QCD, quark and gluon jets, elementary ideas about electroweak theory. [Teaching Hours 15, Marks ~20]

V. Nuclear measurement techniques: Radioactive decay: Alpha decay, Beta decay, Gamma decay, nuclear reactions, nuclear models, detectors: GM counters, scintillation, semiconductor detectors, BF3 counter, accelerators: Van de Graaff accelerator, tandem principle, linear accelerators, cyclotron phase stability principle, synchrotron. [Teaching Hours 15, Marks ~20]

Tutorials: Problems of specific applications.

1. Introduction to Nuclear Physics: Somaiyajulu
2. Nuclear Physics: Kaplan
3. Nuclei and Particles: C Segre
4. Introduction to Nuclear Physics: H Enge
5. Concepts of Particle Physics: Gottfried and Weisskoff
6. Nuclear Detectors and Measurement: GK Knoll

Semester -4

Condensed Matter and Materials Physics - II [Phys-C403]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Magnetism and magnetic resonance: Classification of materials, magnetism in metals, ferromagnetism in insulator, Heisenberg model, mean field theory, Weiss theory of ferromagnetism, spin waves and magnons, Curie-Weiss law for susceptibility, ferri- and antiferro-magnetic order, ferro and anti-ferro electric effect, domains and Bloch-well energy. ESR, NMR, FMR, Mossbaur Spectroscopy. [Teaching Hours 15, Marks ~20]

II. Experimental and computational aided techniques: Introduction to light scattering vibrational (IR, Brillouin and Raman) spectroscopic techniques, electron microscopy, scanning probe and force microscopy, thermal charaterization (DSC, TGA etc.), basics of molecular dynamics simulation. [Teaching Hours 15, Marks ~20]

III. Disordered solids: Resume of point defects and dislocations, non-crystalline solids, diffraction pattern, glasses, amorphous semiconductors and ferromagnets, heat capacity and thermal conductivity of amorphous solids, brief introduction to nanostructures. [Teaching Hours 15, Marks ~20]

IV. Soft condensed matter-I: Polymers- terminology and nomenclature, polymerisation mechanisms, molar masses and distributions, chain-dimensions and structures, mechanical properties of polymers: energy-elasticity, entropy-elasticity, visco-elastic behaviour, the glass transition, general phenomenon and theoretical models, experimental determination.

Soft condensed matter-II: Fluids - examples of fluid flows, fluids as continua, Navier-Stokes equations, conservation of mass. [Teaching Hours 15, Marks ~20]

V. Some exact solutions of the Navier-Stokes equations: Poiseuille flow in a pipe, flow down an inclined plane, very viscous flows, lubrication theory, viscous penetration depth, basics of magnetic fluids and ferrohydrodynamics. [Teaching Hours 15, Marks ~20]

Turorials: Relevant problems

Reference Books:

1. Solid State Physics: C Kittel
2. Solid State Physics: Aschroff and Mermin

Semester -4

Embedded Programming in C [Phys-E401]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Introduction and Basics, Revision of 8051 hardware, introduction to compiler, simulation softwares (e.g. Keil, SDCC etc), Basic programming in C – special features for microcomputers, Switch interfacing, Introduction to object oriented programming in C for structured programming. [Teaching Hours 15, Marks ~20]

II. Real time constraints – hardware delays and applications, design of a simple OS for embedded systems, development of eOS as example. [Teaching Hours 15, Marks ~20]

III. Multi-state systems and function sequences, implementation of multi-state systems, traffic light and animatronic examples, development of washing machine controller. [Teaching Hours 15, Marks ~20]

IV. Serial communication – RS232 concepts, on-chip UART, interfacing with PC, application in data acquisition systems and remote control robot. [Teaching Hours 15, Marks ~20]

V. Case studies: one or more suitable case studies may be taken up to implement the key concepts. [Teaching Hours 15, Marks ~20]

Tutorials: Real life examples and programs as appropriate.

Ref. Books:

1. Embedded C, by Michael J. Pont, Pearson Education,
2. Patterns for Time Triggered Embedded Systems: building reliable applications with the 8051 family of microcontroller – by Michael J. Pont, ACM Press, New York
3. Embedded Operating Systems – by Michael J Pont, Addison Wesley

Semester -4

Communication Systems [Phys-E402]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Waveform Spectra: Sinusoidal and general periodic waveforms, trigonometric Fourier series for a periodic waveform, Fourier coefficients, Spectrum for trigonometric Fourier series, rectangular and saw tooth waves, pulse train, general properties of periodic waveforms, exponential Fourier Series, approximate formula for the Fourier coefficients, energy signals and Fourier transforms, fast Fourier transform, inverse fast Fourier transform, filtering of signals, power signals, bandwidth requirements for analog information signals. [Teaching Hours 15, Marks ~20]

II. Noise: thermal, shot, partition, flicker, burst, avalanche, bipolar junction transistor and field effect transistor noises, equivalent input noise generators, signal to noise ratio, SNR of tandem connection, noise factor, amplifier input noise, noise factors of amplifiers in cascade, noise factor and equivalent input noise generators, noise factor of a lossy network, noise temperature, measurement of noise temperature and noise factor, narrow-band band-pass noise. [Teaching Hours 15, Marks ~20]

III. Amplitude Modulation: AM, AM index, modulation index for sinusoidal AM, frequency spectrum of sinusoidal AM, average power of sinusoidal AM, effective voltage and current for sinusoidal AM, non-sinusoidal modulation, double sideband suppressed carrier modulation, amplitude modulation circuits, amplitude demodulation circuits, AM transmitters, AM receivers, noise in AM systems.
Single sideband modulation: balanced modulators, SSB generation, SSB reception, modified SSB systems, SNR for SSB systems, Companded SSB. [Teaching Hours 15, Marks ~20]

IV. Angle Modulation: frequency modulation, sinusoidal FM, frequency spectrum for sinusoidal FM, average power in sinusoidal FM, non-sinusoidal modulation: deviation ratio, measurement of modulation index for sinusoidal FM, Phase modulation, equivalence between FM and PM, sinusoidal PM, digital PM, angle modulation circuits, FM transmitters, angle modulation detectors, automatic frequency control, amplitude limiters, noise in FM systems, pre-emphasis and de-emphasis, FM broadcast receivers, FM stereo receivers. [Teaching Hours 15, Marks ~20]

V. Pulse modulation: Pulse amplitude modulation, pulse code modulation, pulse frequency modulation, pulse time modulation, pulse position modulation, pulse width modulation. Digital Communication: Synchronization, asynchronous transmission, probability of bit error in base-band transmission, matched and optimum terminal filters, bit timing recovery, eye diagrams, digital carrier systems, carrier recovery circuits, differential phase shift keying, hard and soft decision decoders, error control coding. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

Reference Books:

1 Electronics Communication By Dennis Roddy & John Coolen, PHI
2 Communication System by B. P. Lathi

Semester -4

Nanodevices, Nanosensors and Computational Nanoscience [Phys-E403]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Quantum and classical regimes of electron transport, mesoscopic transport. Diffusive transport: Boltzman transport equation, electron mobility and diffusion coefficient, Drift-diffusion model. Quantum electron transport; Double barrierResonant-Tunneling structures: Coherent tunneling and sequential tunneling, Negative differential resistance, single electron tunneling, Coulomb blockade. [Teaching Hours 15, Marks ~20]

II. Introduction to MEMs / NEMs, Electronic Transport in Nanostructures, Semiconductor devices to Single electron Transistors. [Teaching Hours 15, Marks ~20]

III. Nanosensors: Temperature Sensors, Smoke Sensors, Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry Biosensors. Nanostructure based Photovoltaic Cells. [Teaching Hours 15, Marks ~20]

IV. Introduction to Matlab and Mathematica (and their open source counterparts-Scilab and Octave); examples from nano-optics and nano-electronics. [Teaching Hours 15, Marks ~20]

V. Monte Carlo Simulations; Computational methods and Simulations from ab initio to multiscale, Modeling. Molecular dynamics, computing and simulations. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

References:

1 Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by H. Meixner.
2 Between Technology & Science: Exploring an emerging field knowledge flows & networking on the nanoscale by Martin S. Meyer.
3 Nanoscience & Technology: Novel structure and phenomea by Ping Sheng (Editor)
4 Nano Engineering in Science & Technology: An introduction to the world of nano design by Michael Rieth.
5 Enabling Technology for MEMS and nano devices -Balles, Brand, Fedder, Hierold.
6 Optimal Synthesis Methods for MEMS- G. K. Ananthasuresh
7 MEMS & MOEMS Technology and Applications- P. Rai Choudhury
8 Processing Technologies- Gandhi
9 From Atom to Transistor- Supriyo Datta
10 Introduction to Computer simulation methods. Gould, Tobochnik et al (Addition weekly-2006)

Semester -4

Nanofluidics, Microfluidics and Optofluidics [Phys-E404]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

I. Fluid mechanics in microsystems, Lab-on- a chip technology, fluids in mecahanical equilibrium, basic flow equations, flow simulations, materials and methods for fabrication of microfluidic systems, surface tension, viscosity, diffusion, dimensionless parametrs like Reynolds and Weber numbers, flow characterisation, valves, mechanical and electrokinetical pumps, microfilters, mixing, chemical microreaktors, dispensing, separation, detection, applications within chemistry, biochemistry, biotechnology, biology and medicine, acoustics on chip. [Teaching Hours 15, Marks ~20]

II. Optofluidics: Introduction, fluids-optical advantages, liquid-liquid interfaces, liquid-liquid optical devices, optically driven macrofluidcs, optofluidic transport, optofluidics transport within solid and liquid cone waveguiding devices, optofludic transport in PDMS microfluidics using SU—s waveguide, theory of optofluidic transport. [Teaching Hours 15, Marks ~20]

III. Nanofluidics and surfaces: liquid structure near solid-liquid interfaces, simple liquids, layering electrolytes: Poisson-Boltzmann equation; Debye Hückel approximation, Hydrodynamic boundary condition: slip vs. non-slip, electro kinetic effects - electrophoresis, electro osmotic effect, electro viscous effect, surface reconstruction, dangling bonds and surface states. [Teaching Hours 15, Marks ~20]

IV. Magnetic fluids: Brief review of magnetism, Introduction to ferromagnetic substances, Magnetic fluids, Magnetic force and torque on dipolar matter, interaction energy of two dipoles, generalized Bernoulli equation, stability requirements of magnetic fluids, synthesis of magnetic fluid, magnetization of magnetic fluid, magnetic relaxation in magnetic fluids, equation of motion for magnetic fluid, ferrohydrodynamic Bernouli relationship, magetocaloric energy conversion (brief), various applications of magnetic fluids. [Teaching Hours 15, Marks ~20]

V. Basic understanding of electro-rheological Fluids and magneto-rheological suspensions. synthesis of electro-rheological (ER) fluids and magneto-rheological (MR) suspensions, structures of ER and MR fluids, field induced behavior in uniaxial and biaxial field. rheology and electric properties of ER fluid, rheology and magnetic properties of MR fluid, comparison of these properties based on different materials, mechanical properties of ER fluids, light scattering study of ER and MR fluids, temperature effect on the ER and MR fluids. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

References

1 Theoretical Microfluidics, Henrik Bruss, Oxford Publication, 2008.

2 Optofludics: Fundamentals, Devices and Applications, Y. Fainman, L.P. Lee, D. Pseits, C. Yang, MCGRAW HILL

Semester -4

Special Stellar Objects, Radiation Mechanisms, Galactic Structure and Interstellar Matter [Phys-E405]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

Special Stellar Objects

I. Supernovae, degenerate stars, compact stellar and relativistic objects, pulsars, close binary systems, millisecond pulsars. [Teaching Hours 15, Marks ~20]

Radiation Mechanisms

II. Radiative flux, specific intensity and its moments, black body radiation, radiative transfer equation, optical depth, scattering effects, random walk. [Teaching Hours 15, Marks ~20]

III. Einstein coefficient, radiative diffusion, bremsstrahlung, synchrotron radiation, inverse compton scattering, plasma effects. [Teaching Hours 15, Marks ~20]

Galactic Structures and Interstellar Matter

IV. Our Galaxy: the milky way, shape and size of the milky way, stellar, populations, differential rotation of the galaxy, spiral structures [Teaching Hours 15, Marks ~20]

V. Physical processes in the interstellar medium, interstellar dust, gaseous nebulae, HII regions, star formation, diffuse supernovae remnants [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

References: Other relevant books may be added

1 Cosmology, Michael Rowan – Robinson
2 Galaxies and Cosmology, Paul W. Hodge
3 High Energy Astrophysics, L. Gratton, Acedemic Press
4 Steller instability and evolution, P. Ledoux, A.Noels
5 Cataclysmic Variable Stars – How and Why They Vary, Coel Hellier, Springers
6 The Anthropic Cosmological Principle, Hohn D. Barrow & Frank J. Tipler
7 Theoretical Foundations of Cosmology, Michael Heller, World Scientific

Semester -4

General relativity and relativistic astrophysics, Extragalactic Astronomy and Cosmology, Space Astronomies

[Phys-E406]

Credits: 4 - 100 Marks (Semester end exam 70 + continuous internal evaluation 30)

Note: Any Five (5) Units from the following are to be covered based on the availability of faculty and inclination of students.

General relativity and relativistic astrophysics

I. Elementary tensor analysis and differential geometry, physical concepts behind the general theory of relativity, energy – momentum tensors, Einstein's equations of gravitation. [Teaching Hours 15, Marks ~20]

II. Schwarzschild solution, geodesics of the Schwarzschild metric, relativistic stellar structure, neutron stars, black hole physics, energy processes involving black holes. [Teaching Hours 15, Marks ~20]

Extragalactic Astronomy and Cosmology

III. General characteristics of galaxies and clusters of galaxies, galaxy classification, ellipticals and spirals, galactic morphology, surface brightness, masses, stellar content. [Teaching Hours 15, Marks ~20]

IV. Galaxy rotation curves, mass distribution, dark matter, clusters of galaxies, cooling flows, formation of galaxies, clusters of galaxies and large scale structures. [Teaching Hours 15, Marks ~20]

V. Active Galaxies, radio galaxies, quasars, Robertson – Walker line element, cosmological red shifts, Friedmann models, steady state cosmology [Teaching Hours 15, Marks ~20]

VI. Physical cosmology including primordial nucleosynthesis, cosmic microwave background radiation. [Teaching Hours 15, Marks ~20]

Space Astronomies

VII. The need for space borne instruments, Introductory X – ray astronomy, X – ray binaries, X – ray emission from quasars and clusters of galaxies, X – ray background. [Teaching Hours 15, Marks ~20]

VIII. Infra – red astronomy, UV, g – ray and other astronomies, The Hubble space telescope and other space missions. [Teaching Hours 15, Marks ~20]

Tutorials: Relevant problems

References: Other relevant books may be added

1. Gravitation Theory and Gravitational Collapse, B. Kent Harrision, Kip S. Thorne, Masami Wakabo, John Archibald Wheeler, The University of Chicago Press
2. Introduction to General Relativity, Ronald Adler, Maurice Bazin, Menaher Schiffer, McGraw–Hill Book Company
3. An introduction to the theory of relativity, W.G.V. Rosser, London Butterworths
4. Basic Relativity, Richard A. Mould, Springer – Verlog
5. Observational Astrophysics, Robert C. Smith, Cambridge
6. Theoretical Foundations of Cosmology, Michael Heller
7. High Energy Astrophysics, L. Gratton, Acedemic Press
8. Astrophysics Stars and Galaxies, K D Abhyankar
9. Infrared Astronomy, A. Manepaso, M. Prieto
10. Cosmology, Michael Rowan – Robinson