

FACULTY OF SCIENCES

SYLLABUS

FOR

B.Sc. (Hons.) PHYSICS

PART-III

(Semester: V, VI)

Session: 2018–2019



MATA GUJRI COLLEGE

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B.Sc. (Hons.) PHYSICS
PART-III
SEMESTER V

SEMESTER V						
COURSE CODE	COURSE OPTED	COURSE NAME	Credits	Maximum Marks (Pass Marks 40%)	External Examination	Internal Assessment
BPH 501	Core course-XI	Mathematical Physics-II	4	100	75	25
BPH 501P	Course-XI Practical/Tutorial	Mathematical Physics-II Lab	2	50	50	--
BPH 502	Core course-XII	Digital Systems & Applications	4	100	75	25
BPH 502P	Course-XII Practical/Tutorial	Digital Systems & Applications Lab	2	50	50	--
BPH 503	Discipline Specific Elective -1	Classical Dynamics	4	100	75	25
BPH 503P	Discipline Specific Elective -1 Practical/Tutorial	DSE-1 Lab	2	50	50	--
BPH 504	Discipline Specific Elective -2	Nuclear and Particle Physics	4	100	75	25
BPH 504P	Discipline Specific Elective- 2 Practical/Tutorial	DSE-2 Lab	2	50	50	--

Total Marks: Semester =600 marks, Total credits: 24

B.Sc. (Hons.) PHYSICS
PART-III

SEMESTER VI						
COURSE CODE	COURSE OPTED	COURSE NAME	CREDITS	Maximum Marks (Pass Marks 40%)	External Examination	Internal Assessment
BPH 601	Core course-XIII	Mathematical Physics-III	4	100	75	25
BPH 601P	Course-XIII Practical/Tutorial	Mathematical Physics-III Lab	2	50	50	--
BPH 602	Core course-XIV	Analog Systems & Applications	4	100	75	25
BPH 602P	Course-XIV Practical/Tutorial	Analog Systems & Applications Lab	2	50	50	--
BPH603	Discipline Specific Elective -3	Physics of Devices and Instruments	4	100	75	25
BPH603P	Discipline Specific Elective -3 Practical/Tutorial	DSE-3 Lab	2	50	50	--
BPH 604	Discipline Specific Elective -4	Nanomaterials and Applications	4	100	75	25
BPH- 604P	Discipline Specific Elective -4 Practical/Tutorial	DSE-4 Lab	2	50	50	--

Total Marks: Semester VI=600 marks, Total Credits: 24

Semester V

MATHEMATICAL PHYSICS-II

(CODE: BPH 501)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus and Section C will have 9 short answer type questions, which will cover the entire syllabus uniformly. Sections A and B carry 12 marks each, section C carry 27 marks.

Instruction for the candidates : The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Section-A

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

(14 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes.

(14 Lectures)

Section-B

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function,

Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.
(24 Lectures)

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(4 Lectures)**
Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. **(4 Lectures)**

Reference Books: • Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.

- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books.

Session: 2018–2019

DIGITAL SYSTEMS AND APPLICATIONS

(CODE: BPH 502)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus and Section C will have 9 short answer type questions, which will cover the entire syllabus uniformly. Sections A and B carry 12 marks each, section C carry 27 marks.

Instruction for the candidates : The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Section-A

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **(3 Lectures)**

Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs. **(3 Lectures)**

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. **(6 Lectures)**

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(6 Lectures)**

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. (4 Lectures) Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **(5 Lectures)**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.

(6 Lectures) Section-B

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. (8 Lectures)

Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems: Principles & Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
- Basic Electronics and Linear Circuits, N.N. Bhargava, D.C. Kulshrahta, S C Gupta, TTTI Chandigarh, McGraw Hill, New Delhi.

Session: 2018–2019

PHYSICS-DSE: CLASSICAL DYNAMICS

(CODE: BPH 503)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus and Section C will have 9 short answer type questions, which will cover the entire syllabus uniformly. Sections A and B carry 12 marks each, section E carry 27 marks.

Instruction for the candidates : The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Section-A

Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Poisson brackets. Canonical transformations. (22 Lectures)

Electromagnetic radiation: Review of retarded potentials. Potentials due to a moving charge: Lienard Wiechert potentials. Electric & Magnetic fields due to a moving charge: Power radiated, Larmor's formula and its relativistic generalisation. (15 Lectures)

Section-B

Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction & twin paradox. Four-vectors: space-like, time-like & light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a fourvector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. The Electromagnetic field tensor and its transformation under Lorentz transformations: relation to known transformation properties of E and B. Electric and magnetic fields due to a uniformly moving charge. Equation of motion of charged particle & Maxwell's equations in tensor form. Motion of charged particles in external electric and magnetic fields. (38 Lectures)

Reference Books:

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
- Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press.

Nuclear and Particle Physics

(CODE: BPH 504)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus and Section C will have 9 short answer type questions, which will cover the entire syllabus uniformly. Sections A and B carry 12 marks each, section C carry 27 marks.

Instruction for the candidates : The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Section-A

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excited states. (10 Lectures)

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. (12 Lectures)

Radioactivity decay: (a) Alpha decay: basics of α -decay processes, theory of α - emission, Gamow factor, Geiger Nuttall law, α -decay spectroscopy. (b) β -decay: energy kinematics for β -decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. (9 Lectures)

Section-B

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). (8 Lectures) Nuclear Astrophysics: Early universe, primordial nucleosynthesis (particle nuclear interactions), stellar nucleosynthesis, concept of gamow window, heavy element production: r- and s-process path. (5 Lectures)

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (BetheBlock formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. (6 Lectures)

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector. (6 Lectures)

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. (5 Lectures)

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. (14 Lectures)

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic 50 Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991).
- Introductory Nuclear Physics, by Kulwant S. Thind, Manmohan Singh, Vijay Kumar and Leif Gerward, Susanta Lahiri (Vikas publisher, New Delhi, 2018)
- Introductory Particle Physics, by Kulwant S. Thind, Manmohan Singh, Vijay Kumar and Leif Gerward, Susanta Lahiri (Vikas publisher, New Delhi, 2018)

Semester VI

PHYSICS-VIII: MATHEMATICAL PHYSICS-III

(CODE: BPH 601)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus and Section C will have 9 short answer type questions, which will cover the entire syllabus uniformly. Sections A and B carry 12 marks each, section C carry 27 marks.

Instruction for the candidates : The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Section-A

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. (30 Lectures)

Section-B

Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. (15 Lectures)

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to

Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits. (15 Lectures)

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
- Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.

Session: 2018–2019

ANALOG SYSTEMS AND APPLICATIONS

(CODE: BPH 602)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus and Section C will have 9 short answer type questions, which will cover the entire syllabus uniformly. Sections A and B carry 12 marks each, section C carry 27 marks.

Instruction for the candidates : The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Section-A

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. (10 Lectures)

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell. (6 Lectures)

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. (6 Lectures)

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. (10 Lectures)

Section-B

Coupled Amplifier: RC-coupled amplifier and its frequency response. (4 Lectures)

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. (4 Lectures)

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. (4 Lectures)

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. (4 Lectures)

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. (9 Lectures) Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) (3 Lectures)

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

PHYSICS-DSE: PHYSICS OF DEVICES AND INSTRUMENTS

(CODE: BPH 603)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO₂-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode. (15 Lectures)

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection (3 Lectures)

Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters. (3 Lectures)

Multivibrators: Astable and Monostable Multivibrators using transistors. (3 Lectures)

Phase Locked Loop(PLL): Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046). (5 Lectures)

Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation. (12 Lectures)

Digital Data Communication Standards: Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART). Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port. (4 Lectures)

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK. (15 lectures)

Reference Books: • Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons • Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.

• Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd • Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.

• Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.

• Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.

• PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

Session: 2018–2019

Nano Materials and Applications

(CODE: BPH 604)

Maximum Marks: 100

Time: 3 Hrs

External Examination: 75

Pass marks: 40%

Internal Assessment: 25

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Instruction for the Paper Setter: The question paper will consist of three sections A, B and C. Sections A and B will have four questions from respective sections of the syllabus and Section C will have 9 short answer type questions, which will cover the entire syllabus uniformly. Sections A and B carry 12 marks each, section C carry 27 marks.

Instruction for the candidates : The candidates are required to attempt two questions each from sections A and B of the question paper and the entire section C.

Section-A

NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. (10 Lectures)

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. (8 Lectures)

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. (8 Lectures)

Section-B

OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-

absorption, emission and luminescence. Optical properties of heterostructures and nanostructures. (14 Lectures)

ELECTRON TRANSPORT: Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects. (6 Lectures)

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). (14 Lectures)

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).