Minutes of the BOS meeting

School of Basic Sciences, CSJM University, Kanpur

An online meeting of the Board of Studies of the Department of Physics, School of Basic Sciences was held on 18/05/2022 at 3:00 pm to modify the syllabus of M.Sc Physics as required in NEP structure. The following members (as approved by the Vice Chancellor, CSJM University) attended the meeting.

1. Prof. R.K Shukla, Department of Physics, HBTU, Kanpur, External member
2. Prof. D.K. Dwivedi, Department of Physics, M.M.M.U.T, Gorakhpur External member
3. Dr. R.K. Dwivedi, Director, School of Basic Sciences, CSJM University Kanpur, Internal member
4. Dr. Anju Dixit, Deputy Director, School of Basic Sciences, CSJM University Kanpur, Internal member
5. Dr. Ritika Solanki, Coordinator, Department of Physics, School of Basic Sciences, CSJM University Kanpur, Internal member
6. Dr. Awanish Kumar Bajpeyi, Deputy Coordinator, Department of Physics, School of Basic Sciences, CSJM University, Kanpur, Internal member

The following members of the Physics Department of UIET were also present in the above mentioned meeting as special invitees:

1. Dr. Saswati Sarkar   2. Dr. Ram Janma
3. Dr. Shikha Shukla   4. Dr. Prabal Pratap Singh

The syllabus was discussed in detail and modified as per NEP implementation. Following modifications has been done in our existing M.Sc syllabus:

1. One computer course **"Numerical Analysis & Computer Programming"** has been incorporated in the second semester as recommended by the BOS Members.
2. In each semester Elective courses have been introduced as per NEP course structure.
3. In each semester the Research Project has been introduced as per NEP course structure.

All other minor corrections suggested by the BOS members were incorporated in the syllabus. BOS recommends the enclosed syllabus to be implemented in the Physics Department.

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HBTU, Kanpur

Prof. D. K. Dwivedi
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M.M.M.U.T, Gorakhpur

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Dr. Ritika Solanki
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Dr. Awanish Kumar Bajpeyi
Deputy Coordinator, Department of Physics
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Special Invitees:

Dr. Saswati Sarkar
Department of Physics
School of Basic Sciences
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Dr. Ram Janma
Department of Physics
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Dr. Prabal Pratap Singh
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Dr. Shikha Shukla
Department of Physics
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Proposed NEP Syllabus of M.Sc. (Physics)
Department of Physics
School of Basic Sciences, CSJM University Campus, Kanpur.

Semester wise- Distribution of Course
Full Marks: 2200, Total Credit: 100

First Year				**Second Year**			
I[st] Semester		**2[nd] Semester**		**3[rd] Semester**		**4[th] Semester**	
Paper/Type	Credit	Paper/Type	Credit	Paper/Type	Credit	Paper/Type	Credit
Mathematical Physics Core	4	**Numerical Analysis & Computer Programming** Core	4	Atomic and Molecular Physics Core	4	Nuclear and Particle Physics Core	5
Classical Mechanics Core	4	Statistical Physics Core	4	Fiber optics and Photonics Core	4	Electronics-2 Core	5
Quantum Mechanics- I Core	4	Electronics-1 Core	4	Quantum Mechanics- II Core	4	Condensed Matter Physics-2 Core	5
Condensed Matter Physics-1 Core	4	Elective-1 **High energy particle Physics Or Electrodynamics**	4	Elective-2 **Material Characterization Techniques Or Physics of Nano Materials**	4	Elective-3 **Physics of Lasers and Applications Or Plasma Physics**	5
Laboratory-I	4	Laboratory-II	4	Laboratory-III	4		-
Research Project	-	Research Project	8	Research Project	-	Research Project	8
Total credits	20		28		20		28
Minor elective from other department faculty to be taken in I[st] year only(I[st] or II[nd] semester)							
Minimum credits annually	**52**			**48**			

*Research Project will be evaluated in the second and fourth semester.

Semester-I, Total Marks: 500, Credit:24

Sl.No.	Course Code	Name of Paper	Maximum mark	Credit
1.	MPC-101	Mathematical Physics	100	4
2.	MPC-102	Classical Mechanics	100	4
3.	MPC-103	Quantum Mechanics- I	100	4
4.	MPC-104	Condensed Matter Physics-1	100	4
5.	MPL-105	Laboratory-I	100	4
6	MPR-110	Research Project	-	-

Semester-II, Total Marks:700, Credit:28

Sl. No.	Course Code	Name of Paper	Maximum mark	Credit
6.	MPC-201	**Numerical Analysis & Computer Programming**	100	4
7.	MPC-202	Statistical Physics	100	4
8.	MPC-203	Electronics-1	100	4
9.	MPE-204/ MPE-205	Elective-1	100	4
10.	MPL-206	Laboratory-II	100	4
11	MPC-207	Minor (from other faculty)	100	4
	MPR-210	Research Project	100	8

Semester-III, Total Marks: 500, Credit:24

Sl. No.	Course Code	Name of Paper	Maximum mark	Credit
11.	MPC-301	Atomic and Molecular Physics	100	4
12.	MPC-302	Fiber optics and Photonics	100	4
13.	MPC-303	Quantum Mechanics- II	100	4
14.	MPE-304/ MPE-305	Elective-2	100	4
15.	MPL-306	Laboratory-III	100	4
	MPR-310	Research Project	-	-

Semester-IV, Total Marks: 500, Credit: 24

Sl. No.	Course Code	Name of Paper	Maximum mark	Credit
16.	MPC-401	Nuclear and Particle Physics	100	5
17.	MPC-402	Electronics-2:	100	5
18.	MPC-403	Condensed Matter Physics-2	100	5
19.	MPE-404/MPE-405	Elective-3	100	5
20.	MPR-410	Research Project	100	8

Students may select one of the following elective papers:

Semester-II- Elective I

- MPE-204: High energy particle Physics
- MPE-205: Electrodynamics

Semester-III- Elective II

- MPE-304: Material Characterization Techniques
- MPE-305: Physics of Nano Materials

Semester-IV- Elective III

- MPE-404: Physics of Lasers and Applications
- MPE-405: Plasma Physics

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SEMESTER-I
MPC-101
Mathematical Physics
Full Marks: 100, Credit: 4

Unit I- Elementary ideas about tensors:

Covariant and contravariant tensor, Addition and multiplication of tensors, Tensor contraction, Kronecker delta and Levi-Civita symbols, Definition of stress and strain tensor, moment of inertia tensor, dielectric tensor.

Unit II- Elements of complex analysis:

Analyticity, Cauchy-Riemann condition, Singularities, Cauchy's theorem and integral formula, calculus of residues, Evaluating integrals.

Unit III- Second order linear differential equation:

Series solution of Bessel, Legendre, laguerre and Hermits equations, Generating functions, Recurrence relations and Ortho-normal properties, Green function.

Unit IV- Fourier series and Integral transforms:

Fourier Series of even and odd function, fourier sine and cosine integrals, Laplace transform, Inverse Laplace transform, its properties and applications, Laplace transform of Dirac delta function, Fourier transform and inverse Fourier transform, their properties and applications.

Text and Reference Books:

1. Mathematical Methods for Physics by G. Artken
2. Advanced eogimcriog mathematics by E. Krosig
3. Mathematical Physics by H. K. Dass

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SEMESTER-I
MPC-102
Classical Mechanics
Full Marks: 100, Credit: 4

Unit I- Review of Newtonian mechanics: Constraints, D' Alemnbert's principle, Generalized coordinates, Lagrange's equation, Gyroscopic forces, Dissipative systems, gauge invariance, Generalized momenta, Symmetries of space and time with conservation laws, invariance under Galilean transformations.

Unit II- Central forces: definition and characteristics, Two body problems, General analysis of orbits, Keplar's laws and equation, closure and stability of circular orbits, Rutherford scattering.

Unit III- Hamiltonian equations: Principal of least action, derivation of equation of motion,Variation and end points, Hamilton principle and characteristic functions.

Unit IV- Canonical transformations: generating functions, Properties, infinitesimal generators, Poisson Brackets, Poisson theorems, Angular momentum Poisson brackets.

Unit V- Hamilton — Jacobi theory: Harmonic oscillator and Kepler's problem by Hamilton-Jacobi method, Action angle variables.

Unit VI- Problem of Small oscillations: Examples of two coupled oscillators, General theory of normal coordinates and normal modes of vibration.

Text and Reference Book:

1. Classical Muchanics by H. Goldstein, Narosa Publishing House, Delhi.
2. Classical Mechanics by N. C. Rana and P. S. Joag (Tata McGraw-Hill)
3. Classical Mechanics by J.C. Upadhyaya, Himalaya Publishing House, Mumbai
4. Classical Mechanics of Particles and Rigid Bodies: KC Gupta, New Age International(P) Ltd, New Delhi

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SEMESTER-I
MPC-103
Quantum Mechanics-I
Full Marks: 100, Credit: 4

Unit I- Dimension and basis of vector space: Hilbert space, Dirac bra-ket notation, equation, equations of motion,observables and operator, Eigen values and Eigen vectors of an operator,

Unit II- Matrix representation of operators: solution of one-dimensional harmonic oscillator by operator method, unitary transformations, Dirac delta function Postulate of QM values expectation values and their time evolution Poisson bracket and commutator.

Unit III- Angular Momentum: Matrix representation, Eigen function and Eigen value 0f L_x and L^{2}, operators, solution. of Schrodinger equation. for spherically symmetric potentials, Hydrogen atom, spin angular momentum, spin 1/2 and Pauli matrices, total angular momentum, addition of two angular moments, Clebsch -Gordan coefficients.

Unit IV- Identical Particles: Symmetric and anti-Symmetric wave functions, Pauli exclusion principle, collision of identical particles.

Text and Reference Book:

1. Quantum Mechanics Theory and Applications: Ghatak and Lokanathan.
2. A Text book of Quantum Mechanics: Mathews and Venkatesan.
3. Quantum Mechanics QM Concepts & Applications: N Zettili.
4. Quantum Mechanics: L. I. Schiff.
5. Introduction to Quantum Mechanics: D. J. Griffiths.
6. Quantum Mechanics: I.L. Powell and B. Crasemann.
7. Quantum Mechanics: E. Merzbacher.
8. Advanced Quantum Mechanics : J.J. Sakurai
9. Quantum Mechanics: Cohen Tannoudji

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SEMESTER-I
MPC-104
Condensed Matter Physics-I
Full Marks: 100, Credit: 4

Unit I- Crystallography: Fundamentals of crystallography, symmetry operations, crystal systems, Bravais lattices, unit cells, primitive cells, crystallographic planes and directions, symmetry elements in crystals, proper rotation axis, plane of symmetry, inversion centre, screw axis, glide plane, Type of Bravais lattices, closed packed structures, diamond structure, Zinc blend structure, Weigner-Seitz cell, Miller indices, Liquid crystals.

Unit II- X-rays Diffraction and Reciprocal Lattice: Choice of x-ray, electron and neutron for crystal structure determination, Bragg's diffraction, Reciprocal lattice, The Braggs condition and Ewald construction, Brillouin zones of SC, BC and FCC lattices, Atomic scattering factor, Geometrical structure factor, Laue method, Rotating crystal method, Powder method, Debye Scherer technique, Analysis of powder photograph, Crystal structure determination.

Unit III- Electron in a periodic lattice: Bloch **theorem,** Band theory, Effective mass, Nearly free electron approximation, tight binding approximation, Fermi surfaces, Cyclotron resonance, The De Hass-Van Alfen effect, Magneto resistance, quantum Hall effect. Weiss theory of ferromagnetism, Heisenberg model, Mean field theory, Exchange intraction, Spin waves and magnons, Curie-Weiss law for susceptibility, Domain theory and hysteresis loop, Bloch wall, Anti-ferromagnetism, Ferrimagnetic materials.

Unit IV- Imperfections in Crystal: Point imperfections, Vacancies, Interstitial, Schottky and Frenkel defect. Colour centres, Dislocation of elastic and plastic deformation of solids, Slip planes, Critical resolved shear stress, Elastic energy, Frank and Reid source, Stacking faults, Grain boundaries, Tilt boundaries, and Twin boundaries, Whiskers, Observations of dislocation and other defects.

Text and Reference books:

1. X-ray diffraction by B. D. Cullity
2. Interpretation of X-ray Diffraction Photographs by Henry, Lipson and Booster
3. Crystal Structure Analysis by Burger
4. Elementary Solid State Physics by M. Ali Omar
5. Solid State Physics: Charles Kittel
6. Principles of Condensed Matter Physics: Chaikin and LubensKy
7. Solid state physics: Aschroft and Mermin
8. Introduction to Solids: Azaroff

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SEMESTER-I
MPL-105
Laboratory-I
Full Marks: 100, Credit: 4

Name of Experiments:-

1. Measurement of wavelength of He-Ne laser using a steel scale.
2. Passive Filter
3. Resolving power of prism
4. Young's Modulus and Poisson's ratio of glass by Cornu's fringes
5. Verification of Fresnel's formula
6. Thermal and electrical conductivity of copper and thermal conductivity of a poor conductor
7. Verification of Curie and Weiss law for a ceramic capacitor
8. Calibration of a silicon diode and copper constantan thermocouple against Pt Resistance thermometer

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SEMESTER-II
MPC-201
Numerical Analysis & Computer Programming
Full Marks: 100, Credit: 4

Unit I- Computational Methods:
Methods of determination of zeroes of linear and nonlinear algebraic and transcendental equations, convergence of solutions.

Unit II- Numerical Solution of linear equation and Ordinary Differential Equation:
Gaussian elimination, Iterative method, Matrix inversion, Eigen values and Eigen vectors of matrices, Power and Jacobi method, Euler's and Runge-Kutta method, Predictor-Corrector methods, Elementary ideas of solution of partial differential equations. **Finite differences:** Interpolation with equally spaced and unevenly spaced points curve fitting, polynomial least squares and cubic spline fitting.

Unit III- Numerical differentiation and integration:
Trapezoidal, Simpson and Gaussian integration Methods, Newton-Cotes formula, Cubic spline method. Monte Carlo evaluation of integrals, Methods of importance sampling.

Unit IV: Introduction to computers and Computer Programming in FORTRAN
Basic Structure and functioning of computers Memory, I/O devices. Secondary storage Computer languages, Introduction to UNIX and WINDOWS Data Processing, principle of programming, Algorithms and flow-charts. Elements of the computer language. Constants and variables, Expressions, Arithmatic assignment statement, Input and Output, Format statement, Termination statements, branching statements

Unit V: Idea of Simulation
Generation of uniformly distributed random integers, Statistical tests of randomness, Monte-Carlo evaluation of integrals and error analysis, Metropolis algorithm, Random walk problems and their Monte-Carlo simulation.

Text and Reference Books:

1. Introductory methods of Numerical analysis by S. S. Sastry (Prentice Hall)
2. Matrices and tensors for physicist by A. W. Joshi
3. Numerical analysis by Rajamman
4. Computer Programming in FORTRAN 77: Rajaraman.
5. A Guide to Monte Carlo Simulations in Statistical Physics: Landau and Binder.

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SEMESTER-II

MPC-202

Statistical Physics

Full Marks: 100, Credit: 4

Unit I- Foundation of Statistical Physics: Review of probability concepts; Random talk problem in one dimension-binomial distribution, Specification of state of system, Macrostates and microstates, Concept of statistical equilibrium, Fundamental postulates of equal a priory probability.

Unit II Ensembles: Micro-canonical, Canonical and grand canonical ensembles and their comparative study, Partition function, Calculation of statistical quantities in terms of partition function (connection to thermodynamics), Entropy of mixing of gases (using partition function), Gibbs paradox and its resolution; Derivation of equation of state of classical ideal gas using partition function

Unit III Statistical Mechanics: Ideal quantum gases, Indistinguishability, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics and its applications, Photon statistics, Ideal Bose gas, Bose-Einstein condensation, Ideal Fermi gas, Correlation function. Planck's Radiation formula, Concept of Fermi Energy, Fermi temperature and Fermi velocity. Low Specific heat of metals.

Unit IV Interacting systems: Virial expansion of equation of state, Second Virial coefficient, Ising model, Weiss molecular mean field theory of ferromagnetism.

Text and Reference Book :

1. Fundamental of statistical and Thermal by F. Reif (Tata McGraw-Hill)
2. Statistical Physics (Landau and Lifshitz course) Vol. I (Pergamon Press)
3. Statistical Mechanics by K. Huang (Wiley)
4. Statistical Physics by R. K.Patharia

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SEMESTER-II
MPC-203
Electronics-I
Full Marks: 100, Credit: 4

Unit I-Basics of Operational Amplifier: Differential Amplifier, circuit configurations, dual input balanced output differential amplifier. DC analysis, AC analysis, inverting and non-inverting inputs, CMRR, constant current bias, level translator. Block diagram of a typical Op-Amp analysis. Schematic Symbols, Integrated circuits and pin identification, Open Loop Operational Amplifier Configurations (Differential, Inverting and Non-inverting) Op-Amp with negative feedback, voltage series and shunt feedback, Inverting and non-inverting amplifiers, effect of feedback on closed loop gain, input resistance, output resistance, bandwidth and output offset voltage, voltage follower. Practical Op-Amp input offset voltage, input bias current, input offset current, total output offset voltage, CMRR frequency response.

Unit II - OpAmp Applications: Addition, Subtraction, Summing, scaling and averaging amplifier, Integrator and differentiator, Logarithmic and anti logarithmic amplifier, Oscillators principles, oscillator types, frequency Stability, response, Phase shift, Wein bridge, LC tunable oscillators, Square wave and Triangular wave generators, VCO, Comparators, Schmitt trigger, V/F and F/V converter, A/D and *D/A* converters, Sample and hold circuit, multivibrators.

Unit III- Memory and other devices Complementary metal oxide semiconductor (CMOS), MOSFET transistors as n-channel (NMOS), Static random acces s memory (SRAM) and dynamic random access memory (DRAM), Read only memory (ROM), electrically programmable ROM (EPROM) and electrically erasable programmable ROM (EEPROM), volatile and non volatile memory, Magnetic, optical and ferroelectric memories and devices, Charge coupled device (CCD). Piezoelectric, electrostrictive and magnetostrictive effect related materials and their application in devices.

Unit IV -High frequency devices: Frequency dependence of gain, transit time effect in bipolar and in field effect transistors, Schottky Barrier FET (MES FET), modulation doped transistor (MODFET or HEMT) , Ballistic transistors- Metal base transistors, ballistic GaAs Transistors Two terminal devices- Gunn diode, Impact avalanche and transit time (IMPATT) diode Tunnel diode.

Text and Reference books:

1. Optical Electronics: A. Ghatak and K. Thygrajan
2. Introduction to semiconductor devices: M. S. Tyagi
3. Physics and Technology of Semiconductor Devices: S. M. Sze

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SEMESTER-II
MPE-201
Elective Papers
High Energy particle Physics
Full Marks: 100, Credit: 4

Unit I- Symmetries and Conservation Laws
Conservation laws, parity transformations, charge conjugation, time reversal, CPT theorem, G-parity, Gell-Mann-Nishijima relation, Isotopic Spin, Lie algebras and fundamental representations of SU(2) and SU(3).

Unit II- Quark Model of Hadrons
Historical development of the quark model, Quark flavors and colours, quark-antiquark and three quark bound states of Mesons and Baryons, colour factors, Application of quark model to Hadron masses, Quark Parton model.

Unit III- Weak Interactions
Intermediate vector bosons, four-fermi interactions, parity violation and V-A theory of weak current, CP violation in Kaon decays.

Unit IV- Gauge Invariances
Global and local gauge symmetries, Noether's theorem and conservation laws, Abelian and Non-Abelian gauge invariance.

Unit V- Standard Model and Beyond Spontaneous breaking of gauge symmetry, Higggs mechanism, Glashow-Salam-Weinberg theory of electroweak interactions, fermion masses, Phenomenlogy of extra dimensions.

Text and Reference books:

1- Quarks and Leptons- F. Halzen and A.D. Martin.
2- Introduction to Particle Physics- M. P. Khanna.
3- Gauge Theories in Particle Physics- I.J.R. Aitchison and Hey.
4- Lapton and Quarks- L.B. Okum.
5- Gauge theory of elementary Particles- T.P. Cheng and L.F. Li.
6- Weak interaction of Leptons and Quarks- P.M. Bucksbaum and E. Cummins
7- Introduction of High Energy Physics- D. H. Perkins.
8- Quarks and Partons- F. E.Close.

SEMESTER-II
MPE-202
Electrodynamics
Full Marks: 100, Credit: 4

Unit I- Maxwell's equations, Wave equations for vector and scalar potential and solutions, Lineard-Wiechart potential.

Unit II- Electric and Magnetic fields due to a uniformly moving charge and an accelerated charge, Power radiated by a point charge, Linear and circular acceleration,angular distribution of power radiated, Synchrotron radiation and Cerenkov radiation, Reaction force of radiation.

Unit III - Lorentz transformation in four dimensional space, Four vectors (x, del, p, *J*, A) and their transformation under LT, Electromagnetic field tensor F, Maxwell's equations in terms ofF, Dual field tensor, Transformation of electric and magnetic field.

Text and Reference Book:

1. D.J. Griffiths: Introduction to Electrodynamics
2. W.K. H. Panofsky and M Phillips: Classical Electricity and Magnetism

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SEMESTER-II
MPL-206
Laboratory-II
Full Marks: 100, Credit: 4

Name of Experiments:-

1. Measurement of inductance and capacitance and study of LCR series and parallel
2. I-V characteristics of Silicon controlled rectifier
3. I-V characteristics of Uni-junction transistor
4. MOSFET characteristics.
5. Measurement of inductance and capacitance using AC bridges
6. AC Experiments Measurements of L and C and Series and parallel Resonant circuits.
7. Rigidity modulus of a brass wire.

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SEMESTER-III
MPC-301
Atomic and Molecular Physics
Full Marks: 100, Credit: 4

Unit I- Atomic Spectra: Quantum States of an electron in an atom, Hydrogen Spectrum, Spin-orbit interaction and fine structure , Term symbols, equivalent and non equivalent electrons, spectra of alkali elements, Normal and anomalous Zeeman effect, Paschen-Back effect, Stark effect, LS and JJ Couplings, hyperfine structure, line broadening mechanisms

Unit II- Molecular Spectra: Types of molecules, diatomic, linear, symmetric top, asymmetric top and spherical top molecules, Microwave Spectroscopy- Rotational spectra of diatomic molecules (rigid and non rigid rotor model), microwave spectrometer

Unit III- Infrared Spectroscopy- Vibrational Spectra, Diatomic molecule as a simple harmonic and anharmonic oscillator, energy levels and infrared spectra, molecule as vibrating rotor, P, Q and R branches, IR spectre of polyatomic systems

Unit IV- Raman Spectra, Principle of mutual exclusion, Structure determination Raman Spectroscopy.

Text and Reference books:

1. Introduction to Atomic Spectra by H. E. White
2. Fundamentals of Molecular Spectroscopy by C. B. Banwell
3. Introduction to Molecular Spectroscopy by G. M. Barrow
4. Molecular Spectroscopy by J. M. Brown
5. Spectra of Diatomic Molecules by Hertzberg

SEMESTER-III
MPC-302
Fiber Optics and Photonics
Full Marks: 100, Credit: 4

Unit I- Modal propagation in Optical Fiber:
Modal propagation characteristics of step index and graded index fibers, weakly guided step index fibers, losses in fibers, material dispersion , numerical techniques of the analysis of simple optical waveguides in weak guidance approximation.

Unit II- Fiber Optics Technology:
Waveguide dispersion and design consideration, optical materials, fabrication, cabling and installation of optical fibers, optical joints and couplers, integrated optical waveguide types, modes in asymmetric planar waveguide, channel and strip waveguides.

Unit III- Periodic Optical Fibers:
Guided and defect modes in periodic optical waveguides, optical filters and monochromator, Bragg's reflection waveguides and Bragg's filters, Helically cladded optical fibers and their applications, Modes selection in different fibers.

Unit IV- Optical Solitons and Application of Fiber Optics:
Analysis of optical solitons and their applications, leaky modes, Optical Amplification and Si – doped waveguides, Application of fiber optics in non- communication and sensors.

Unit V- Photonic Band Gap Materials:
Photonic crystal, Photonic crystal fibers, Photonic band gap structure, Analytical and numerical study of photonic band gap fibers and their dispersion characteristics, reflectance, transmittance in PBG fibers, negative refractive materials, optical filters from photonic band gap and its application in loss bonds and high Q cavities.

Text and Reference books:

1. Mynbav & Scheiner: Fiber optic communication technology Prentice hall
2. Ajoy Ghatak & K. Tyagrajan: introduction to fiber optics
3. Peter L. Bocho James

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SEMESTER-III
MPC-303
Quantum Mechanics -II
Full Marks: 100, Credit: 4

Unit I- Approximation method for stationary states: Perturbation theory (non degenerate and degenerate case), Variational method, WKB method.

Unit II- Time-dependent perturbation theory: Fermi golden rule, Harmonic Perturbation. Semi-classical theory of radiation: Transition probability for absorption and induced emission (stimulated), Electric dipole approximation, Selection rules, Forbidden transitions. Transition probability for spontaneous emission Einstein's A and B coefficients.

Unit III- Scattering: Differential scattering cross section and total scattering cross section, scattering in the Lab and CM frames, scattering amplitude, Born approximation., Partial wave analysis for elastic scattering, phase shift, optical theorem, scattering by a perfectly rigid sphere and by an attractive; square well potential.

Unit IV- Relativistic wave equations: Klein-Gordan equation, its interpretation and free particle solution, Free particle Dirac equation. and plane wave solution, alpha and beta matrices, covariant form of Dirac equation. Gamma matrices, spin and magnetic moment of electron, interpretation of negative energy states.

Text and Reference books:

1. Quantum Mechanics Theory and Applications: Ghatak and Lokanathan.
2. A Text book of Quantum Mechanics: Mathews and Venkatesan.
3. Quantum Mechanics QM Concepts & Applications: N Zettili.
4. Quantum Mechanics: L. I. Schiff.
5. Introduction to Quantum Mechanics: D. J. Griffiths.
6. Quantum Mechanics: I.L. Powell and B. Crasemann.
7. Quantum Mechanics: E. Merzbacher.

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SEMESTER-III
MPE-304
Materials Characterization Techniques
Full Marks: 100, Credit: 4

Unit I- Introduction to materials and techniques; Spectroscopic methods- UV-visible and vibrational spectroscopy- Infrared and Raman spectroscopy, Electron spectroscopy

Unit II- Optical microscopy, Electron microscopy, SEM, TEM, X-ray photoelectron spectroscopy, Auger electron spectroscopy, Scanning Probe Microscopies: STM, AFM

Unit III- Thermal analysis- TGA, DTA, DSC, DMA, TMA, DETA

Unit IV- NMR, RBS, Positron Annihilation Spectroscopy, Mossabauer Spectroscopy

Text and Reference books:

1. Y. Leng, Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia), 2008.
2. S. Zhang, Lin Li, A. Kumar, Materials Characterisation Techniques, CRC press, 2008.
3. D.A. Skoog, F.J. Holler, S. R. Crouch, Instrumental Analysis, Cengage Learning, 2007.
4. J.C. Vickerman, I. Gilmore, Surface Analysis: The Principal Techniques, 2 nd ed., John Wiley & Sons, Inc.2009.
5. W. W. Wendlandt, Thermal Methods of Analysis, John Wiley, 1974.

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SEMESTER-III
MPE-305
Physics of Nano materials
Full Marks: 100, Credit: 4

Unit I- Physics of the Solid State: Crystal structures, Band and free electron theory of solids, Idea of band structure, Density of state in bands, Diffusive transport, scattering mechanisms, Surfaces, Interfaces and Layered Systems.

Unit II - Quantum Nature of Nanoworld: Introduction of Nanomaterials, Characteristic or Critical lengths in mesoscopic systems e.g. mean free path, scattering length, coherence length etc; Idea of quantum well, Quantum wire & and Quantum dots; One and Two dimensional electron systems: general properties, Quantum confinements, Variation of density of states and band gap with dimensionality, Optical properties of semiconductor and metal nanomaterials, Surface Plasmon Resonance in Metal Nanoparticles. Carbon Nanostructures (Fullerenes, Carbon Nanotubes and Graphene) and their Renewable Energy Applications.

Unit III - Nano fabrication: Synthesis of nanomaterial (0, 1& 2 Dimensional) by Top down and Bottom-up Approaches; Ball Milling. Lithography, etching. epitaxial growth, physical and chemical vapour deposition (PVD & CVD) methods, Microwave, Hydrothermal and Solvo-thermal synthesis methods, Chemical synthesis of nanomaterial etc.

Unit IV - Characterization of Nano materials: Structure (X-Ray and electron Diffraction}; Determination of Particle size, Crystallography, atomic and surface structures, Microscopy (Scanning and Transmission electron microscopy, atomic force microscopy, Scanning tunnelling microscopy); Spectroscopy (X-ray Photoelectron Spectroscopy, Infrared and Raman Spectroscopy).

Text and Reference Books:

1. Introduction of Nanotechnology by Charles P Poole Jr and F J Owens Wiley India
2. Nanotechnoology for Microelectronics and optoelectronics by JMM Duart, RJM Palma and F A Rueda Elsevier
3. Introduction to Solids by Kittel
4. Physics of semiconductor nanostructure by KP *Jain*, Narosa
5. Physics of low dimensional semiconductors by John H. Davies

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SEMESTER-III
MPL-306
Laboratory-III
Full Marks: 100, Credit: 4

Name of Experiments:-

1. Measurement of resistivity of semiconductor by four probe method and determination of band gap.
2. Measurement of Hall coefficient of given semiconductor to estimate charge carrier.
3. Measurement of thermal and electrical conductivity of copper and determinationof Lorentz number.
4. B-H curve of a ferromagnetic material.
5. Measurement of polarizability of nonpolar liquid and dipole moment of polar liquid.
6. Dielectric constant of solid(Wax) by Lecher wire.

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SEMESTER-IV

MPC-401

Nuclear & Particle Physics

Full Marks: 100, Credit: 5

Unit I- Nuclear Forces: Nuclear two body problem, simple theory of deuteron, spin dependence and non central nature of nuclear forces, nucleon-nucleon scattering, scattering length and effective range theory, exchange force and meson theory of nuclear force.

Unit II- Nuclear Reactions: Q value and threshold energy, compound nuclear and direct reaction mechanisms, nuclear reaction cross-sections, resonance phenomenon, Breit-Wigner one level formula.

Unit III- Nuclear models: Liquid drop model, Semi-emperical mass formula, Bohr-Wheeler theory of fission, Evidences of shell structure, Shell model, spin-orbit coupling, predictions of shell model, Collective model.

Unit IV- Nuclear Decay: Beta decay, Fermi theory of beta decay Allowed and Forbidden transitions, Fermi and Gamow-Teller selection rules, Parity violation in beta decay Neutrino detection Gamma decay, Multipole transitions, angular momentum and parity selection rules, Internal conversion, Nuclear isomerism

Unit V- Elementary Particle Physics: Four fundamental interactions, classification of elementary particles, Hadrons and Leptons, Symmetry and Conservation laws, CP violation and CT invariance, SU(2) and SU(3) multiplets, Eight fold way, Quark model, Gell-Mann Okubo mass formula for hadrons, Basic ideas of standard model.

Text and Reference books:

1. Atomic and Nuclear Physics by S. N. Ghoshal.
2. Introductory Nuclear Physics by Y. R. Waghmar
3. Concepts of Nuclear Physics by B. L. Cohe
4. Introduction to Elementary Particles by D. Griffiths
5. Introduction to Nuclear Physics by M. A. Enge
6. Nuclear Physics by I. Kaplan

SEMESTER-IV
MPC-402
Electronics-2
Full Marks: 100, Credit: 5

Unit I- Analog Communication Electronics: Amplitude modulation, generation of AM waves, demodulation of AM waves, DSBSC modulation, generation of DSBSC waves, coherent detection of DSBSC waves, SSB modulation, generation and detection of SSB Waves, Vestigial sideband modulation.

Unit II- Frequency modulation, Frequency spectrum for sinusoidal FM. Non-sinusoidal modulation,Phase modulation, Comparison of PM & FM. Varactor diode modulators, Reactance modulator,FM transmitter, Armstrong indirect method, FM detectors, Foster-Seeley discriminator, Ratio detector

Unit III- Digital Communication: Sampling theorem, sampling of Low Pass and Band – pass signals, Pulse Modulation-PAM, PWM, **PPM,** ideal sampling, Natural sampling, Flat-top sampling,. Quantization of signals; Quantization, PCM, Differential PCM, Delta modulation, Adaptive Delta modulation, CVSD, Line encoding; unipolar, polar, bipolar, Manchester encoding

Unit IV - Digital Modulation Techniques: Amplitude Shift Keying (ASK), Phase Shift Keying (PSK) -Binary (BPSK), Differential (DPSK), Quadrature (QPSK) & M-ARY Quadrature Amplitude Shift Keying (QASK), QAM, Frequency Shift Keying (FSK).

Text and Reference books:

1. Principles of Communication System- Taub and Schilling, McGraw Hill Co.
2. Communication Systems- Simon Haykin, John Wiley & Sons, Inc.
3. Electronic Communications, Dennis Roddy & John Coolen, Pearson Education.
4. Modern Digital and Analog Communication systems- B P Lathi, Oxford Univ Press
5. Electronic Communication system- R Blake, Cengage india edition
6. Communication System Engineering- Proakis and Salehi, PHI Learning
7. Advance Electronics Communications Systems, Wayne Tomasi, Pill, Edn.
8. Electronic Communication System, George Kennedy & Bernard Davis, McGraw Hill Publ.

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MPC-403
Condensed Matter Physics-2
Full Marks: 100, Credit: 5

Unit I - Transport Properties of Solids: Boltzmann transport equation, resistivity of metals and semiconductors, Fermi surfaces –determination, Landau levels, de Hass van Alphen effect, Quantum Hall effect- Integral quantum Hall effect and Magnetoresistance.

Unit II - Dielectric Properties of Solids: Dielectrics and ferroelectrics, macroscopic electric field, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, piezoelectric crystals, ferroelasticity, electrostriction.

Unit III - Optical properties: Optical constants and their physical significance, Reflectivity in metals, plasmonic properties of metals, determination of band gap in semiconductors: direct and indirect band gap, defect mediated optical transitions, excitons, photoluminescence, Electroluminesence

Unit IV - Magnetism: Types of magnetic materials, Quantum theory of paramagnetism, Hund's rule, Ferromagnetism, antiferromagnetism: molecular field, Curie temperature. Domain theory, Magnetic Anisotropy, Magnetic interactions, Heitler-London method, exchange and superexchange, magnetic moments and crystal-field effects, spin-wave excitations and thermodynamics, antiferromagnetism, Magnetostriction.

Unit V - Electron Phonon Interaction: Interaction of electrons with acoustic and optical phonons, Polaron, Superconductivity: Manifestation of energy gap, Cooper pairing due to phonons, BCS theory of superconductivity, Ginzsburg-Landau theory and application to Josephson effect, High temperature superconductors.

Text and Reference books:

1. Elementary Solid State Physics by M. Ali Omar
2. Introduction to solid State Theory by Madelung
3. Quantum theory of Solids by Callaway
4. Theoretical Solid State Physics by Huang
5. Quantum theory of Solids by C. Kittel
6. Electrical Engineering Materials by R.K. Shukla & Archna Singh Mc Graw Hill Publications.

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SEMESTER-IV
MPE-404
Physics of Lasers and Laser applications
Full Marks: 100, Credit: 5

Unit I- Properties of laser beams, Basic elements of a laser, Population inversion, gain and Threshold, Three level and four level laser, mate equations, CW operation of laser, optical resonators, cavity modes, mode selection, pulsed operation of laser, Q-switching and mode locking, Pulse shortening picoseconds and femto-second operation.

Unit II- Different laser systems, Ruby laser, He-Ne laser, Nd:YAG laser, CO_2 laser, Semiconductor diode laser, Dye lasers, Excimer lasers

Unit III- Laser induced fluorescence spectroscopy, Laser applications in metrology, optical communication, materials processing and holography, LIDAR, Medical applications.

Text and Reference books:

1. Lasers by A. E. Siegmann, University science books
2. Lanser Physics by P. W. Milonni and J. H. Eberly
3. Laser Spectroscopy by W Demtrodur
4. Principles of Laser by O. Swelto
5. Lasers, Theory and Applications by K. Thyagarajan and A. K. Ghatak

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SEMESTER-IV
MPE-405
Plasma Physics
Full Marks: 100, Credit: 5

Unit I- Plasma as a state of matter, Debye shielding, Motion of charged particles in uniform electric and magnetic field.

Unit II- Time varying and space dependent electric and magnetic fields, Diffusion of electrons and ions in weakly ionised plasma without and with magnetic field, Plasma confinement, Magnetic mirror, First, second and third adiabatic invariants.

Unit III- Plasma oscillations, Magneto hydro dynamics, pinch effect, Hydro magnetic waves and magneto sonic waves

Text and Reference Book:

1. J.A. Bitten court: Fundamentals of Plasma Physics
2. Jackson: Classical Electrodynamics

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