Curriculum & Syllabi

of

Master of Science

In

Physics

(w.e.f. 2018-19)

Vision
Mission
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Overall Credit Structure
Curriculum
Syllabus

Offered By

PHYSICS AND MATERIAL SCIENCE DEPARTMENT
M. M. M. UNIVERSITY OF TECHNOLOGY,
GORAKHPUR-273010, UP

August 2021

Department of Physics and Material Science

CURRICULA & SYLLABI

M.Sc. Physics (Specialization in Electronics)

Vision: To develop department as an academic centre of excellence by promoting interest and enthusiasm through fostering quality education, igniting research in the field of Physics and Material Science.

Mission:

1. To impart quality education in both theoretical as well as experimental physics.
2. To disseminate state of the art knowledge so that the students can apply the ideas of physics to compete with engineering professionals.
3. To promote and practice the highest ethical principles in scientific research for critical thinking and awareness to nascent social, scientific, technological and educational changes from time to time.
4. To nurture creativity among the students to contribute to the betterment of society by their knowledge of Physics.
5. To inspire and prepare the students to meet the needs of the nation in particular and enable them to contribute as global citizens in general.

Programme Educational Objectives (PEO)

1. Develop core competence in the various basic and advance level courses of physics.
2. To identify and apply the appropriate analytic, numerical and computational tools to handle basic and advance level problems of physics and engineering.
3. Acquire competence in handling and setting up of instruments in physics laboratory.
4. Develop the ability to analyze scientific problems, evaluate evidence and identify ambiguity.
5. To integrate knowledge of physics to make appropriate intellectual connections in the area of physics.
6. Develop familiarity with the current state of research in one or more subfields of physics
7. Enhance the presentation skill ability to communicate scientific information effectively.
8. To develop the professional, ethical and social responsibilities among the learners.

Programme Outcome (POs)

After completing the M.Sc. course in Physics,

1. The students would be able to take up advance studies in physics, such as M.Phil/Ph.D and/or as project and research fellows in different national/international laboratories.
2. Student can find opportunities in many interdisciplinary research areas such as biophysics, molecular modeling, quantum physics, material science, solar cell, photonics, sensors, nanofluids, nanotechnology, optics, and renewable energies in different reputed institutes of India and abroad.
3. Students may opt for the profession of teaching in schools, colleges, universities/institutes in India and abroad.
4. Students may opt for career in science and technology where higher level of expertise in physics is required.
5. Student would get an opportunity to work as scientist in different R & D laboratories and research centers within India and abroad.
6. The student will acquire knowledge and skill of necessary tools and techniques to find scientific solutions to cater the need of the society with professional, ethical and social responsibilities.

Programme Specific Outcome (PSOs)

1. To develop understanding of basic concepts of Physics and realise the importance of fundamental laws governing diverse natural phenomenon.
2. To advance knowledge in the direction of the latest progress and applications in Physical Science, and in the field of Electronics.
3. To inculcate logical thinking and skills for deductive analysis.
4. To learn experimental skills and analytic tools.
5. To encourage for research and higher studies in Physics, Material Science and Electronics.
6. To prepare for Physics competitive exams e.g., CSIR-NET, GATE, JEST etc. to secure positions at prominent academic and research institutions/industries
7. To prepare foundations for making quality Physics teachers and scientists.
8. To make students lifelong learners and contribute to the need of society.
9. To develop comprehensive understanding of the entire range of electronic devices, communication system, microprocessor, and microcontrollers with added state of art knowledge on advanced electronic systems.
10. To develop sound knowledge for computer programming, simulation techniques and software uses and handling.

Syllabus and Credit structure: Credit Structure for M. Sc. Physics with specialization in Electronics (For newly admitted students from Session 2019-2020)

Category	I	II	III	IV	Total
Programme Core (PC)	19	10	14	6	**49**
Programme Electives (PE)	-	8	4	-	**12**
Dissertation (D)			3	12	**15**
Audit					
Total	**19**	**18**	**21**	**18**	**76**

Curriculum for M. Sc. Physics with specialization in Electronics
(For newly admitted students from Session 2019-2020)

Junior Year, Semester I

S. N.	Category	Paper Code	Subject Name	L	T	P	Credits
1.	PC	MPM-101	Mathematical Physics and Classical Mechanics	3	1	0	**4**
2,	PC	MPM-102	Condensed Matter Physics	3	1	2	**5**
3.	PC	MPM-103	Quantum Mechanics	3	1	0	**4**
4.	PC	MPM-104	Semiconductor Devices and Integrated Circuit	3	1	-	**4**
5.	PC	MPM-105	Electronic Devices and Circuit lab	-	-	04	**2**
6.	AC	Audit Subject	Audit Subject				**-**
			Total	**12**	**4**	**6**	**19**

Junior Year, Semester II

S. N.	Category	Paper Code	Subject Name	L	T	P	Credits
1.	PC	MPM-106	Atomic, Molecular Physics and Lasers	3	1	0	**4**
2.	PC	MPM-107	Electrodynamics	3	1	0	**4**
3.	PC	MPM-108	Spectroscopic and Laser Lab	-	-	4	**2**
4.	PE1	MPM*	Program Elective-1	2	1	2	**4**
5.	PE2	MPM**	Program Elective-2	2	1	2	**4**
6.	AC		Audit Subject				**-**
			Total	**10**	**4**	**8**	**18**

*One course from Program Elective-1, **One course from Program Elective-2

Senior Year, Semester III

S. N.	Category	Paper Code	Subject Name	L	T	P	Credits
1.	PC	MPM-201	Thermodynamics and Statistical Mechanics	3	1	0	**4**
2.	PC	MPM-202	Optoelectronics and Optical Communication System	3	1	0	**4**
3.	PC	MPM-203	Nuclear and Particle Physics	3	1	0	**4**
4.	PC	MPM-204	Optoelectronics and Optical Communication Lab	-	-	4	**2**
5.	PE-3	MPM***	Program Elective-3	3	1	0	**4**
6.	D	MPM-350	Dissertation Part-I	0	0	6	**3**
			Total	**12**	**4**	**10**	**21**

*** One course from Program Elective-3

Senior Year, Semester IV

S. N.	Category	Paper Code	Subject Name	L	T	P	Credits
1.	PC	MPM-205	Microprocessor and Application	3	1	0	**4**
2.	PC	MPM-206	Microprocessor and Microcontroller Lab	-	-	4	**2**
3.	D	MPM-450	Dissertation Part-II	0	0	24	**12**
			Total	3	1	28	**18**

Programme Core for M. Sc. Physics with Specialization in Electronics

S. N.	Paper Code	Subject Name	L	T	P	Credits
1.	MPM-101	Mathematical Physics and Classical Mechanics	3	1	0	**4**
2.	MPM-102	Condensed Matter Physics	3	1	2	**5**
3.	MPM-103	Quantum Mechanics	3	1	0	**4**
4.	MPM-104	Semiconductor Devices and Integrated Circuit	3	1	0	**4**
5.	MPM-105	Electronic Device and Circuit lab	-	-	4	**2**
6.	MPM-106	Atomic, Molecular Physics and Lasers	3	1	0	**4**
7.	MPM-107	Electrodynamics	3	1	0	**4**
8.	MPM-108	Laser and Spectroscopy Lab	-	-	4	**2**

9.	MPM-201	Thermodynamics and Statistical Mechanics	3	1	0	**4**
10.	MPM-202	Optoelectronics and Optical Communication System	3	1	0	**4**
11.	MPM-203	Optoelectronics and Optical Communication Lab	-	-	4	**2**
12.	MPM-204	Nuclear and Particle Physics	3	1	0	**4**
13.	MPM-205	Microprocessor and Application	3	1	0	**4**
14.	MPM-206	Microprocessor and Microcontroller Lab	-	-	4	**2**
			30	**10**	**09**	**49**

Programme Electives (PE-I)

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPM-121	Computational Technique and Programming		2	1	2	**4**
2.	MPM-122	Physics of Materials		3	1	0	**4**
3.	MPM-123	Methods in Theoretical Physics		3	1	0	**4**
4.	MPM-124	Mobile Communication		3	1	0	**4**
			Total	**11**	**4**	**2**	**16**

Programme Electives (PE-II)

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPM-131	Analogue and Digital Communication		2	1	2	**4**
2.	MPM-132	Instrumentation Technology		3	1	0	**4**
3.	MPM-133	Solar and Astrophysics		3	1	0	**4**
4.	MPM-134	Satellite Communication and Remote Sensing		3	1	0	**4**
			Total	**11**	**4**	**2**	**16**

Programme Electives (PE-III)

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPM-221	Advance Quantum Mechanics		3	1	0	**4**
2.	MPM-222	Quantum Field Theory		3	1	0	**4**
3.	MPM-223	Fiber Optics and Nonlinear Optics		3	1	0	**4**
4.	MPM-224	Wireless Communication		3	1	0	**4**
			Total	**12**	**4**	**0**	**16**

***Audit course for M. Sc. Physics with Specialization in Electronics**

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	BCS-01	Introduction to Computer Programming		3	1	2	**5**
2.	MAS-105	Applied Probability and Statistics		3	1	0	**4**
3.	MBA-109	Research Methodology		3	1	0	**4**
4.	BEE-20A	Simulation Techniques		0	0	6	3
			Total	**09**	**3**	**4**	**16**

*****The syllabus of above-mentioned audit courses recommended for the M. Sc. Physics with Specialization in Electronics during Ist and IInd Semester will be same as recommended by different department and running as the part of different other courses of this university.

SYLLABI

MPM-101: MATHEMATICAL PHYSICS AND CLASSICAL MECHANICS

Course category : Department Core (DC)

Pre- requisites : B.Sc. with Physics and Math

Contact hours/week : Lecture: 3, Tutorial: 1, Practical:0

Number of Credits : 4

Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs):

1. The students will understand various functions, solutions to differential equations and matrix applications to solve the related problems.
2. The foundation for understanding of different series, complex analysis and their applications will be laid.
3. Foundation for the applications of transformation techniques will be laid.
4. The students will understand dynamics of particles and conservation laws.
5. The understanding of different mechanical problems and their solutions will be developed.

Unit-I: Theory of Functions, Matrices and Differential Equations: 9

Vector algebra and vector calculus, matrices, Cayley- Hamilton theorem, Eigen values, Properties of Eigen values, Power of Matrix, Eigen Vectors, Properties of Eigen Vectors, Orthogonal Vectors. Linear differential equations of first order, Linear differential of second order. Special functions, Legendre, Bessel, Hermite and Laguerre functions (Generating functions and recurrence relations).

Unit-II: Complex Variable, Fourier and Laplace Transforms and Probability theory: 9

Elements of Complex analysis, Cauchy-Riemann conditions, Cauchy's Integral formula, Taylor & Laurent Series, singularities, pole and calculus of residues. Fourier Series, Fourier and Laplace Transforms. Elementary Probability Theory, random variables, binomial, Poisson and normal distributions, Central Limit Theorem.

Unit-III: Classical Mechanics : Dynamics of Bodies and relativistic kinematics 9

Newton's laws of motion, Inertial frame, dynamical systems, phase space dynamics, Stability analysis, conditions of equilibrium. Central force motions, Two body collisions- scattering in laboratory and center of mass frames. Generalized coordinates of a rigid body, body and space reference systems, Angular Momentum and Inertia Tensor. Special theory of relativity, Lorentz transformations, relativistic kinematics and mass- energy equivalence

Unit-IV: Classical Mechanics: Langrangian and Hamiltonian Dynamics 9

Non-inertial frame of reference and pseudoforce, Generalized coordinates, Principle of virtual work and D' Alembert's principle, Langrange's equation from D' Alembert's principle, Hamiltonian formalism: Generalized momentum and cyclic Coordinates, conservation theorems, conservation of linear and angular momentum, Hamiltonian function H and conservation of Energy: Jacobis integral. Two coupled oscillators, normal coordinates and normal mode.

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Books & References:

1. Mathematical Methods for Physicists -G. Arfken, Elsevier Academic Press, USA
2. Mathematics for Physicists and Engineers- Pipes, -MC Graw Hill Publishing Company, New York
3. Mathematical Methods for Physics- Wyle, McGraw-Hill 1995
4. M. R. Spiegel -Theory and Problems of Complex Variables, Schaum's outline series
5. Mathematical Methods of Physics- J. Mathews and R. I. Walker -W.A. Benjamin
6. Mathematical Physics by H.K. Dass, S. Chand and Company.

7. Classical Mechanics by J.C. Upadhyaya, Himalaya Publishing House
8. Classical Mechanics by N.C. Rana and P.S. Joag, Mc Graw Hill Education.

MPM-102: CONDENSED MATTER PHYSICS

Course category : Department Core (DC)
Pre- requisites : B.Sc. with Physics and Math
Contact hours/week : Lecture: 3, Tutorial: 1, Practical:2
Number of Credits : 5
Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes:

1: To disseminate fundamental knowledge about structures of materials used in manufacturing devices for various applications.

2: To make them learn about thermal, optical, semiconducting, ferro-magnetic, ferro-electric and superconducting properties of materials which have novel applications in diverse areas of science & engineering.

3: To enable students to carry out experiments so that they can perform the task of characterizing materials, and correlated their properties with structures.

4: Enabling students to gain applied knowledge so that they can solve real problems in research institutions and industries.

Unit-I: Crystal Structure & Band Theory of Solids **9**

Space lattice and basis; Types of lattice, Bravais lattices, Miller indices, Crystal structures of NaCl and diamond; Reciprocal lattice and Brillouin zones; Laue diffraction: atomic and structure factor, Basic idea of crystal defects and dislocations, Ordered phases of matter: translational and orientational order, Quasi crystals, Bonding in solids, Band theory of solids: metals, insulators and semiconductors, Density of states, Origin of energy bands: Bloch Theorem; Kronig Penney model

Unit-II: Thermal and Optical Properties **9**

Elastic properties, Lattice vibrations of mono and diatomic chains, Quantization of lattice vibration, Phonons and its properties, Lattice specific heat: Classical and quantum theory (Dulong-Petit law, Einstein theory, Debye law), Fermi Energy, Drude and Sommerfeld model: electrical and thermal conductivity, Kramers- Kronig relations, Hall effect: classical and quantum theory, Thermoelectric power

Unit-III: Magnetic and Ferro-electric Properties **9**

Magnetism and its origin, Paramagnetism in metals and insulators, Magnetic dipoles, ground and excited states, multiplet separation, Ferromagnetism: Weiss Molecular field theory, Heisenberg explanation of internal magnetic field, Landau theory of domain, Bloch $T^{3/2}$ law, Anti-ferromagnetism, ferrimagnetism: Neel's two sub-lattice model, Ising model

Ferro-electricity: Ferroelectric materials; their properties and classification, Order-disorder and displacive type ferro electric materials, Occurrence of ferro-electricity due to polarization, Catastrophe and lattice modes, Devonshire theory of ferroelectric phase transition

Unit-IV: Superconductivity **9**

Superconductors: Type-I & Type-II superconductors, Meissner effect, Transport currents, Elements of BCS theory: Coherence and phase of electron pair waves, energy gaps, London equation: penetration depth, Ginzburg-Landau theory, Thermodynamics of superconductors: Entropy, specific heat and latent heat, Applications of superconductors: Cooper-pair tunneling (AC &DC Josephson effect), Super conducting quantum interference device (SQID), Superfluidity in He^3

Books & References:

1. Solid State Physics by A-J.Dekkar (McMillan and Co., London)
2. Introduction to Solid State Physics by C.Kittel (Wiley Eastern, New Delhi)
3. Solid State Physics by N.W. Ashcroft and N.D. Mermin, Brooks/Cole
4. Elementary Solid-State Physics: Principle and Application by Omar Ali (Addison Wesley, London)
5. Electrons and Phonons by J.M.Ziman (Oxford University Press, London)
6. Condensed Matter Physics, M.P. Marder, Wiley
7. Quantum Theory of Solid by C. Kittel (John Wiley and Sons, London)

LIST OF EXPERIMENTS

1. Electron Spin Resonance
2. Nuclear Magnetic Resonance
3. Measurement of Resistivity-Four Probe and van der Paw techniques; determination of band gap
4. Measurement of magneto resistance
5. B-H curve and hysteresis loss in ferromagnets
6. Hall effect
7. Magnetic Susceptibility
8. Measurement of dipole moment
9. e/m by Zeeman effect
10. EPR of free radicals

MPM-103: QUANTUM MECHANICS

Course category : Department Core (DC)
Pre- requisites : B.Sc. with Physics and Math
Contact hours/week : Lecture: 3, Tutorial: 1, Practical:0
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs):

1. The students will develop the foundation for understanding of Quantum Mechanics.
2. The student will understand the concepts of quantum mechanics and solving operator equations for different quantum problems.
3. The students will understand wave mechanical formulation of quantum particles and various rules arising out of it.
4. The understanding of different formulations of quantum mechanics laying foundations for the study of identical particles and their properties.

Unit I: Mathematical Preliminaries **09**

Concept of Hilbert Space, linearly independent and dependent vectors, Dirac's bra and ket notations, Properties of kets, bras, and bra-kets operators, linear operators, Hermitian Adjoint, Hermitian and skew-Hermitian operators, projection operators, properties of projection operators, matrix representation of kets, bras, and operators, eigenvalue equations and related theorems, equivalence of matrix mechanics and wave mechanics, Schrodinger picture, Heisenberg picture.

Unit II: Schrödinger Equation and Application **09**

Schrodinger Equation: the free particle solution, wave packets, the potential barrier problem, transmission and reflection through a potential barrier, the tunnelling effect, the finite square well potential, particle in a square well potential, bound state solutions, simple harmonic oscillator, eigen value problems using operator or algebraic methods, occupation number operator, annihilation and creation operators, energy eigen value and eigen states.

Unit III: Theory of Angular momentum **09**

angular momentum, orbital angular momentum, orbital, spin and total angular momentum operators, commutation relations, eigenstates and eigenvalues equations of the angular momentum operator, matrix representations and geometrical representation, Addition of angular momenta, eigenvalues of J^2 and J_z, Clebsch-Gordon coefficients

Unit IV: Identical Particles **09**

Distinguishability of identical particles, exchange degeneracy, construction of symmetric and antisymmetric wave functions, Pauli's exclusion principle and Slater's determinant, Electron spin hypothesis, spin angular momentum, general theory of spin, Pauli's spin matrices and eigen value equations

Books & References:

1: Modern Quantum Mechanics by J. J. Sakurai (Pearson Education India)
2: Quantum Mechanics: Concept & Applications, Nouredine Zettili, A John Wiley & Sons, Ltd., Pubication
3: Quantum Mechanics, Vol. (I) by Albert Messiah (North Holland Publishing Company, Amsterdam, 1961)
4: Concepts in Quantum Mechanics by V. S. Mathur and Surendra Singh (CRC Press, 2009)
5: Quantum Mechanics by L.I. Schiff (Mc-Graw Hill Inc.)

6: Quantum Mechanics by B. K. Agarwal and Hari Prakash (Prentice-Hall of India Pvt Ltd, New Delhi, 2005)
7. Qunatum Mechanics by Ajoy K Ghatak (McMillan Co. of India)

MPM-104: SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUIT

Course category	: Department Core (DC)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:2
Number of Credits	: 5
Course Assessment	: Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will get in-depth understanding of the electronic structure, charge carrier statistics and charge transport properties in semiconductors.
2. Develop understanding of principles of operation of new and future electronic and photonic devices based on semiconductors.
3. Infer the op-amp characteristics and parameters in different configuration and its application in practical circuits.
4. Apply the information of number system in solving K-maps and digital circuits: both combinational and sequential circuits and relate their application in designing and simplifying new digital circuits.
5. Understand the working of different devices like encoder, de-coder, multiplexer,flip-flops, register, counter etc.

Unit-I: Semiconductor Physics **9**

Bandgaps in semiconductors, Fermi distribution and density of states, Scattering Mechanism: electron - electron and electron - phonon scattering, Carrier transport by drift and diffusion. Electron - hole pair generation and recombination, Excitons, Continuity equations.

Unit-II: Semiconductor Devices **9**

Light emitting diodes, Varactor diode, Zener diode, Schottky diode, Tunnel diode, Semiconductor laser, Photodiodes, Solar cell, UJT, Gunn diode, IMPATT devices, Liquid crystal displays, FET and MOSFET.

Unit-III: Op-Amp Circuits **9**

Characteristics and parameters of Op-Amp, Frequency response, Current mirror and current loading biasing, Concept of ideal op-amp, Differential amplifiers, IC 741 circuits - amplifiers, Scalar, Summer, Subtractor, Comparator, Logarithmic amplifiers, Multiplier, Divider, Differentiator, Integrator.

Unit-IV: Digital Circuits **9**

Survey of number systems, Logic simplification using K-maps, SOP and POS design of logic circuits, Logic Families, Combinational Circuits: Adders, subtractors, Encoder, De-coder, Comparator, Multiplexer, De-multiplexers, Sequential Circuits: Flip-flops, Registers, Counters, Memories; A/D and D/A conversion.

Books & References :

1. Semiconductor Physics and Devices by D.A. Neamen, (3rd Ed.,Tata McGraw-Hill), 2002.
2. Semiconductor Devices - Physics and Technology by S.M. Sze (John Wiley), 2002.
3. Electronic Principles by A.P. Malvino (Tata McGraw, New Delhi), 7th edition, 2009.
4. Electronic Devices and Circuits Theory : Boylested and Nashelsky, (Pearson Education) 10th ed. 2009.
5. OPAMPS and Linear Integrated circuits : Ramakant A Gayakwad (Prentice Hall), 1992.
6. Operational amplifiers and Linear Integrated circuits, R.F. Coughlin and F.F. Driscoll, (Prentice Hall of India, New Delhi), 2000.
7. Digital Design by M. Morris Mano, Michael D. Ciletti, (Prentice Hall of India Pvt. Ltd.), 2008.

MPM-105: ELECTRONIC DEVICES AND CIRCUIT LAB

Course category : Department Core (DC)
Pre- requisites : B.Sc. with Physics and Math
Contact hours/week : Lecture: 0, Tutorial: 0, Practical:4
Number of Credits : 2
Course Assessment Methods : Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will obtain and analyse the V-I characteristics of zener diode and different LEDs.
2. Implement the experiment to study the frequency response of common source FET and MOSFET amplifiers
3. Design and analyze circuits to study operational amplifier's frequency response and use op-amp to perform different mathematical operations.
4. Demonstrate the IC 555 in astable and monostable modes.
5. Verify the truth table for Logic gates and flip flops and also verify A/D and D/A conversion.

List of Experiments

1. Volt-Ampere Characteristics of Zener Diode and Zener Voltage regulator characteristics.

2. To obtain the V-I Characteristics of LED for different LEDs (Red, Blue, Green, Yellow etc.) and find the LED voltages of different LEDs

3. To obtain Frequency response characteristics and bandwidth of Common Source FET and MOSFET amplifiers.

4. Use of timer IC 555 in astable and monostable modes and applications involving relays, LDR.

5. To study the frequency response of an operational amplifier & to use operational amplifier for different mathematical operations

6. To configure various shift registers and digital counters. Configure seven segment displays and drivers.

7. To verify the truth table for Logic Gates and flip flops.

8. To verify A/D and D/A converter

Books & References:

1. Milman J. and Halkias C.C., Electronic Devices and Circuits, Tata McGraw Hill, 1993
2. Semiconductor Physics and Devices by D.A. Neamen, (3rd Ed.,Tata McGraw-Hill), 2002.
3. Electronic Principles by A.P. Malvino (Tata McGraw, New Delhi), 7th edition, 2009.
4. Electronic Devices and Circuits Theory: Boylested and Nashelsky, (Pearson Education) 10th ed. 2009.
5. OPAMPS and Linear Integrated circuits: Ramakant A Gayakwad (Prentice Hall), 1992.
6. Digital Design by M. Morris Mano, Michael D. Ciletti, (Prentice Hall of India Pvt. Ltd.), 2008.

MPM-106: ATOMIC, MOLECULAR PHYSICS AND LASERS

Course category : Department Core (DC)
Pre- requisites : B.Sc. with Physics and Math
Contact hours/week : Lecture: 3, Tutorial: 1, Practical:0
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will understand various mechanism of atomic transitions in view of electromagnetic radiations.
2. Understanding of vector atom model for the successful explanation of the electromagnetic spectrum produced by different atoms.
3. Explanation of the effect of magnetic and electric fields on the spectral lines of atoms.
4. Understanding of various electromagnetic transitions in molecules and their applications.
5. Basic understanding of Raman Spectroscopy and its applications.
6. Different LASER and their applications in industries and research and developments.

Unit- I: Principles of Spectroscopy: 09

Quantum states of an electron in atom. Origin of one electron atomic spectra, correction for finite nuclear mass, Spectra of H and He^{+}. Sommerfeld extension of Bohr' s model, Relativistic correction for energy levels of hydrogen atom. Vector atom model and electron spin. Stern-Gerlach Experiment. Hydrogen hyperfine structure and isotopic shift width of spectral lines. Spectra of Helium and alkali atoms.

Unit-II: Atomic Spectroscopy 09

L-S and j-j coupling, Lande interval rule, Spectral terms for L-S coupling, Selection rules for multi-electron atoms in L-S Coupling and j-j coupling, Zeeman effect, Anomalous Zeeman effect, Paschen- Back effect. Spectra of Helium and alkali atoms. Nuclear spin and hyperfine splitting.

Unit-III: Molecular Spectroscopy, NMR and ESR 09

Born- Oppenheimer Approximation, Types of Molecular Spectra, Rotational, Vibrational Spectra, Molecule as anharmonic Oscillator, Vibrational frequency and force constant for anharmonic Oscillator. Formation of Electronic Spectra, Franck-Condon Principle, Raman spectra, Experimental arrangement for Raman Spectra, Classical and Quantum theory of Raman Effect, Raman Spectra of Diatomic Molecules and Selection Rules. Magnetic properties of Nuclei, Resonance Condition, NMR Instrumentation, Principles of ESR, ESR spectrometer.

Unit-IV: Basic Principles of Laser **09**

Two level, Three and Four level laser system, Rate equations for three and four level system, threshold pump power, Relative merits and de-merits of three and four level system, Solid State and Semi-conductor Lasers, Gas and dye lasers, Application of Laser in Material Processing, Optical resonators, Stability of resonators, Characteristics of Gaussian beam, Transverse and longitudinal modes, mode selection, losses in a resonator.

Books & References:

1: Physics of Atoms and Molecules by B.H. Bransden and C.J. Joachain, Pearson

2: Quantum Chemistry by I.N. Levine, Prentice Hall

3: Quantum Mechanics by L.D. Landau and E.M. Lifshitz, Pergamon Press

4: Molecular Quantum Mechanics by P.W. Atkins and R.S. Friedman, Oxford University Press

5: Atomic & Molecular Spectra: Laser by Rajkumar, Kedar Nath and Ram Nath, Meerut.

6: Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, Cengage Learning Pvt. Limited.

7: Molecular Structure and Spectroscopy by G. Aruldhas, PHI, Learning Pvt. Limited.

8: Atomic, Laser and Spectroscopy by S. N. Thakur and D. K. Rai, Perntice Hall of India, New Delhi, India

MPM-107: ELECTRODYNAMICS

Course category	: Department Core (DC)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will understand the nature of electric and magnetic fields and electromagnetic waves.
2. Basic understanding of electric and magnetic fields and its applications.
3. The students will understand various physics of electromagnetic waves.
4. The students will be able to apply the concepts of electromagnetics' physics for the successful explanation of the electromagnetic wave and its characteristics.

UNIT- I Mathematical Preliminaries & Formulations in Electrodynamics with Vector Analysis 9

Vector Algebra, operations, separation vectors, Differential Calculus, gradient, The operator del, The divergence, the curl, product rule, Integral calculus, Line, Surface and Volume integrals, Curvilinear coordinates, Spherical polar coordinates, cylindrical coordinates

UNIT- II Electrostatics and Magnetostatics 9

Electrostatics: The Electric field, Flux and Guass's Law, Applications of Gauss's Law, Methods of solving electrostatic problems in cartesian, spherical and cylindrical coordinates, Magnetostatics: Biot-Savart Law, Electromagnetic induction, Faraday's law, Ampere's law, modification in Ampere's law, concept of displacement current

UNIT- III Electrodynamics and Electromagnetic waves 9

Conservation laws, Wave equations, Maxwell's wave equations in free space and physical significance, energy transmitted by a plane wave, Poynting theorem, Electromagnetic waves in free space and isotropic dielectrics, Waves in conducting media, skin depth, Wave Guides, Transmission Line

UNIT- IV Potentials, Field and Relativistic Electrodynamics 9

The potential formulation, Scalar and Vector Potentials, Gauge transformation, Lorentz Gauge, Coulomb Gauge, Retarded potential, Special Relativity: The structure of Spacetime, four vectors and transformations, Lorentz transformation matrix, four-dimensional product, covariant and contravariant vector, transformation of fields, tensor notation, electrodynamics in tensor notation

Books & References

1. David J. Griffith-Introduction to Electrodynamics, Fourth Edition, Prentice Hall, 2013
2. L.D. Landau & E.M. Lifshitz- Electrodynamics of Continuous Media, Pergamon Press 1960
3. J.D. Jackson, Classical Electrodynamics, Wiley
4. Andrew Zangwill, . Modern Electrodynamics, Cambridge University Press, 2013, United Kingdom,
5. Parcell, Edward M., Electricity and Magnetism, 2nd Edition, McGraw-Hill Company, 1985
6. S.P. Puri, Classical Electrodynamics, (Narosa Pu blishing House) 2011.
7. A.Z. Capri and P.V. Panat, Introduction to Electrodynamics, (Narosa Publishing House) 2010
8. Saroj K. Dash & Smruti R. Khuntia-Fundamentals of Electromagnetic Theory, PHI
9. Edward C. Jordan, Electromagnetic Waves and Radiating System, Prentice Hall Electrical Engineering Series.

MPM-108: SPECTROSCOPY AND LASER LAB

Course category : Department Core (DC)

Pre- requisites : B.Sc. with Physics and Math
Contact hours/week : Lecture: 0, Tutorial: 0, Practical:4
Number of Credits : 2
Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will realize the practical demonstration of electromagnetic radiations due to the atomic and molecular transitions.
2. Practical applications of photoelectric effect and LASER.
3. Practical demonstration of the effect of magnetic fields on the spectral lines of atoms.
4. Measurement of various electromagnetic transitions in due to different samples.
5. Measurement of ionization potential and dissociation energy of different samples.

List of Experiments

1. Spectroscopy of iodine vapor.
2. Laser diffraction by a thin wire
3. Measurement of Planck's constant using photoelectric effect
4. To study Zeeman effect using Na lamp.
5. Experiment with liquid/solid using UV/Fluorescence spectroscopy
6. Measurement of optical spectrum of an alkali atom
7. Laboratory spectroscopy of standard lamps
8. Measurement of FTIR/Raman spectrum of solid/liquid (CCl_4)
9. Ionization potential of Lithium
10. Dissociation Energy of I_2 molecule

Books & References:

1. Physics of Atoms and Molecules: Bransden and Joachain.
2. Lasers - Theory and Applications: K. Thyagrajan and A.K. Ghatak.
3. Introduction to Atomic Spectra: H.E. White.
4. Introduction to Atomic Spectra: HG Kuhn
5. Modern Spectroscopy : J.M. Hollas
6. Fundamentals of Molecular Spectroscopy : C.N. Banwell.

MPM-201: THERMODYNAMICS AND STATISTICAL MECHANICS

Course category	: Department Core (DC)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes:

1: To disseminate fundamental concepts of statistical physics, and thermodynamics.

2: To enable students to solve complex science and engineering problems using different ensembles, free energies and statistical distributions.

3: To make them learn and acquire knowledge about different phases of specific materials and their dependence on various parameters relevant for industry applications.

4: To make students learn about microscopic distributions laws which yield macroscopic results independent of the microscopic detail.

5: To help students to acquire knowledge and skill so that they can apply statistical analysis in different walks of life.

Unit-I: Thermodynamics and Phase Equilibrium **9**

Laws of thermodynamics and their consequences, Thermodynamic potentials, Maxwell relations, Chemical potential, Phase equilibria, Entropy of mixing, First -and second -order phase transitions, Thermodynamic functions and their properties, Clausius-Clapeyron's deduction, Triple point, Thermal conductivity of liquids, Einstein Diffusion equation: Viscosity.

Unit-II: Statistical Treatment of Thermodynamics **9**

Thermodynamic treatment of variation of latent heat, Statistical theory of heat, Statistics of the motion of molecular system, Introduction of temperature, pressure, entropy and energy: Their relations, Maxwell velocity distribution, Statistical analysis of law of thermodynamics, Boltzmann relation between entropy and probability.

Unit-III: Classical Statistical Mechanics **9**

Phase space, micro-and macro-states, Micro-canonical, canonical and grand -canonical ensembles, Partition functions, Free energy, Classical statistics, Ising model, Mean-field theory in zeroth and first approximations, Exact solution in one dimension.

Unit- IV: Quantum Statistics **9**

Fermi-Dirac and Bose-Einstein statistics, Ideal Bose and Fermi gases, Blackbody radiation and Planck's distribution law, Bose-Einstein condensation, BEC in a harmonic potential, Properties of simple metals, Pauli paramagnetism , Quantum liquid, Tisza two fluid model

Reference Books:

1. Statistical Mechanics by by Landau and Lipsitz (Butterworth, Heinemann)
2. Fundamentals of Statistical and Thermal Physics by F. Reif (TataMc Graw Hill, New York)
3. Statistical Mechanics by K. Huang (John-Wiley, USA)
4. Statistical Mechanics by R K Pathria Paul D. Beale (Elsevier)
5. Principles of Equilibrium Statistical Mechanics by D. Choudhury and D. Stauffer (Wiley-VCH)
6. Heat and Thermodynamics by Mark W. Zemansky and Richard H. Dittman (TataMc Graw Hill)
7. Thermal Physics by C. Kittel (John Wiley, USA)

MPM-202: OPTOELECTRONICS AND OPTICAL COMMUNICATION SYSTEM

Course category	: Department Core (DC)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will develop fundamental physical and technical base of optical processes in semiconductors and an understanding of basic laws and phenomena that define behaviour of optoelectronic systems.
2. Analyse the working and characteristics of semiconductor laser, LEDs, photodetectors and phototransistors.
3. Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.
4. Learn about different fiber components and will get practical knowledge about the fiber connectors, joint losses and the digital and analog communication system in totality.
5. Develop a keen interest in the era of research in optoelectronic devices.

UNIT I: Optical process in semiconductors **9**

Optoelectronic properties of semiconductor: effect of temperature and pressure on bandgap, carrier scattering phenomena, conductance processes in semiconductor, bulk and surface recombination phenomena, optical properties of semiconductor, EHP formation and recombination, absorption in semiconductors, effect of electric field on absorption.

UNIT II: Optical sources and detectors **9**

An overview of optical sources (Semiconductor Laser and LEDs), Optical Detectors: Type of photo detectors, characteristics of photo detectors, noise in photo detectors, photo transistors and photo conductors.

UNIT III: Optical fiber **9**

Structure of optical wave guide, light propagation in optical fiber, ray and wave theory, modes of optical fiber, step and graded index fibers, transmission characteristics of optical fibers, signal degradation in optical fibers; attenuation, dispersion and pulse broadening in different types of optical fibres.

UNIT IV: Fiber components and optoelectronic modulation **9**

Fiber components: Fibre alignments and joint loss, fiber splices, fiber connectors, optical fiber communication, components of an optical fiber communication system, modulation formats, digital and analog optical communication systems, analysis and performance of optical receivers, optoelectronic modulation.

Books and References:

1. Semiconductor Optoelectronics Devices: Pallabh Bhattacharya. Pearson Education
2. Physics of Semiconductor Devices-:S. M. Sze, Wiley Publications.
3. Optical Electronics: Ghatak and Thyagrajan
4. Optical Fiber Communication: Principles, John. M. Senior, Prentice Hall of India.
5. Optical Fiber Communication, Gerd Keiser, McGraw Hill, 3rd edition.
6. Fiber Optic and Optoelectronics, R.P. Khare, Oxford University press.

MPM-203: NUCLEAR AND PARTICLE PHYSICS

Course category	: Department Core (DC)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will learn nuclear structure its energy and conservation laws.
2. Understanding of nuclear fission and fusion and their applications in nuclear reactors.
3. Elementary particles and their characteristics.
4. Knowledge of conservation laws of elementary particles and the Effect of Electro-Magnetic field on elementary particles.
5. Be prepared for research in areas related to nuclear and particle physics.

UNIT 1: Nuclei and Its Properties **09**

Discovery of the nucleus, Rutherford scattering: Scattering cross-section, form factors, Kinematics of (non-) relativistic scattering, Properties of nuclei: size, mass, charge, angular momentum, magnetic moment, parity, quadrupole moment, Charge and mass distribution, Mass defect, Binding-energy statistics, Bethe-Weiszacker mass formula, Magic numbers, Characteristics of nuclear forces -Range and strength

UNIT 2: Nuclear Stability **09**

Nuclear stability: alpha, beta and gamma decay, Tunneling theory of alpha decay, Fermi theory of beta decay, Parity violation, Nuclear reactions: Fission and fusion, Construction and function of nuclear reactors, Nuclear models: Shell model, Nilson model etc.

UNIT 3: Elementary Particles **09**

Elementary particles, Classification and properties of elementary particles: Leptons, Baryons, mesons particles and antiparticles, Excited states and resonances, Various types of interactions: Gravitational, electromagnetic, weak and strong interactions and their mediating quanta.

UNIT 4: Conservation Laws **09**

Conservation laws in fundamental interactions, Charge symmetry and charge independence, Parity and charge conjugation, Conservation of parity and its violation in different types of interactions, Strange particles: Associated production, strangeness and decay modes of charged Kaons, Isospin and its conservation.

REFERENCES

1.Concepts of Nuclear Physics by B.L. Cohen (Tata McGraw Hill)

2: Nuclear Physics by I. Kaplan (Addison-Wesley)

3: Introduction to Elementary Particles by D. Grrifiths (Academic Press, 2nd ed. 2008)

4: Nuclear and Particle Physics: An Introduction by B. R. Martin (Wiley, 2006)

5: Physics of Nuclei and Particles by Pierre Marmier and Eric Sheldon (Elsevier)

6: Nuclei and Particles by Emilio G. Segre (2nd ed. Basic Books)

7: Introduction to Nuclear and Particle Physics by A. Das and T. Ferbel (World Scientific)

MPM-204: OPTOELECTRONICS AND OPTICAL COMMUNICATION LAB

Course category : Department Core (DC)

Pre- requisites : B.Sc. with Physics and Math

Contact hours/week : Lecture: 0, Tutorial: 0, Practical:4

Number of Credits : 2

Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will verify and study the characteristics of various optoelectronic devices like LDR and phototransistor.
2. Design circuits to study the characteristics of photodiode and opto-coupler.
3. Learn the method of measurement of the numerical aperture of single mode and multi-mode fiber.
4. Measure the bending loss and splice loss in multimode fiber.
5. Calculate the normalized frequency and mode field diameter of single mode fiber.

List of Experiments

1. Characteristic study of Light Dependent Resistor (LDR)

2. Characteristic study of Photo Transistor

3. Characteristic study of Photodiode

4. Characteristic study of Opto-Coupler

5. Numerical aperture measurement of single mode and multi-mode fiber

6. Measurement of bending loss and splice loss in multi-mode fiber

7. Calculation of normalized frequency or V-number of single mode fiber

8. Calculation of mode field diameter of single mode fiber.

Books and References:

1. Semiconductor Optoelectronics Devices: Pallabh Bhattacharya. Pearson Education
2. Physics of Semiconductor Devices-:S. M. Sze, Wiley Publications.
3. Optical Electronics: Ghatak and Thyagrajan
4. Optical Fiber Communication: Principles, John. M. Senior, Prentice Hall of India.
5. Optical Fiber Communication, Gerd Keiser, McGraw Hill, 3rd edition.
6. Fiber Optic and Optoelectronics, R.P. Khare, Oxford University press.

MPM-205: MICROPROCESSOR AND APPLICATION

Course category	: Department Core (DC)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will identify the internal organization of popular 8085/8086/8051 microprocessors/microcontrollers.
2. Analyze hardware and software interaction and integration.
3. Impart the knowledge about the instruction set & peripheral interfacing.
4. Understand the basic idea about the data transfer schemes and its applications
5. Develop skill in simple program writing for 8085 & 8086 and applications in various electronic devices.

UNIT I: Introduction to microprocessors **9**

Evolution of microprocessors, Register structure, ALU, Bus organization, Timing and control, Architecture: Architecture of 8085/8086/ Intel organization, Bus cycle.

UNIT II: Assembly language programming **9**

Addressing modes, Data transfer instructions, Arithmetic and logic instructions, Program control instructions (Jumps, Conditional jumps, Subroutine call), Loop and String instructions, Assembler Directives, Parameter passing and Recursive procedures.

UNIT III: Peripherals interfacing **9**

Programmed I/O, Interrupt driven I/O, DMA, Parallel I/O (8255-PPI), Serial I/O (8251/ 8250, RS-232 Standard), 8259 – Programable Interrupt Controller, 8237 DMA controller, 8253/ 8254 – Programmable Timer/ Counter.

UNIT IV: Microprocessor application **9**

Interfacing of ADC and DAC with microprocessor, user of sample and hold circuit and multiplexer with ADC. Microprocessor Applications: Design methodology, examples of microprocessor applications.

Books and References:

1. Microprocessor Architecture, Programming and application with 8085, 4th Edition, Ramesh S Gaonkar, Penram International Publishing, New Delhi, 2000.
2. Microprocessor Systems: The 8086/ 8088 family Architecture, Programming and Design, Yu-Chehg Liu and Gibson
3. Advanced Microprocessors - A. K. Rai and K. M. Bhurchandi (Tata McGraw Hill), 2006
4. Advanced Microprocessors - Y. Rajshree (New Age)

MPM-206: MICROPROCESSOR AND MICROCONTROLLER LAB

Course category	: Department Core (DC)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 0, Tutorial: 0, Practical:4
Number of Credits	: 2
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will be able to write and execute a program to add and substract two hexadecimal and decimal numbers.
2. Write and execute a program to add and substract two BCD numbers using 8085 microprocessor.
3. Write a program to perform multiplication and division of two 8 bit numbers using different methods.
4. Find largest and smallest number from an array.
5. Application of 8085 microprocessor in performing various operations.

List of Experiments:

1. Write a program to add two hexadecimal & decimal numbers.

2. Write a program to subtract two hexadecimal & decimal numbers.

3. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.

4. Write a program to perform multiplication of two 8 bit numbers using bit addition method.

5. Write a program to perform multiplication of two 8 bit numbers using bit rotation method.

6. Write a program to perform division of two 8 bit numbers using Repeated Subtraction method.

7. Write a program to perform division of two 8 bit numbers using bit rotation method.

8. Finding the largest and smallest number from an array.

9. Finding the smallest number from an array.

Books and References:

1. Microprocessor Architecture, Programming and application with 8085, 4th Edition, Ramesh S Gaonkar, Penram International Publishing, New Delhi, 2000.

2. Microprocessor Systems: The 8086/ 8088 family Architecture, Programming and Design, Yu-Chehg Liu and Gibson

3. Advanced Microprocessors - A. K. Rai and K. M. Bhurchandi (Tata McGraw Hill), 2006

4. Advanced Microprocessors - Y. Rajshree (New Age)

Pools of Programme Electives

There are three pools of programme elective PE-I, PE-II and PE-III

First Pool of Programme Electives (PE-I)

MPM-121: COMPUTATIONAL TECHNIQUE & PROGRAMMING

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:2
Number of Credits	: 5
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes:

1: To disseminate fundamental knowledge about computational techniques & tools.

2: To enable students to solve complex science and engineering problems using different numerical methods.

3: To make them learn and acquire programming knowledge and skills in C^{++} and Fortran-77 & 90.

4: To enable students to work out theoretical models to solve real problems e.g. population control, traffic control and molecular modeling etc. which may also help them in finding research positions in academic institutions and industries.

5: To make students learn computational tools & techniques to perform computational experiments and match with real experimental data.

Unit I: Interpolation **09**

Methods of interpolation, least square curve fitting, Methods of equal intervals, unequal intervals, Central Difference method, Inverse interpolation: Iteration of successive approximation, exchange of dependent and independent variables and reversion of series

Unit II: Numerical integration **09**

Simpson's one-third and three-eighth rule, Euler-Maclaurin formula, Quadrature formulae, Numerical Solution to ordinary differential equation by Euler's and Runge-Kutta methods, Solution of algebraic and transcedental equations: Convergence, Newton-Raphson method, Iterative methods.

Unit III: Elements of Programming in Languages-C++ & Fortran **09**

Flow Charts, Integer and Floating points, Logical and Arithmetic Expressions, Built in functions, Executable and Non-Executable statements, Assignments, Control and Input and Output Statements, Looping, Function and Subroutines, Operation with files.

Unit IV: Simulation Techniques **09**

Monte Carlo methods, molecular dynamics, simulation methods for the Ising model and atomic fluids, simulation methods for quantum-mechanical problems, time-dependent Schrödinger equation, discussion of selected problems in percolation, nonlinear dynamics, traffic problems, diffusion-limited aggregation etc.

Books & References:

1: Introductory Methods of Numerical Analysis by S. S. Sastry (PHI Learning Pvt. Ltd)

2: Numerical methods by Balguruswamy (Tata McGraw-Hill Education)

3: Fortran 77 and Numerical Methods by C. Xavier (New Age International)

4: Let US C^{++} by Yashavant Kanetkar (BPB Publication)

5: Numerical Recipes in FORTRAN 90 by W. Press et al. (Cambridge university Press)

6: Computer Programming in Fortran 90 & 95 by V. Rajaraman (Prentice Hall of India)

7: Computer Simulation Methods in Theoretical Physics by D.W. Heermann (Springer-verlag)

8: Computer Simulation of Liquids by M. P. Allen and D. J. Tildesley (Oxford Science Publication)

9: The Art of Molecular Dynamic Simulation by D. C. Rapport (Cambridge University Press)

LABORATORY EXPERIMENT LIST

Students will have to perform any five experiments from the following list.

1: Jacobi Method for Matrix Diagonalization

2: Solution of Transcendental or Polynomial Equations by Newton Raphson Method

3: Least Square Fitting of Straight Line and Quadratic Curve.

4: Summation, Subtraction and Multiplication of Matrices

5: Matrix Inversion and Solution of Simultaneous Equation

6: Interpolation Using Lagrange' Method.

7: Numerical Integration Using Gaussian Quadrature Method

8: Solution of First Order Differential Equations Using Rung-Kutta Method

9: Numerical First Order Differentiation of A Given Function

10: Fast Fourier Transform

11: Generation of Random Numbers.

12: Exercises on Monte Carlo and Molecular Dynamic Simulation

MPM-122: PHYSICS OF MATERIALS

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment	: Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs):

1. The students will understand the Physics of Liquid crystals and Ionic Liquids and their applications in solid devices.
2. The foundation for understanding of different properties of polymers and their applications will be laid.
3. The student will be able to analyse the properties of super ionic solids for their applications.
4. Foundation for the synthesis and characterisation of nanomaterials and their applications will be laid.

UNIT- I **9**

Physics of Liquid crystals and Ionic Liquids: Definition, Classification, Characteristic features; Thermotropic and Lyotropic Liquid Crystals, Application of liquid crystal, importance of ionic liquids, synthesis and characterisations, thermal, electrical, optical and structure behaviour, Ionogels, solid electrolytes based on ionic liquids, Application of ionic liquid in solid devices.

UNIT- II **9**

Physics of Polymers: Definition, Structure, properties and methods of Polymerization, Molecular weights, Degradation of polymers, Viscoelastic state, Glass transition temperature, Electro active polymers, Classification and Applications.

UNIT- III **9**

Physics of super ionic solids or fast ion conductors: Definition, Classification, Conduction in fast ion conductors, synthesis, Characteristic features and properties, Importance and application,

UNIT- IV **9**

Physics of Nano materials and Semiconducting materials: Definition, Types and characteristic features; Quantum size effect; density of states, Synthesis and characterization; Nanocomposites, Application in devices, Semiconducting materials and devices.

Books and Reference:

1. Liquid Crystals by S. Chandrashekhar, (Cambridge Univ. Press, London)
2. Fundamentals of Polymer Physics and Molecular Biophysics, H. Bohidar, Cambridge Uni. Press
3. An Introduction to Polymer Physics by I. I. Perepechko (Mir Publishers)
4. Fast Ion Transport in solids, W. Van Goo1 (Ed.), North Holland publishing Company (1973). 2. S. Geller (Ed.), Solid Electrolytes, Springer-Verlag, Berlin (1977).
5. Super ionic Solids: Principles and Application, S. Chandra, North Holland Publishing Company (1981).
6. The Physics of Amorphous Solids, Richard Zallen, John Wiley & Sons Inc., New York (1983).
7. Introduction to Nanotechnology - C.P. Poole Jr and F.J. Owens, Wiley India, New Delhi
8. Handbook of Nanostructured Materials & Nanotechnology, vol.-5, Academic Press, 2000

MPM-123: METHODS OF THEORETICAL PHYSICS

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment	: Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs):

1. The students will understand Vector, Tensor and Matrix operations to solve the related problems.
2. The foundation for understanding of different series, complex analysis and their applications will be laid.
3. The student will be able to use various functions to solve the related problems.
4. Foundation for the applications of different differential equations and transformation techniques will be laid.

Unit- I: Vectors, Tensors, Matrices and Operators **09**

Vector spaces, Linear operators and matrices, Inverse operators and matrices, The dual space, Change of basis, Canonical form of complex matrices, examples, Some consequences of the Jordan decomposition, Functions of operators/matrices, Hermitian Opertors, Tensors: Covariant and contravariant vectors, mixed tensor, metric tensor, Manipulating tensors: contraction, raising and lowering indices. Tensor densities, Levi-Civita Tensor and its transformations

Unit-II: Complex Variable **09**

Recapitulation: Complex numbers, triangular inequalities, Schwarz inequality. Function of a complex variable : single and multiple-valued function, limit and continuity; Differentiation; Analytic and harmonic function; Complex integrals, Classification of singularities; Branch point and branch cut; Residue theorem and evaluation of some typical real integrals using this theorem.

Unit-III: Special Functions **09**

The Gamma function. Definitions, Digamma and Polygamma functions, Stirling's series, The Beta function., Bessel functions, Neumann functions, Hankel functions, Spherical Bessel functions, Legendre functions, Hermite functions, Laplace function and its application, Green's Functions in one dimensions, Dirac δ-function, its specific representations, step-function

Unit-IV: Ordinary Differential Equation & Fourier Series **09**

Linear ordinary differential equations and their singularities. Sturm- Liouville problem, expansion in orthogonal functions. Series solution of second-order equations, Applications and properties of Fourier Series, Gibbs phenomenon, etc. Integral transformations, Fourier integral, Momentum representation, Laplace transform, Inverse transforms.

Books & References:

1: Guide to Mathematical Methods for Physicists: With Problems and Solutions by Michela Petrini , Gianfranco Pradisi, Alberto Zaffaroni,, (Essential Textbooks Series in Physics), World Scientific Publishing Europe Ltd 2017

2: Mathematical Methods for Physicists by George B Arfken, Hans. J. Weber, Frank E Harris, Elsevier India; 7th edition (2012)

3: Matrices and tensors in physics by A. W. Joshi, New Age International, 1995

4: Vector Analysis by Murray R Spiegel, Symour Lipschutz, Schaum's Outlines Series, 2009

5: Schaum's Outline of Complex Variables by Dennis Spellman, John J. Schiller, Murray R. Spiegel, and Seymour Lipschutz, 2ed, 2009.

6: Methods of Theoretical Physics (Vol. I & II) by P.M. Morse and H. Feshbach, Feshbach Publishing

MPM-124: MOBILE COMMUNICATION

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will be able to understand the concept of mobile computing paradigm, its novel applications and limitations.
2. To understand the database issues in mobile environments & data delivery models.
3. Able to debate on any new technical issue related to this new paradigm and come up with a solution(s).
4. Develop new ad hoc network applications and/or algorithms/protocols.
5. Get detailed information about various important systems like electronic navigation & surveillance systems, blue tooth, GPS and Global Mobile Satellite Systems.

UNIT- I **9**

Fixed TDM, classical ALOHA, Slotted ALOHA, Carrier Sense Multiple Access,Demand Assigned Multiple Access

UNIT- II **9**

Introduction, Fundamental Concepts, pseudo noise sequences, CDMA, FHSS, DSSS, Synchronization of Spread Spectrum, Spread Spectrum applications in cellular communication, PCs, and mobile communication

UNIT- III **9**

Mobile Services, System Architecture, Radio interface, Protocols, localization and calling, Handover, Security, New Data Services.

UNIT- IV **9**

TCP, UTP, SCTP, Routing & Bridging, Mobile IP. Electronic navigation & surveillance Systems, Blue tooth, GPS, Global Mobile Satellite Systems

Books & References

1. Wireless Digital Communications- Dr.Kamilo Feher, PHI
2. Mobile Communications-Jochen Schiller, Pearson Education
3. Mobile and Personal Communication Systems and Services- Raj Pandya, IEEE Press, PHI

Second Pool of Programme Electives (PE-II)

MPM-131: ANALOG AND DIGITAL COMMUNICATION

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:2
Number of Credits	: 5

Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will be able to classify the signals and systems and understand their frequency-domain and geometrical representation.
2. Understand the concept of autocorrelation function, energy and power spectral density.
3. Impart the detailed information about the different types of noise in the communication system and noise remedies.
4. Learn the methods and need of digital multiplexing.
5. Demonstrate various experiments of analog and digital modulation techniques and perform their waveform analysis.

Unit I-Signal Representation **6**

Time domain and frequency domain representation, Fourier series and Fourier transform, Properties of Fourier transform; Linearity, Symmetry, Folding, Delay, Frequency shift. Cosine and Sine transform, Transforms of derivatives, Convolution theorem, Dirac Delta function, energy signal and Power signal, Energy spectral density, Power spectral, Cross–correlation, Auto-correlation function, Parseval's theorem.

Unit II- Noise **6**

External and internal source of noise, Voltage and current models of a noisy resistor, Calculation of thermal noise in RC circuit, Shot noise, Noise figure, Noise temperature, Equivalent noise bandwidth, Calculation of noise figure for the cascaded network. Review of Analog Communication System: Amplitude and Angle Modulation.

Unit III- Digital Modulation System **6**

Sampling Theorem, types of analog pulse modulation, method of generation and detection of PAM, PWM and PPM, Linear quantizer, Quantization noise power calculation, Signal to quantization noise ratio. PCM, DM, ADM and DPCM.

Unit IV- Digital Multiplexing **6**

Fundamental of TDM, Digital Modulation Technique: Types of Digital Modulation, Waveform for ASK, FSK, and PSK, Differential Phase Shift Keying, QPSK and MSK.

Books and References:

1. Modern Analog and Digital Communication by B.P. Lathi, (Oxford University Press)
2. Principles of Communication System by Taub & Schilling (Mc Graw Hill)
3. Communication System by Haykin,
4. Electronic Communication System by Tomasi,

5. E Digital Communication by Prokis.
6. Electronic Communication System by Kennedy and Davis.
7. Digital Communications, John G. Proakis, 4/e, McGraw-Hill.

List of Experiments:

1. Sampling Theorem – verification.
2. Time division multiplexing.
3. Pulse Code Modulation.
4. Delta modulation.
5. Frequency shift keying - Modulation and Demodulation.
6. Phase shift keying - Modulation and Demodulation.
7. Differential phase shift keying - Modulation and Demodulation.
8. QPSK - Modulation and Demodulation.

MPM-132: INSTRUMENTATION TECHNOLOGY

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will be able to understand the fundamentals of spectroscopic and associated technologies and its application to understand the molecular properties.
2. In-depth understanding of molecular configurations and their characteristics and applications.
3. The students will learn the fundamentals of structural and surface characterization techniques to solve physical properties problems.
4. The students will be able to analyse the experimental research data for electrical circuit performance

UNIT- I Spectroscopic Techniques **9**

UV and Visible spectroscopy, FTIR and Raman spectroscopy: Identification of groups, hydrogen bonding and study of conformers, Time–resolved spectroscopy and study of biological samples, Laser as a source of radiation and its characteristics, Laser fluorescence and absorption spectroscopy

UNIT- II Advanced Spectroscopic and Mechanical Techniques **9**

Qualitative and quantitative analysis of trace elements. Basics of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy, X-ray Photoelectron Spectroscopy (XPS/ESCA) for chemical analysis, Viscometry and Rheology.

UNIT- III Structural and Surface Characterization Techniques 9

Micro, meso and macro porous structural characterization, pore parameters and porosity characterization, X-ray diffraction, small angle X-ray scattering and its application in evaluation of shape and size of surface particles, Basics and applications of Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic Force Microscopy (AFM).

UNIT- IV Thermal and Electrical Characterisation Techniques 9

TGA, DTGA and DSC, Electrochemical impedance spectroscopy, Dielectric relaxation studies, Electrochemical analysis, Energy and power density measurements, Cyclic voltametry, Chare-discharge characterization.

Books and Reference:

1. Spectroscopy Volume 1, 2 and 3: B.P. Straughan and S. Walker.
2. Modern Spectroscopy: J.M. Hollas.
3. Transmission Electron Microscopy of Metals: Gareth Thomas
4. Elements of X-ray Diffraction: Bernard Dennis Cullity.
5. Atomic Force Microscopy/Scanning Tunneling Microscopy: M.T. Bray, Samue
6. Electron Microprobe Analysis: S.J. B. Reed.
7. Physical Chemistry of Macromolecules: S.F. Sun, Basic Principles and Issues, Wiley
8. Analytical Techniques for Thin Film Treatise on Material Science and Technology, Vol. 27: K.N. Tu and R. Rosenberg (ed.).

MPM-133: SOLAR AND ASTROPHYSICS

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes:

1: Students will get acquainted with fundamental concepts of formation of solar system, galaxies and the universe as a whole

2: Students will gain knowledge about the astrophysical processes inside the Sun and its surface, Sun flare, solar wind and solar neutrinos etc., which are useful for protecting our satellite systems.

3: Information about large scale structures, their formation, collisions etc. and the subsequent release of high energy radiations, and cosmic rays are useful for protecting our satellite systems.

4: To help students to acquire knowledge about evolution of life on earth, and possibly on other planets in remote parts of the Universe

5: They may secure positions as Scientists and Engineers in Space Research Organizations and other Space Research Laboratories in India and abroad

Unit I: Our Solar System **09**

Origin of our solar system, Sun and its theoretical model, Energy production inside stars: proton-proton chain & CNO cycle, Solar neutrino and its detection, Description of eight planets and their moons with their atmospheric and geographical conditions & vital statistics, Classification of planets, Other planetary bodies: Asteroids, comets and meteorites, Types of asteroids and their properties, Keplar's laws of planetary motion, Newton's law of gravitation from Keplar's law of planetary motion.

Unit II: Solar Phenomena **09**

Solar atmosphere, Photosphere, Chromosphere, Corona; Solar Structures: granules, super granules, giant cells, spicules and plages, Sun spots and their properties, Prominences: structure and theory of generation, Solar Flare: classifications, their phases and flare theory; Solar activity, Solar cycle, Solar magnetic field; Coronal hole, Coronal Mass Ejections (CME), Observed and derived properties of solar wind, Solar wind formation: Spatial configuration of magnetic field frozen into solar wind, Termination of solar wind.

Unit III: Astrophysical Processes **09**

Our galaxy, Types of galaxies: Elliptical, Spiral and SO type of galaxies, Irregular galaxies, their morphology, evolution and contents, Hubble's tuning fork diagram, Cluster of galaxies and their evolution, Collision and merger of galaxies, Types of galaxies, Schwarzchild solution: massive stars, singularity and the black holes, Loss of information from a black hole, Accretion of mass and emission of jets in a binary star system, Theory of compact stars.

Unit IV: Big-Bang Theory **09**

The expanding Universe: Hubble's law and constant, Flaw in Hubble's measurement, Hot big-bang model: arguments in its favor and against, Evolution of the Universe after big-bang: description of different phases, matter, energy and forces, Models of the Universe: the closed, open and flat models and their relevance with observations, Origin of various bands of electromagnetic bands of spectrum in the Universe, COBE: black body spectrum of the Universe, Dark matter and Dark Energy, Cosmic rays.

Books & References :

1: Astrophysics of the Sun by Harold Zirin, Cambridge University Press, Cambridge, U.K.

2: Solar System Astrophysics by J.C. Brandt & P.W. Hadge

3: Guide to the Sun by Kenneth J. H. Philips, Cambridge University Press, U.K.

4: Introduction to Special Relativity and Space Science by S. P. Singh, Wiley India Pvt. Ltd., New Delhi, India

5: Introduction to Modern Astrophysics by W. Carroll & D. A. Ostlie, Addison Wesley

6: Introduction to Cosmology by J V Narlikar, Cambridge University Press.

MPM-134: SATELLITE COMMUNICATION AND REMOTE SENSING

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes:

1: Students will learn principles involved in satellite communications.

2: Students will gain knowledge about the interaction of electromagnetic waves with atmospheric gases.

3: They will learn about different types of satellites and their designing process.

4: To help students to acquire knowledge about remote sensing and the various ways for the same.

5: Students may secure positions as Scientists and Engineers in Space Research Organizations and other Space Research Laboratories in India and abroad

UNIT- I **9**

Principle of Satellite Communication: General and Technical characteristics, Active and Passive satellites, Modem and Codec.

Communication Satellite Link Design: General link design equation, Atmospheric and Ionospheric effect on link design, Earth station parameters.

UNIT- II **9**

Satellite Analog Communication: Baseband analog signal, FDM techniques, S/N and C/N ratio in FM in satellite link. Digital Satellite Transmission: Advantages, Elements of Digital satellite communication, Digital base band signal, Digital modulation Technique, Digital link Design, TDM, TDMA, Some Applications (VSAT, GPS, LEO mobile communication).

UNIT- III **9**

Concept and Foundations of Remote Sensing: Electromagnetic Radiation (EMR), Interaction of EMR with Atmosphere and Earth surface, Application areas of Remote Sensing.

Characteristics of Remote Sensing Platforms & Sensors: Ground, Air & Space platforms, Return Beam Vidicon, Multi-spectral Scanner.

UNIT- IV **9**

Microwave Remote Sensing: Microwave sensing, RADAR: SLAR & applications, LIDAR: basic components & applications.

Earth Resource Satellites: Brief description of Landsat and Indian Remote Sensing (IRS) satellites.

Books and Reference

1. Satellite Communication - D.C. Agrawal & A. K. Maini, Khanna Publications; 4th Edition (1996)
2. Satellite Communication -T. Pratt and C. W. B Ostiern-, John Wiely and Son.
3. Satellite Communication Systems- M. Richharia, MacGraw Hill.
4. Introduction to Remote Sensing -J. B. Campbell, 72 Spring Street, New York (NY), 10012.
5. Manual of Remote Sensing, Vol I & II, Edited by R. N. Colwell, American Society of Photogrammetry.

Third Pool of Programme Electives (PE-III)

MPM-221: ADVANCE QUANTUM MECHANICS

Course category : Department Core (PE)

Pre- requisites : B.Sc. with Physics and Math
Contact hours/week : Lecture: 3, Tutorial: 1, Practical:0
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs):

1. The students will learn the advanced concepts of quantum mechanics and its application to understand the molecular structure.

2. Understanding of molecular electronic configurations and their characteristics and applications.

3. The students will learn the approximate methods for solving many body problems.

4. Be prepared for research in molecular, atomic and particle physics

Unit I: Formulation of Relativistic Quantum Theory 09

Relativistic Notations, The Klein-Gordon equation, Physical interpretation, Probability current density & Inadequacy of Klein-Gordon equation, Dirac relativistic equation & Mathematical formulation, α and β matrices and related algebra, Properties of four matrices α and β, Matrix representation of $\alpha_i^{'s}$ and β, True continuity equation and interpretation.

Unit II: Covariance of Dirac Equation 09

Covariant form of Dirac equation, Dirac gamma (γ) matrices, Representation and properties, Trace identities, fifth gamma matrix γ^5, Solution of Dirac equation for free particle (Plane wave solution), Dirac spinor, Helicity operator, Explicit form, Negative energy states.

Unit III: Field Quantization 09

Introduction to quantum field theory, Lagrangian field theory, Euler–Lagrange equations, Hamiltonian formalism, Quantized Lagrangian field theory, Canonical commutation relations, The Klein-Gordon field, Second quantization, Hamiltonian and Momentum, Normal ordering, Fock space, The complex Klein-Gordan field: complex scalar field

Unit IV: Approximate Methods **09**

Time independent perturbation theory, The Variational method, Estimation of ground state energy, The Wentzel-Kramers-Brillouin (WKB) method, Validity of the WKB approximation, Time-Dependent Perturbation theory, Transition probability, Fermi-Golden Rule

Books & References:

1: Advance Quantum Mechanics by J. J. Sakurai (Pearson Education India)

2: Relativistic Quantum Mechanics by James D. Bjorken and Sidney D. Drell (McGraw-Hill Book Company; New York, 1964).

3: An Introduction to Relativistic Quantum Field Theory by S.S. Schweber (Harper & Row, New York, 1961).

4: Quantum Field Theory by F. Mandl & G. Shaw (John Wiley and Sons Ltd, 1984)

5: A First Book of Quantum Field Theory by A. Lahiri & P.B. Pal (Narosa Publishing House, New Delhi, 2000

MPM-222: QUANTUM FIELD THEORY

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will learn the advanced concepts of quantum mechanics and its application to relativistic quantum field theory.
2. Understanding of molecular structures and their characteristics and applications.
3. The students will learn the atomic electronic configurations for solving energy states problems.
4. Be prepared for research in molecular, atomic and particle physics

Unit I Formulation of Relativistic quantum theory **09**

Klein-Gordon equation, Plane wave solution and Physical interpretation, Inadequacy of Klein-Gordon equation; Dirac equation, α and β matrices and related algebra, Representation and arbitrariness of α and β, Probabilistic interpretation.

Unit II Covariance of Dirac equation **09**

Covariance of Dirac equation, Dirac(γ) matrices, Representation and algebra, Linearly independent set of composite γ-matrices; Infinitesimal and Finite proper Lorentz transformation, Proof of covariance, Plane wave solution and negative energy states; Two component Pauli spin theory, Non relativistic correspondence.

Unit III – Second Quantization **09**

Lagrangian and Hamiltonian formalism for field, Canonical commutation relations: Quantization of Klein-Gordon and Dirac field; Hamiltonian and Normal ordering in Fock space, Complex scalar field.

Unit IV- S-matrix formulation **09**

S-matrix expansion, Wick's theorem, Diagrammatic representation in configuration space, the momentum representation, Feynman diagrams of basic processes, Feynman rules of QED, Applications of S-matrix formalism: the Coulomb scattering, Bhabha scattering, Compton scattering and pair production.

References:

1. An Introduction to Relativistic Quantum Field Theory by S.S. Schweber (Harper & Row, New York).
2. Quantum Field Theory by F. Mandl & G. Shaw (John Wiley and Sons Ltd)
3. Quantum Field Theory by Claude Itzykson, Zean Bernard Zuber (McGraw Hill Education)
4. A First Book of Quantum Field Theory by A. Lahiri & P.B. Pal (Narosa Publishing House, New Delhi)

MPM-223: FIBER OPTICS AND NONLINEAR OPTICS

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

1. The students will be able to understand the terms, basic theory and principle involved in designing different types of optical fiber and their application.
2. Know the transmission method and characteristics of optical fibers.
3. Impart the detailed information about the different types of losses in optical fiber and their remedies.
4. Understand non-linear optical susceptibility and find its expression for classical anharmonic oscillator.
5. Demonstrate various concepts involved in spontaneous light scattering and acousto-optics.

Unit-I: Optical Fiber Waveguides **9**

Introduction, Ray theory transmission, Total internal reflection, Acceptance angle, Numerical aperture, Skew rays, Electromagnetic mode theory for optical propagation, Electromagnetic waves, Modes in a planar guide, Phase and group velocity, Phase shift with total internal reflection and the evanescent field, Goos–Haenchen shift, Cylindrical fiber, Modes, Mode coupling, Step index fibers, Graded index fibers, Single-mode fibers, Cutoff wavelength, Mode-field diameter and spot size, Effective refractive index.

Unit-II: Transmission Characteristics of Optical Fibers and Losses **9**

Attenuation, Material absorption losses in silica glass fibers, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Mid-infrared and far-infrared, transmission, Dispersion, Chromatic dispersion, Intermodal dispersion,Overall fiber dispersion, Dispersion-modified single-mode fibers, Polarization, Nonlinear effects, Soliton propagation.

Unit-III: Nonlinear Optical Susceptibility **9**

Introduction to Nonlinear Optics, Descriptions of Nonlinear Optical Processes, Formal Definition of the Nonlinear Susceptibility, Nonlinear Susceptibility of a Classical Anharmonic Oscillator, Properties of the Nonlinear Susceptibility. The Wave Equation for Nonlinear Optical Media, The Coupled-Wave Equations for Sum-Frequency Generation.

Unit-IV: Spontaneous Light Scattering and Acoustooptics **9**

Features of Spontaneous Light Scattering, Microscopic Theory of Light Scattering, Thermodynamic theory of scalar light scattering, Acoustooptics. Introduction to the Electrooptic Effect, Linear Electrooptic Effect. Electrooptic Modulators, Introduction to the Photo refractive Effect, Photo refractive Equations of Kukhtarev *et al* . Two-Beam Coupling in Photorefractive Materials, Four-Wave Mixing in Photorefractive Materials.

Reference Books:

1. Optical Fiber Communications by Jhon M. Senior: Printice Hall of India
2. Optical Fiber Communication by Gerd Keiser : Tata McGraw Hill
3. Nonlinear Fiber optics by Govind Agrawal: Academic Press
   Nonlinear Optics by Robert W. Boyd: Academic Press

MPM-224: WIRELESS COMMUNICATION

Course category	: Department Core (PE)
Pre- requisites	: B.Sc. with Physics and Math
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, assignments, Quizzes and Minor test and Major Theory & Practical Examination

Course Outcomes (COs)

The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. The students will be able to understand the Wireless communication systems and standards.
2. Able to understand the infrastructure to develop mobile communication system.

3. Able to understand the characteristics of different multiple access techniques in mobile/wireless communication.
4. Able to understand the need of coding, channel models, diversity, equalization and channel estimation techniques. Able to apply analytical and empirical models in the design of wireless links.

UNIT-I **9**

Evolution of mobile communications, Mobile Radio System around the world, Types of Wireless communication System, Comparison of Common wireless system, Trend in Cellular radio and personal communication. Second generation Cellular Networks, Third Generation (3G) Wireless Networks, Wireless Local Loop(WLL), Wireless Local Area Network(WLAN), Bluetooth and Personal Area Networks.

UNIT-II **9**

Fundamentals of equalisation, Equalisers in communication receiver, Survey of equalisation techniques, linear equaliser, Algorithms for Adaptive Equalization, Diversity techniques, RAKE receiver. Characteristics of speech signals, quantisation techniques, vocoders, linear predictive coders, Multiple Access techniques for Wireless Communications.

UNIT-III **9**

Large scale path loss:-Free Space Propagation loss equation, Path-loss of NLOS and LOS systems, Reflection, Ray ground reflection model, Diffraction, Scattering, Link budget design, Max. Distance Coverage formula, Empirical formula for path loss, Indoor and outdoor propagation models, Small scale multipath propagation, Impulse model for multipath channel, Delay spread.

UNIT-IV **9**

GSM system architecture, Radio interface, Protocols, Localization and calling, Handover, Authentication and security in GSM, GSM speech coding, Concept of spread spectrum, Architecture of IS-95 CDMA system, Air interface, CDMA forward channels, CDMA reverse channels, Soft handoff, CDMA features, Power control in CDMA, Performance of CDMA System, CDMA2000 cellular technology, GPRS system architecture.

Books and References:

1. T.S. Rappaport, “Wireless Communication-Principles and practice”, Pearson, Second Edition.40
2. T L Singal, “Wireless Communications”, McGraw Hill Publications.
3. Andrea Goldsmith, “Wireless Communications”, Cambridge University press.
4. Andreas F. Molisch, “Wireless Communications”, Wiley Student Edition.
5. S. Haykin & M. Moher, “Modern wireless communication”, Pearson, 2005.