DEPARTMENT OF APPLIED SCIENCE
M. M. M. UNIVERSITY OF TECHNOLOGY
GORAKHPUR

Credit Structure for M. Sc. Physics with specialization in Electronics
(For newly admitted students from Session 2018-2019)

Category	I	II	III	IV	Total
Programme Core (PC)	18	10	11	9	**48**
Programme Electives (PE)	-	6	3	3	**12**
Dissertation (D)			4	8	**12**
Seminar (S)	-	2	-	-	**2**
Audit					
Total	**18**	**18**	**18**	**20**	**74**

Curriculum for M. Sc. Physics with specialization in Electronics
(For newly admitted students from Session 2018-2019)

Junior Year, Semester I

S. N.	Category	Paper Code	Subject Name		L	T	P	Credits
1.	PC	MPC-101	Mathematical Physics and Electromagnetic Theory		3	1	0	**4**
2.	PC	MPC-102	Computational Technique and programming		3	1	2	**5**
3.	PC	MPC-103	Quantum Mechanics		2	1	0	**3**
4.	PC	MPC-104	Semiconductor Devices and Integrated Circuit		3	1	0	**4**
5.	PC	MPC-105	Electronics Laboratory		0	0	4	**2**
6.	AC	Audit	Audit Subject					**-**
				Total	**11**	**4**	**6**	**18**

Junior Year, Semester II

S. N.	Category	Paper Code	Subject Name		L	T	P	Credits
1.	PC	MPC-201	Advanced Quantum Mechanics		3	1	0	**4**
2.	PC	MPC-202	Condensed Matter Physics		2	1	2	**4**
3.	PC	MPC-203	Spectroscopy and Laser		0	0	4	**2**
4.	PE1	MPE*	Program Elective-1		2	1	0	**3**
5.	PE2	MPE**	Program Elective-2		2	1	0	**3**
6	S	MPS-201	Seminar		-	-	4	**2**
7.	AC		Audit Subject					**-**
				Total	**9**	**4**	**10**	**18**

Senior Year, Semester III

S. N.	Category	Paper Code	Subject Name		L	T	P	Credits
1.	PC	MPC-301	Analogue and Digital Communication		3	1	2	**5**
2.	PC	MPC-302	Optoelectronics and Optical Communication System		3	1	0	**4**
3.	PC	MPC-303	Communication and Optoelectronics Lab		0	0	4	**2**
4.	PE-3	MPE***	Program Elective-3		2	1	0	**3**
6.	D		Dissertation Part-I		0	0	8	**4**
				Total	**8**	**3**	**14**	**18**

Senior Year, Semester IV

S. N.	Category	Paper Code	Subject Name		L	T	P	Credits
1.	PC	MPC-401	Microprocessor and Application		3	1	2	**5**
2.	PC	MPC-402	Quantum Electronics		3	1	0	**4**
3.	PE-4	MPE****	Program Elective-IV		2	1	0	**3**
4.	D		Dissertation Part-II		0	0	16	**8**
				Total	**8**	**3**	**18**	**20**

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

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPC-101	Mathematical Physics and Electromagnetic Theory		3	1	0	**4**
2.	MPC-102	Computational Technique and programming		3	1	2	**5**
3.	MPC-103	Quantum Mechanics		2	1	0	**3**
4.	MPC-104	Semiconductor Devices and Integrated Circuit		3	1	0	**4**
5.	MPC-105	Electronics Laboratory		0	0	4	**2**
6.	MPC-201	Advanced Quantum Mechanics		3	1	0	**4**
7.	MPC-202	Condensed Matter Physics		2	1	2	**4**
8.	MPC-203	Spectroscopy and Laser Laboratory		0	0	4	**2**
9.	MPC-301	Analogue and Digital Communication		3	1	2	**5**
10.	MPC-302	Optoelectronics and Optical Communication System		3	1	0	**4**
11.	MPC-303	Communication and Optoelectronics Lab		0	0	4	**2**
12.	MPC-401	Microprocessor and Application		3	1	2	**5**
13.	MPC-402	Quantum Electronics		3	1	0	**4**
			Total	**28**	**10**	**20**	**48**

Programme Electives (PE-I)

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPE-201	Classical Electrodynamics		2	1	0	**3**
2.	MPE-202	Solar and Astrophysics		2	1	0	**3**
3.	MPE-203	Methods in Theoretical Physics		2	1	0	**3**
4.	MPE-204	Mobile Communication		2	1	0	**3**
			Total	**8**	**4**	**0**	**12**

Programme Electives (PE-II)

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPE-205	Atomic, Molecular Physics and Laser		2	1	0	**3**
2.	MPE-206	Instrumentation Technology		2	1	0	**3**
3.	MPE-207	Physics of Materials		2	1	0	**3**
4.	MPE-208	Satellite Communication and Remote Sensing		2	1	0	**3**
			Total	**8**	**4**	**0**	**12**

Programme Electives (PE-III)

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPE-301	Thermodynamics and Statistical Mechanics		2	1	0	**3**
2.	MPE-302	Particle Physics		2	1	0	**3**
3.	MPE-303	Fiber Optics and Nonlinear Optics		2	1	0	**3**
4.	MPE-304	Wireless Communication		2	1	0	**3**
			Total	**8**	**4**	**0**	**12**

Programme Electives (PE-IV)

S. N.	Paper Code	Subject Name		L	T	P	Credits
1.	MPE-401	Nuclear Technology		2	1	0	**3**
2.	MPE-402	Theory of Relativity and Space Science		2	1	0	**3**
3.	MPE-403	Advanced Semiconductor Devices		2	1	0	**3**
4.	MPE-404	Science and Technology of Nanostructured Materials		2	1	0	**3**
			Total	**8**	**4**	**0**	**12**

***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	0	**4**
2.	MAS 105	Applied Probability and Statistics		3	1	0	**4**
3.	MBA 109	Research Methodology-		3	1	0	**4**
4.	BEE 20	Simulation Techniques-		3	1	0	**4**
			Total	**12**	**4**	**0**	**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.

MCP-101: MATHEMATICAL PHYSICS AND ELECTROMAGNETIC THEORY

4 Credits (3-1-0)

Unit-I: Theory of Functions of a Complex Variable **9**

Complex Variables: Introduction, Cauchy-Riemann conditions, Cauchyôs Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation. Hermite, Bessel, Laguerre and Legendre functions.

Unit-II: Fourier and Laplace Transforms **9**

Fourier transform, Sine, Cosine and Complex transforms with examples, Definition, Properties and Representations of Dirac Delta Function, Laplace transform, Properties and examples of Laplace Transform, Convolution theorem and its applications.

Unit-III: Introduction to Electromagnetic Theory **9**

Gaussôs law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, modification in Ampere's law concept of displacement current. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Dynamics of charged particles in static and uniform electromagnetic fields.

Unit-IV: Propagation of Electromagnetic Waves **9**

Wave equation, plane waves in free space and isotropic dielectrics, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnelôs amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewsterôs angle, Total internal reflection, Stokeôs parameters, EM wave guides, Cavity resonators.

Books & References:

1. Mathematical Methods for Physicists -G. Arfken, Elsevier Academic Press
1. 30 Corporate Drive, Suite 400, Burlington, MA 01803, 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. 5.M. R. Spiegel -Theory and Problems of Complex Variables, Schaumôs outline series
5. Mathematical Methods of Physics- J. Mathews and R. I. Walker -W.A. Benjamin
6. Saroj K. Dash & Smruti R. Khuntia-Fundamentals of Electromagnetic Theory, PHI
7. David J. Griffith-Introduction to Electrodynamics, Fourth Edition, Prentice Hall, 2013
8. L.D. Landau & E.M. Lifshitz- Electrodynamics of Continuous Media (Volume 8 of A Course of Theoretical Physics), Pergamon Press 1960
9. Electromagnetic Waves and Radiating System- Edward C. Jordan, Prentice Hall Electrical Engineering Series.

MPC-102: COMPUTATIONAL TECHNIQUE & PROGRAMMING

Credit 05 (3-1-2)

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

MPC-103: QUANTUM MECHANICS Credit 03 (2-1-0)

Unit I: Mathematical Preliminaries **06**

Concept of Hilbert Space, Dirac's bra and ket notations, Orthonormality and completeness relations (discrete and continuous), linear and real operators, eigenvalue equations and related theorems, projection operators and measurement, application to Harmonic Oscillator, equivalence of wave and matrix mechanics.

Unit II: Schrödinger Equation and Spherically Symmetric Potential **06**

Schrodinger Equation: Free-particle solution, wave packets, particle in a square well potential, transmission through a potential barrier, simple harmonic oscillator by wave equation and operator methods, charged particle in a uniform magnetic field, coherent states, Schrodinger picture, Heisenberg picture, Spherically Symmetric Potentials: Separation of variables in spherical polar coordinates, orbital angular momentum, parity, spherical harmonics, free particle in spherical polar coordinates, square well potential, hydrogen atom.

Unit III: Theory of Angular momentum **06**

Orbital, spin and total angular momentum operators: eigen value equations and matrix representations, Ladder operators, commutation relations, Addition of angular momenta, Rotation operators, angular momentum algebra, eigenvalues of J^2 and J_z, Clebsch-Gordon coefficients

Unit IV: Identity of Particles **06**

Distinguishability of identical particles, exchange degeneracy and operator, construction of symmetric and antisymmetric wave functions, Pauliôs exclusion principle and Slaterôs determinant, Electron spin hypothesis, Pauliôs spin matrices and eigen value equations, Symmetric and antisymmetric wave functions for hydrogen molecule.

Books & References:

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

2: Qunatum Mechanics by Ajoy K Ghatak (McMillan Co. of India)

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)

MPC-104: SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUIT

4 Credits (3-1-0)

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: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons, Continuity equations.

Unit-II: Semiconductor Devices **9**

Light emitting diodes, Varactor diode, Zener diode, Schottky diode, Switching diodes, Tunnel diode, Semiconductor laser, Photodiodes, Solar cell, UJT, Gunn diode, IMPATT devices, pnpn devices and applications, Liquid crystal displays, MOSFET, Enhancement and depletion mode, FET as switch and amplifier configurations.

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, Active filters, Multiplier, Divider, Differentiator, Integrator, wave shapers, Oscillators. Schmitt trigger; 555 Timer: Astable, monostable and bistable multivibrators, Voltage controlled oscillators, Voltage regulator ICs.

Unit-IV: Digital Circuits **9**

Survey of number systems, Logic simplification using K-maps, SOP and POS design of logic circuits, Logic Families: RTL, DTL, ECL, TTL, MOS and CMOS; Combinational Circuits: Adders, subtractors, Encoder, De-coder, Comparator, Multiplexer, De-multiplexers, Parity generator and checker; 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.

MPC-105: ELECTRONICS LABORATORY 2 Credits (0-0-4)

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. 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.

MPC-201: ADVANCE QUANTUM MECHANICS Credit 04 (3-1-0)

Unit I: Formulation of Relativistic Quantum Theory **09**

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

Unit II: Covariance of Dirac Equation **09**

Covariant form of Dirac equation, Dirac (ɔ) matrices, Representation and algebra, Linearly independent set of composite ɔ- 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: Quantization **09**

Introduction to quantization theory, Quantization of Klein-Gordon field: Lagrangian and Hamiltonian formalism for field, canonical commutation relations and quantization; Hamiltonian and Normal ordering in Fock space, Complex scalar field.

Unit IV: Approximate methods **09**

Time independent perturbation theory and anharmonic oscillator, Application to Zeeman effect, isotopic shift and stark effect, Variational method and Helium atom, Time dependant theory and Transition probability (Fermi-Golden Rule-2), WKB method and beta decay, Variational method and its applications.

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)

MPC-202: Condensed Matter Physics

4 Credits (2-1- 2)

Unit-I: Crystal Structure **6**

Space lattice and basis; Types of lattice, Bravais lattices, Miller indices, Crystal structures of NaCl and diamond; Reciprocal lattice and Brillouin zones; Diffraction and the structure factor, Basic idea of crystal defects and dislocations, Ordered phases of matter: translational and orientational order, Quasi crystals.

Unit-II: Band Theory of Solids **6**

Bonding of solids, band theory of solids: metals, insulators and semiconductors, Somerfield model, Density of states, Fermi and Mean energies at zero and finite temperatures; Origin of energy bands; Bloch Theorem; Kronig Penny model, Electron dynamics in crystalline lattice; Tight binding approximation.

Unit-III: Thermal and Optical Properties **6**

Elastic properties, Lattice vibrations of mono and diatomic chains, Quantization of lattice vibration, Phonon, lattice specific heat, Free electron theory and electronic specific heat, Einstein equation. Response and relaxation phenomena. Thermal conductivity; Drude model of electrical and thermal conductivity. Reflectance, Kramers-Kronig relations; Electron motion in a periodic potential, Hall effect and thermoelectric power

Unit-IV: Superconductivity **6**

Superconductors; thermodynamics of superconductors, Meissner effect, Type-I and Type-II superconductors, Electrodynamics of superconductivity, Elements of BCS theory, Applications of superconductors: Particle tunneling and Josephson effect, Superfluidity.

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, 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. Solid State Physics, G. Burns (Academic Press)
7. Condensed Matter Physics, M.P. Marder, Wiley

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

MPC-203: Spectroscopy and Laser Laboratory 2 Credit (0-0-4)

List of Experiments

1. Spectroscopy of iodine vapor.
2. Laser diffraction by a thin wire
3. Measurement of Planckôs 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.

MPE-201: Classical Electrodynamics

3 Credits (2-1- 0)

UNIT- I Formulations in Mechanics and **Rigid body dynamics** **6**

Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion, Poisson brackets and canonical transformations, Conservation laws and cyclic coordinates, Central force motions, Periodic motion: small oscillations, normal modes. Special theory of relativityLorentz transformations, relativistic kinematics and massï energy equivalence.

UNIT- II Four Potential, Four Field and Gauge Transformations 6

Electromagnetic field Tensor and Maxwellôs Equations and Displacement Current; Wave Equation and solution, Gauge Transformations, Lorenz Gauge, Coulomb Gauge, plane waves in free space, conducting, non-conducting media and isotropic dielectrics, Reflection and Refraction of Electromagnetic Waves at a Plane Interface Between two Dielectrics, Reflection and Transmission coefficients, polarization by reflection, Frequency Dispersion Characteristics of Dielectrics and Conductors, Plasmas

UNIT- III Wave Guides **6**

Fields at the surface of and within a conductor, Cylindrical cavities and waveguides, Waveguides, Modes in a rectangular waveguide, Energy flow and attenuation in waveguides, Multimode propagation in optical fibers, Modes in dielectric waveguides, Radiating systems, Multipole fields and radiations.

UNIT- IV Charged Particle Dynamics **6**

Dynamics of charged particles in E and B Fields, Non-relativistic motion in uniform constant fields, Time varying magnetic field, space varying magnetic field, Acceleration of charged particles: Electric and Magnetic fields due to a uniformly moving charge and an accelerated charge, Relativistic motion of a charged particle in uniform & non-uniform E and B Fields, Time varying E and B Fields, Bremsstrahlung, Synchrotron radiation and Cerenkov radiation, Reaction force of radiation, Electromagnetic mass of the electron.

Books & References

1. Classical Electrodynamics, J.D. Jackson, Wiley
2. Introduction to Electrodynamics: D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2012.
3. H. Goldstein, C.P. Poole and J.F. Safko, Classical Mechanics, Addison-Wesley
4. N.C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill
5. J.V. Jose and E.J. Saletan, Classical Dynamics: A Contemporary Approach, Cambridge University Press
6. L.D. Landau and E.M. Lifshitz, Mechanics, Butterworth-Heinemann
7. Classical Electrodynamics: S.P. Puri (Narosa Publishing House) 2011.
8. Introduction to Electrodynamics: A.Z. Capri and P.V. Panat (Narosa Publishing House) 2010.

MPE-202: SOLAR AND ASTROPHYSICS **Credit 3 (2-1-0)**

Unit I: Our Solar System **6**

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, Keplarôs laws of planetary motion, Newtonôs law of gravitation from Keplarôs law of planetary motion.

Unit II: Solar Phenomena **6**

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 **6**

Our galaxy, Types of galaxies: Elliptical, Spiral and SO type of galaxies, Irregular galaxies, their morphology, evolution and contents, Hubbleôs 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 **6**

The expanding Universe: Hubbleôs law and constant, Flaw in Hubbleôs 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.

MPE-203: METHODS OF THEORETICAL PHYSICS Credit 3 (2-1-0)

Unit- I: Vectors, Tensors, Matrices and Operators **6**

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 **6**

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 **6**

The Gamma function. Definitions, Digamma and Polygamma functions, Stirlingôs series, The Beta function., Bessel functions, Neumann functions, Hankel functions, Spherical Bessel functions, Legendre functions, Hermite functions, Laplace function and its application, Greenôs Functions in one dimensions, Dirac ŭ-function, its specific representations, step-function

Unit-IV: Ordinary Differential Equation & Fourier Series **6**

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

MPE-204: MOBILE COMMUNICATION 3 Credits (2-1-0)

UNIT- I **6**

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

UNIT- II **6**

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 **6**

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

UNIT- IV **6**

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

MPE-205: ATOMIC, MOLECULAR PHYSICS & LASER Credit 03 (2-1-0)

Unit- I: Many-Electron Atoms **6**

Review of H and He atom, ground state and first excited state, quantum virial theorem. Determinantal wave function. Thomas-Fermi method, Hartree and Hartree-Fock method, density functional theory, Hydrogen molecular ion (numerical solution), hydrogen molecule, Heitler-London method, molecular orbital, Born-Oppenheimer approximation, bonding, directed valence, LCAO

Unit-II: Atomic and Molecular Spectroscopy **6**

Fine and hyperfine structure of atoms, electronic, vibrational and rotational spectra for diatomic molecules, role of symmetry, selection rules, term schemes, applications to electronic and vibrational problems. Raman spectroscopy, introduction to electron spin, Stern-Gerlach experiment, spin-orbit interaction and fine structure, relativistic correction to spectra of hydrogen atom, Lamb shift, effect of magnetic field on the above spectra, Zeeman and Paschen-Back effect, Spectra of divalent atoms: Singlet and triplet states of divalent atoms, L-S and j-j coupling, branching rule

Unit-III: Basic Principles of Laser **6**

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

Unit-IV: Lasers in Spectroscopy **6**

Broadening of spectral lines, Doppler-free spectroscopy, Excitation spectroscopy, Ionization spectroscopy, Tera Hertz spectroscopy with innovative applications, Properties of light: interaction between light and matter, Properties of laser radiation, Non-linear phenomena and generation of short pulses, Laser systems for spectroscopy, Instrumentation for detection of optical signals and time-resolved measurements, Time-resolved and ultra-fast laser spectroscopy, Special applications of laser spectroscopy

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: Applied Quantum Mechanics by W.A. Harrison, World Scientific

6: Atomic Physics by C.J. Foot, Oxford Univ Press

7: Elementary Atomic Structure by G. Woodgate, Oxford Univ Press

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

MPE-206: Instrumentation Technology

3 Credit (2-1-0)

UNIT- I Spectroscopic Techniques **6**

UV and Visible spectroscopy, FTIR and Raman spectroscopy: Identification of groups, hydrogen bonding and study of conformers, Timeï 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 **6**

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 **6**

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 **6**

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.).

MPE-207 Physics of Materials

3 Credit (2-1-0)

UNIT- I **6**

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 **6**

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 **6**

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 **6**

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

MPE-208: SATELLITE COMMUNICATION AND REMOTE SENSING

3 Credits (2-1-0)

UNIT- I **6**

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 **6**

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 **6**

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 **6**

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.

MPC-301 Analogue and Digital Communication Credits 5 (3-1- 2)

Unit I-Signal Representation **9**

Time domain and frequency domain representation, Fourier series and Fourier transform, Numerical computation of FT, Properties of Fourier transform; Linearity, Smmetry, 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 **9**

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 **9**

Sampling Theorem, types of analog pulse modulation, method of generation and detection of PAM, PWM and PPM, Discretization in time and amplitude, Linear quantizer, Quantization noise power calculation, Signal to quantization noise ratio, non-uniform quantizer, A-law and μ law companding; Encoding and Pulse Code Modulation, Band width of PCM, DPCM, DM, ADM, Adaptive DPCM.

Unit IV- Digital Multiplexing

Fundamental of TDM, Digital Modulation Technique: Types of Digital Modulation, Waveform for ASK, FSK, and PSK, Differential Phase Shift Keying, QPSK and MSK. **9**

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.

MPC-302 Optoelectronics and optical communication system Credits 4 (3-1-0)

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, absorption in quantum wells, radiation in semiconductors, deep level transitions, Augur recombination.

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, principle of APD and PIN diodes, 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

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, system design for optical communication, optoelectronic modulation: analog and digital modulation, Franz-Keldysh and Stark effects, electro-optic modulators. **9**

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.

MPC-303 Communication and Optoelectronics Lab Credits 2 (0-0-4)

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.

MPC-401 Microprocessor and Application Credits 5 (3-1-2)

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, A/D and D/A conversion.

UNIT IV: Microprocessor application **9**

Microprocessor compatible ADC and DAC chips, 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)

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.

MPC-402 Quantum Electronics Credits 4 (3-1-0)

UNIT I: Electromagnetic waves **9**

Brief review of electromagnetic waves, light propagation though anisotropic media, nonlinear effects, nonlinear polarization.

UNIT II: Second order effects **9**

Second-order effects: second harmonic generation, sum and difference frequency generation, parametric amplification, parametric fluorescence and oscillation, concept of quasi--phase matching; periodically poled materials and their applications in nonlinear devices.

UNIT III: Third order effects

Third-order effects: self-phase modulations, temporal and spatial solitons, cross-phase modulation, stimulated Raman and Brilloun scattering, four-wave mixing, phase conjugation. **9**

UNIT IV:

Quantization of the electromagnetic field; number states, coherent states and their properties: squeezed states of light and their properties, application of optical parametric processes to generate squeezed states of light, entangled states and their properties; generation of entangled states; quantum eraser, ghost interference effects; applications in quantum information science. **9**

References

1. Quantum Electronics , A Yariv, John Wiley, NY, 1989.
2. Optical Electronics, A Ghatak and K Thyagarajan, Cambridge Univ Press, UK, 1989.
3. Quantum Optics, M O Scully and M S Zubairy, Cambridge Univ. Press, UK, 1997.
4. Nonlinear Fiber Optics, G P Agarwal, Academic Press, Boston, 1989.
5. Introduction to Fiber Optics, A Ghatak and K Thyagarajan, Cambridge Univ Press, UK, 1998.

MPE- 301: Thermodynamics and Statistical Mechanics 3 Credits (2-1-0)

Unit-I: Thermodynamics and Phase Equilibrium **6**

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

Unit-II: Statistical Treatment of Thermodynamics **6**

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

Unit-III: Classical Statistical Mechanics **6**

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

Unit- IV: Quantum Statistics **6**

Fermi-Dirac and Bose-Einstein statistics. Ideal Bose and Fermi gases, Debye theory of specific heat, Properties of black-body radiation, Bose-Einstein condensation, BEC in a harmonic potential, Ideal Fermi gas, Properties of simple metals, Pauli paramagnetism , Quantum liquid, Tisza two fluid model

Reference Books:

1. Statistical Mechanicsby by Landau and Lifshitz (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)

MPE: 302 Particle Physics 3 Credits (2-1-0)

Unit 1: Elementary Particles **06**

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 2: Conservation Laws **06**

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.

Unit 3: Group Classifications **06**

Gell-Mann Nishijima scheme, Properties of quarks and their classification, Elementary ideas of SU(2) and SU(3) symmetry groups, Hadron classification, Introduction to standard model

Unit 4: Symmetry and Forces **06**

Gauge symmetry and fundamental forces, Weak interaction, W and Z bosons, Higgs mechanism and spontaneous symmetry breaking, Higgs particle, Gluons and strong interaction, Neutrino oscillations

REFERENCES

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

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

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

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

5: The Ideas of Particle Physics by G.D. Coughlan and J.E. Dodd (Cambridge University Press)

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

MPE-303: FIBER OPTICS AND NONLINEAR OPTICS 3 Credits (2-1-0)

Unit-I: Optical Fiber Waveguides **6**

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 **6**

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.

Unit-III: Nonlinear Optical Susceptibility **6**

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.

Unit-IV: Spontaneous Light Scattering and Acoustooptics **6**

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.

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
4. Nonlinear Optics by Robert W. Boyd: Academic Press

MPE-304 Wireless Communication Credits 3 (2-1-0)

UNIT-I **6**

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 **6**

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

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. **6**

UNIT-IV

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. **6**

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.

MPE: 401 Nuclear Technology 3 Credits (2-1-0)

Unit 1: Nuclei and Its Properties **06**

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.

Unit 2: Nuclear Forces **06**

Mass defect, Binding-energy statistics, Bethe-Weiszacker mass formula, Magic numbers, Characteristics of nuclear forces -Range and strength, Simple theory of two nucleon system -deuterons, Spin states of two nucleon system, Effect of Pauli's exclusion principle, Magnetic dipole moment and electric quadrupole moment of deuteron

Unit 3: Nuclear Stability **06**

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

Unit 4: Nuclear Detectors: **06**

Interaction of radiation with matter, Ge and Si solid state detector, Calorimeeters and their us for measuring jet energies, Scintillation and Cerenkov counters, Proton synchrotron, Betatron, Qualitative ides of hybrid detectors.

REFRENCES

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

2: An introduction to Nuclear Physics by W.N. Cottingham and D.A. Greenwood (Cambridge University Press)

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

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

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

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

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

MPE-402: THEORY OF RELATIVITY AND SPACE SCIENCE 3 Credits (2-1-0)

UNIT 1: Theory of Special Relativity **6**

Four Dimensional Formulation: Minkowski Space, Intervals, Light cone, Proper time, Four Vectors, Doppler Effect (Transverse and Longitudinal) and Aberration, Relativistic Mechanics: Langrangian formulation, Principle of least action, Four-momentum vector of a free particle, Hamiltonian, Equation of motion, Transformation of Electric and Magnetic vectors, Field of a uniformly moving point charge

UNIT 2: General Theory of Relativity **6**

Principle of equivalence, Metric formulation and tensor nature of gravitational field, Geodesic motion in curved space time, Gradient, divergence, curl: curvature and torsion in general relativity, Bianchi identity and curvature tensor, Einstein filed equation and gravitation, Schwarzchild metric and solution of Einstein equation, Perhilion motion of Mercury, Penrose diagram, Ray-Chaudhary equation

UNIT 3: Sun & Solar Phenomena **6**

Structure of the Sun: Solar interior, 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) and Coronal heating, Solar wind with magnetized and unmagnetized bodies: Bow shock and their formation

UNIT 4: Astrophysical Processes **6**

Gravity: Newtonian Gravity and basic potential theory, Simple orbits, Kepler's laws, Flat rotation curve of galaxies and implications for dark matter, Role of gravity in different astrophysical systems, Radiative Process: Radiation theory and Larmor formula, Different radiative processes, Contribution of radiative processes in different astrophysical systems, Big-Bang theory and Universe model

Reference Books:

1: Classical Mechanics by Herbert Goldstein, (Narosa Publishing House)
2: Astrophysics of the Sun: Harold Zirin, Cambridge University Press, Cambridge, U.K.
3: Solar System Astrophysics: J.C. Brandt & P.W. Hadge
4: Introduction to cosmology, by J V Narlikar, Cambridge UNiversity Press (USA)
5: An Introduction to Modern Astrophysics: W. Carroll & D. A. Ostlie, Addison Wesley
6: The Physics of Astrophysics Vol I & II: Frank H. Shu, University Science Books, USA
7: Astrophysical Concepts: M. Harwitt, Springer-Verlag, New York
8: Introduction to Special Relativity and Space Science, S. P. Singh, Wiley India Pvt. Ltd., New Delhi

MPE-403 Advanced Semiconductor Devices Credits 3 (2-1-0)

UNIT-I **6**

Review of fundamentals of semiconductors: semiconductor materials and their properties, carrier transport by drift and diffusion. electron - hole pair generation and recombination: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. **6** continuity equations.

UNIT-II

Advanced semiconductor devices: tunnel diode, tunnelling field-effect transistor (TFET), thin film transistor (TFT), JFET and MESFET, high electron-mobility transistor (HEMT), modulation-doped FET (MODFET), single-electron transistor, floating gate MOSFET. **6**

UNIT-III

Special purpose diodes: P-I-N diode, IMPATT diode, TRAPATT diode, BARITT diode, Photo detectors: photoconductor, photodiodes, avalanche photodiode, phototransistor, charge-coupled device (CCD).

UNIT-IV

Optoelectronic devices: light emitting diodes, semiconductor lasers, solar cell: generation of photo voltage, **6** light generated current, I-V equation, solar cell characteristics, parameters of solar cells, Relation of V_{oc} and E_g.

Books and References:

[1] M.S. Tyagi, "Introduction To Semiconductor Materials And Devices", John Willy-India Pvt. Ltd.

[2] S. M. Sze, "Physics of Semiconductor Devices", 2e, John Willy-India Pvt. Ltd.

[3] B. G. Streetman and S. Banerjee, "Solid state electronics devices", 5e, PHI

[4] Solar Photovoltaics: Fundamentals, Technologies and Applications, C. S. Solanki, 2nd Edition Prentice Hall of India, 2011.

MPE-404 Science and Technology of Nanostructured Materials Credits 3 (2-1-0)

UNIT- I Introduction to nanostructured materials **6**

Crystalline & amorphous materials, Nano composites, Polymer based nanostructured materials, Nano-structured Ionogels and fast ionic conducting materials, nanostructured energy storage materials, luminescent materials, Science and technology of nanostructured materials

UNIT- II Preparation techniques of nanostructured materials **6**

Preparation of Quantum Nanostructure, Preparation of materials by different techniques: Single crystal growth, solution cast techniques, sol-gel, hydrolytic and non-hydrolytic techniques, phase inversion techniques, Thermal evaporation technique, Chemical Vapour Deposition (CVD), micro emulsion technique, polymer processing, different technique of thin film preparations: Basic principles.

UNIT- III Synthesis of nanostructured materials **6**

Top down and bottom up approaches of synthesis of nano-structured materials, nanorods, nanotubes, Quantum Wells, Wires and quantum dots, Single wall and multiwall nanotubes Graphenes, Fullerenes and tubules.

UNIT- IV Characterization techniques for nanostructured materials **6**

Electron Microscopy techniques: Transmission electron microscopy, Scanning electron microscopy, Atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), UV-VIS, Fourier-transform infrared spectroscopy (FTIR), Raman and X-ray Diffraction techniques, Thermogravimetric analysis (TGA), DTA, Differential scanning calorimetry (DSC), Electrochemical analysis and impedance spectroscopy

Books and Reference:

1. Handbook of Nanostructured Materials & Nanotechnology‖ vol.-5, Academic Press, 2000
2. Introduction to Nanotechnology - C.P. Poole Jr and F.J. Owens, Wiley India, New Delhi
3. Nano Materials - A.K. Bandyopadhyay, New Age International
4. Materials science and Engineering by V. Raghavan, Prentice-Hall Pvt. Ltd.
5. The Structure & Properties of Materials (Volume II) by J. H. Brophy, R. M. Rose and J. Wulff, Wiley Eastern Ltd.
6. The Physics of Amorphous Solids, Richard Zallen , John Wiley & Sons Inc., New York (1983).