CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

FOR

MASTER OF SCIENCE (M.Sc.)

(2 Year Post graduate Degree Program)

IN

PHYSICS

[w. e. f. 2020-21]

FACULTY OF SCIENCE AND HUMANITIES

SRM UNIVERSITY DELHI-NCR, SONEPAT

Plot No.39, Rajiv Gandhi Education City, P.S. Rai, Sonepat Haryana-131029

SRM UNIVERSITY DELHI-NCR, SONEPAT (HARYANA)

VISION

- To create a diverse community campus that inspires freedom and innovation.
- Strengthen Excellence in educational & skill development processes
- Continue to build productive international alliances
- Explore optimal development opportunities available to students and faculty
- Cultivate an exciting and rigorous research environment

MISSION

SRM University Haryana aims to emerge as a leading World Class Institution that creates and disseminates knowledge upholding the highest standards of instruction in Engineering & Technology, Science & Humanities, Commerce, Management, Hotel Management & Medicine & Health Science. Along with academic excellence, our curriculum imparts integrity and social sensitivity so that our graduates may best serve the Nation and the World.

DEPARTMENT OF PHYSICS

VISION

1. Build a holistic, comprehensive and personalized learning environment so that the necessities of every individual student are taken care of.

2. Offer a contemporary and comprehensive skill-based curriculum at all levels.

3. Grow as an international level centre for research and innovation in both basic and applied areas of Physics.

4. Develop a direct lab-to-industry industry relationship so that discoveries, at least in the applied areas of physics, can be smoothly converted to technology for the betterment of the society.

5. Strive to become a centre of excellence for comprehensive teaching, learning and cutting-edge research in Physics.

6. And above all, to build an academic ambience where ‘knowledge is free’ of all bounds, innovative and creative ideas are encouraged, and talents are nurtured to realize their full potential.

MISSION

Our mission is to lend a helping hand to the students in their pursuit of this enormous field of knowledge. We aim to imbibe the right kind of skills and aptitude in students which will not only help them to build a career in physics but as a human being as a whole.

1. We aim to offer a balanced blending of comprehensive training in the core areas of physics along with the cutting-edge recent topics of physics.
2. We tried to keep a balance between the theoretical courses and experimental courses with an emphasis on problem-solving. This will help the students to develop fundamental concepts, verify them in the lab and thereby discourage the rote-learning.
3. Our motto is to prepare a student with the fundamental concepts of physics as well as the skills required to apply them so that they can go on to become a professional physicist in future.
4. Overall, we intend to equip a student with the right aptitude and skills so that they can go on to become a professional Physicist in future.
5. Additionally, we also intends to inculcate skills like logical thinking, quantitative argumentation, and capability of analyzing a large amount of information (or data) in the students so that even those, who are not going to build a career as a professional physicist, will benefit both professionally and also as a human being.

PROGRAM REQUIREMENT

General Education Requirements: Applied Science and Humanities (ASH)

Basic Science and Engineering Requirements: Fundamental Sciences (FS) through regular/online mode

Disciplinary Requirements comprising of:

PHYSICS DEPARTIMENT	Core courses (through regular/online mode)
PHYSICS DEPARTIMENT	Discipline Specific Electives (through regular/online mode)
COMPUTER SCIENCE DEPARTMENT	Generic Electives (regular/online)

Practical and Research component:

1. Regular Practical.
2. Minor and Major Project

SEMESTER-I

Code	Category	Course	L	T	P	C
Theory						
20MSP 101	Core Course	Mathematical Physics	4	0	0	4
20MSP 103		Classical Mechanics	4	0	0	4
20MSP 105		Quantum Mechanics I	4	0	0	4
20MSP 107		Computational Physics	4	0	0	4
20MSPGE 101/ 20MSPGE 103	Generic Elective I	Satellite Communication and Remote Sensing / BioPhysics	4	0	0	4
Practical						
20MSP 109	Core	Physics Lab I (General)	0	0	8	4
Total			20	0	08	24
Total Contact Hours			28			24

SEMESTER-II

Code	Category	Course	L	T	P	C
Theory						
20MSP 202	Core Course	Electrodynamics	4	0	0	4
20MSP 204		Electronics	4	0	0	4
20MSP 206		Quantum MechanicsII	4	0	0	4
20MSP 208		Statistical Mechanics	4	0	0	4
20MSPGE 202 / 20MSPGE 204	Generic Elective II	Programming in C / MatLab	4	0	0	4
Practical						
20MSP 210	Core	Physics Lab II (General)	0	0	8	4
Total			20	0	08	24
Total Contact Hours			28			24

SEMESTER-III

Code	Category		Course	L	T	P	C
Theory							
20MSP 301	Core Course		Atomic & Molecular Physics	3	1	0	4
20MSP 303	Core Course		Solid State Physics	3	1	0	4
20MSPDSE 301	Discipline Specific Elective 1	Condensed Matter Physics	Crystals & Defects	4	0	0	4
20MSPDSE 303	Discipline Specific Elective 1	Condensed Matter Physics	Characterization of Materials	4	0	0	4
20MSPDSE 305	Discipline Specific Elective 1	Condensed Matter Physics	Soft Matter Physics	4	0	0	4
20MSPDSE 307	Discipline Specific Elective 1	Spectroscopy	Laser Physics & Applications	4	0	0	4
20MSPDSE 309	Discipline Specific Elective 1	Spectroscopy	Nanophotonics	4	0	0	4
20MSPDSE 311	Discipline specific Elective II	Spectroscopy	Nonlinear Spectroscopy	4	0	0	4
20MSPDSE 313	Discipline specific Elective II	Electronics	Analog Communication	4	0	0	4
20MSPDSE 315	Discipline specific Elective II	Electronics	Digital Communication	4	0	0	4
20MSPDSE 317	Discipline specific Elective II	Electronics	Optoelectronics	4	0	0	4
Practical							
20MSPDSEL 301	Discipline specific Lab		CMPLabI	14	2	8	4
20MSPDSEL 303	Discipline specific Lab		Laser&Spectroscopy Lab1	14	2	8	4
20MSPDSEL 305	Discipline specific Lab		Electronics LabI	14	2	8	4
Total				14	2	08	20
Total Contact Hours				24			20

Note: The student will opt any one option which will be continued in IV Semester as well.

SEMESTER-IV

Code	Category		Course	L	T	P	C
Theory							
20MSP 402	Core Course		Nuclear and Particle Physics	4	0	0	4
20MSPDSE 402	Discipline Specific Elective 1II	Condensed Matter Physics	Renewable Energy Sources	4	0	0	4
20MSPDSE 404			Nano Science & Technology				
20MSPDSE 406			Thin Film Technology				
20MSPDSE 408		Spectroscopy	Fiber Optics Sensors				
20MSPDSE 410			Applied Optics				
20MSPDSE 412	Discipline specific Elective IV		Rotational & Vibrational Molecular Spectroscopy	4	0	0	4
20MSPDSE 414		Electronics	Novel and Smart Materials				
20MSPDSE 416			Microprocessor & Interfacing				
20MSPDSE 418			Semiconductor Physics				
Practical							
20MSPDSEL 402	Discipline specific Lab		CMPLab II	0	0	8	4
20MSPDSEL 404			Laser&Spectroscopy Lab I1				
20MSPDSEL 406			Electronics Lab II				
20MSPDSE 414	Project		Dissertation (Compulsory)	0	0	12	6
20MSPDSE 416				12	0	20	22
20MSPDSE 418				32			22

SUMMARY OF CREDITS

Category	I Sem	II Sem	III Sem	IV Sem	Total	%
CORE	20	20	08	04	52	57.8
GENERIC ELECTIVE	04	04	-	-	08	8.9
DISCIPLINE SPECIFIC ELECTIVE	-	-	12	12	24	26.7
PROECT	-	-	-	06	06	6.7
TOTAL	24	24	20	22	90	

EVALUATION SCHEME

INTERNAL EVALUATION (THEORY)

Assessment	Internal Assessment				Assignment/Presentation/ Class participation	Total
	UNIT-1	UNIT-II	UNIT-III	UNIT-IV		
Marks	10	10	10	10	10	50

INTERNAL EVALUATION (PRACTICAL)

Assessment	Daily Assessment/Observation	Programs performed during Lab hours	Programs performed during Internal practical Examinations	Viva- Voce	Total
Marks	10	15	15	10	50

EXTERNAL EVALUATION (THEORY)

Assessment	End Semester Examination	Total
Marks	100	Will be scaled in 50

EXTERNAL EVALUATION (PRACTICAL)

Assessment	Record File	Programs performed during External Practical Examinations	Written Work	Viva- Voce	Total
Marks	15	15	10	10	50

PROGRAM OBJECTIVE

M.Sc. Physics is the advanced and final degree in the formal training of Physics. The main objective of this course is to equip the students with the advanced concepts and techniques of Physics and ability to apply them in problem solving and prepare them for a career in Physics.

1. To equip students with the advanced concepts of Physics such as quantum mechanics, statistical mechanics, relativity etc and command the advanced techniques to apply them in addressing the practical and heuristic issues.
2. To gain command of the advanced topics and recent developments in the subject.
3. To impart the capability to systematically tackle unknown real life problem and thereby prepare for the doctoral study
4. To inculcate skills like logical thinking, quantitative argumentation, the capability of analyzing a large amount of information (or data) so that even those, who are not going to build a career as a professional Physicist, will benefit both professionally and also as a human being.

PROGRAM OUTCOME

1. Command over the advanced concepts and techniques of the subject.
2. Ability to apply them to problem solving.
3. Ability to systematically pursue unsolved problems and augment new knowledge.
4. Overall scientific temper, ability of quantitative analysis, logical thinking and capability of working in the interdisciplinary domains.

LIST OF GENERIC ELECTIVES

Code	Category	Course	L	T	P	C
Generic Elective-I						
20MSPGE 101		Satellite Communication and Remote Sensing	4	0	0	4
20MSPGE 103		BioPhysics	4	0	0	4
Generic Elective-II						
20MSPGE 202		Programming in C	4	0	0	4
20MSPGE 204		MatLab	4	0	0	4

LIST OF DISCIPLINE SELECTIVE ELECTIVES

Code	Category	Course	L	T	P	C
Discipline Selective Elective-I & II						
20MSPDSE 301	DSE-I	Crystals & Defects	4	0	0	4
20MSPDSE 303		Characterization of Materials				
20MSPDSE 305		Soft Matter Physics				
20MSPDSE 307		Laser Physics & Applications				
20MSPDSE 309	DSE-II	Nanophotonics	4	0	0	4
20MSPDSE 311		Nonlinear Spectroscopy				
20MSPDSE 313		Analog Communication				
20MSPDSE 315		Digital Communication				
20MSPDSE 317		Optoelectronics				

Discipline Selective Elective-III & IV						
20MSPDSE 402	DSE-I	Renewable Energy Sources	4	0	0	4
20MSPDSE 404		Nano Science & Technology				
20MSPDSE 406		Thin Film Technology				
20MSPDSE 408		Fiber Optics Sensors				
20MSPDSE 410		Applied Optics				
20MSPDSE 412	DSE-II	Rotational & Vibrational Molecular Spectroscopy	4	0	0	4
20MSPDSE 414		Novel and Smart Materials				
20MSPDSE 416		Microprocessor & Interfacing				
20MSPDSE 418		Semiconductor Physics				

		L	T	P	C
20MSP101	**MATHMATICAL PHYSICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. The purpose of the course is to introduce students to methods of mathematical physics.
2. Develop required mathematical skills to solve problems in quantum mechanics, electrodynamics and other fields of theoretical physics.

UNIT	Course contents	Contact Hours
Unit-I	**Title: LINEAR ALGEBRA:** Vector space: Axiomatic definition, linear independence, bases, dimensionality, inner product; Gram-Schmidt orthogonalization .Matrices: Representation of linear transformations and change of base; Matrix diagonalization; Eigenvalues and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors.	**15**
Unit-II	**Title: THEORY OF SECOND ORDER DIFFERENTIAL EQUATION** Homogeneous equation: Regular and irregular singular points; Frobenius method; Fuch's theorem; Linear independence of solutions, Wronskian, second solution. Sturm-Liouville theory; Hermitian operators; Completeness, Solution of inhomogeneous Differential equation by Green’s functions, Properties of Bessel, Legendre, Hermite and Laguerre functions (Generating functions, orthogonality and recurrence relations only).	**15**
Unit-III	**Title: COMPLEX ANALYSIS:** Function of complex variable, limit, continuity and differentiability of function of complex variables,Analytic function, Cauchy-Riemann conditions, Cauchy’s integral theorem, Cauchy’s Integral formula, Taylor’s and Laurent’s series, singular points, branch point and branch cut, residues, evaluation of residues, Cauchy’s residue theorem, Jordan’s lemma, evaluation of real definite integrals.	**15**
Unit-IV	**Title: GROUP THEORY:** Definitions; Multiplication table; Rearrangement theorem; Isomorphism and homomorphism; Illustrations with point symmetry groups; Group representations: faithful and unfaithful representations, reducible and irreducible representations; Lie groups and Lie algebra, SU(2), SU(3), SO(2), SO(3) algebra.	**15**

LEARNING OUTCOME:

1. The Candidate has advanced knowledge within the subject areas mathematics and physics.
2. The Candidate has broad knowledge of the scientific theories and methods of the subject areas.
3. The Candidate has knowledge of the relevant numerical/computational tools and methods that are used in mathematics and physics, as well as experimental methods.

Learning Resources	
Text Book	1. Mathematical Methods for Physicists, G. Arfken, H.J. Weber, and F. E. Harris, (Elsevier). 2. Mathematical Methods for Physicists, T. L. Chow (Cambridge university press). 3. Matrices and Tensors in Physics, A.W. Joshi (Wiley Eastern). 4. Group Theory, A.W. Joshi (Wiley Eastern). 5. Group Theory and Its Application to Physical Problems, M. Hamermesh (Dover Publications). 6. Mathematical Physics, P.K. Chattopadhyay (Wiley Eastern). 7. Introduction to Mathematical Physics, C. Harper (Prentice Hall of India). 8. Mathematical Methods in the Physical Sciences, M.L. Boas (Wiley). 9. Applied Mathematics for Engineers and Physicists, L Pipes& L.R. Horwell 10. Complex variables and Applications, J. W. Brown & R. V. Churchill (McGraw-Hill). 11. Schaum’s outline of Complex variables, M. R. Spiegel, S. Lipschutz, J. J. Schiller, D. Spellman (McGraw-Hill). 12. Mathematical Methods for Physics, J. Mathews and R. L. Walker, (Addison-Wesley).

		L	T	P	C
20MSP 103	**CLASSICAL MECHANICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Learning advanced techniques of classical mechanics.
2. Developing skills to apply different techniques of classical mechanics to real world problems.
3. Developing understanding of the fundamental dynamical problems from real world viz., rigid body motion and small oscillations.
4. Learning mechanics at high velocity limit - special theory of relativity.

UNIT	Course contents	Contact Hours
Unit-I	**Title: FORMALISMS OF CLASSICAL MECHANICS** Difficulty in Newtonian mechanics, Constraints of motion, generalized coordinates, D' Alembert's Principle and Lagrange's equation, Velocity dependent forces and the dissipation function, Simple applications including central force problem (equation of motion only). Hamilton principle, Lagrange's equation from Hamilton principle, extension to non-holonomic systems, Legendre Transformation, Hamilton's equations of motion, Hamilton's equations from variation principle, Principle of least action. Canonical transformation and its examples, Poisson's brackets, Equation of motion, Angular momentum, Poisson's Brackets relations, infinitesimal canonical transformation, Conservation Theorems and symmetry properties. Hamilton-Jacobi equation for Hamilton's principal function, Harmonic Oscillator problem.	**15**
Unit-II	**Title: RIGID BODY MOTION AND SMALL OSCILLATIONS** Independent coordinates; orthogonal transformations and rotations (finite and infinitesimal); Euler's theorem, Euler angles; Inertia tensor and principal axis system; Euler's equations; Heavy symmetrical top with precession and nutation, Free vibrations, Normal coordinates, Euler angles, forced oscillations and effect of dissipative forces. Vibration of Tri-atomic Molecule.	**15**
Unit-III	**INTRODUCTION TO CLASSICAL FIELD THEORY** System with infinite degrees of freedom Classical fields: Lagrangian and Hamiltonian formulations Equations of motion. Symmetries and invariance principles, Noether's theorem.	**15**
Unit-IV	**Title: SPECIAL THEORY OF RELATIVITY** Lorentz transformations; 4-vectors, Tensors, Transformation properties, Metric tensor, Raising and lowering of indices, Contraction, Symmetric and antisymmetric tensors; 4-dimensional velocity and acceleration; 4-momentum and 4-force; Covariant equations of motion; Relativistic kinematics (decay and elastic scattering); Lagrangian and Hamiltonian of a relativistic particle.	**15**

LEARNING OUTCOME:

1. Knowledge of the advanced techniques of classical mechanics and skills to apply those techniques to real world problem.
2. Knowledge of dynamics of rigid bodies and small oscillations.
3. Knowledge of special theory of relativity

Learning Resources	
Text Book	1. Classical Mechanics,H. Goldstein, C.Poole& J. Safko, (Pearson Education Asia, New Delhi). 2. Classical Mechanics,N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991). 3. Classical Mechanics, A Course of Lectures: A K Raychaudhuri (Oxford University Press).

		L	T	P	C
20MSP 105	**QUANTUM MECHANICSI**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on treatment of quantum particle.
2. To develop formulation of equation of motion for quantum particle.
3. To introduce the concept of perturbation approximation on a quantum particle.

UNIT	Course contents	Contact Hours
Unit-I	**Title: SCHROEDINGER EQUATIONS AND APPLICATIONS** The Schrödinger equations: Time dependent and time independent forms, Probability current density, expectation values, Ehrenfest's theorem, Gaussian wave packet and its spreading. Exact statement and proof of the uncertainty principle, minimum uncertainty wave packet, eigenvalues and Eigen functions, wave function in coordinate and momentum representations, Degeneracy and orthogonality. One dimensional problem: Harmonic Oscillator, delta potential, Double-delta potential; Aharonov-Bohm effect, Three dimensional problems: 3-Dspherical well and Fermi energy, free particle, 3-D harmonic oscillator, and Hydrogen atom.	**15**
Unit-II	**Title: OPERATORS** Operator in quantum mechanics, Hermitian operator and Unitary operator change of basis, Eigenvalues and eigenvectors of operators, Dirac's Bra and Ket algebra, Linear harmonic oscillator, coherent states, Time development of states and operators, Heisenberg, Schrödinger and interactive pictures, annihilation & creation operators, Matrix representation of an operator, Unitary transformations.	**15**
Unit-III	**Title: ANGULAR MOMENTUM** Angular momentum algebra, Commutation relations, Eigen values and eigenvectors of L^2 and L_z. Ladder operators and their matrix representations, Spin angular momentum, Eigenvalues and eigenvectors of J^2 and J_z. Representation of general angular momentum operator, Addition of angular momentum, C.G. coefficients, Wigner-Ekrat theorem.	**15**
Unit-IV	**Title: TIME INDEPENDENT APPROXIMATION METHODS:** Time independent perturbation theory: Non degenerate case, Degenerate case, Application to one-electron system - Relativistic mass correction, Spin-orbit coupling (L-S and j-j), Zeeman effect and Stark effect. The Variational Method, Helium atoms, Vander-Waal interactions. Exchange degeneracy; Ritz principle for excited states for Helium atom, WKB Approximation: WKB method for one-dimensional problems, Application to barrier penetration.	**15**

LEARNING OUTCOME:

1. Understanding of the quantum treatment of a particle.
2. Understanding of the operator application on wave function and their outcome.
3. The ability to understand the time independent perturbation theory and its applications.

Learning Resources	
Text Book	1. Quantum Mechanics,L.I. Schiff(Tata McGraw-Hill). 2. Quantum Mechanics,B. Craseman and J.L. Powell(Narosa Publishing House). 3. Quantum Mechanics,S. Gasiorowicz (Wiley). 4. Modern Quantum Mechanics,J.J. Sakurai (Addison Wesley). 5. Quantum Mechanics,P.M. Mathews &K.Venkatesan(Tata McGraw-Hill). 6. Quantum Mechanics,V.K. Thankappan(New Age International Publisher). 7. Quantum Mechanics, Concepts and Applications,N. Zettili (John Wiley & Sons Ltd.). 8. Quantum Mechanics,B.H. Bransden and C.J. Joachain (Pearson Education).

		L	T	P	C
20MSP 107	**COMPUTATIONAL PHYSICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Basic Computer Organization
2. Various numerical method techniques

UNIT	Course contents	Contact Hours
Unit-I	**Title: BASIC COMPUTER ORGANIZATION& PROGRAMMING** Input and output units, Storage unit, Arithmetic Logic unit, Control unit, Central processing unit. Fortran Programming: Data types, Arithmetic & logical expression, Input-output statements, If statement, Do loop, Arrays and subscripted variables, functions and subroutines, Handling input and output files.	**15**
Unit-II	**Title: ERROR & CURVE FITTING** Errors: Round off errors, truncation error, machine error, random error. Solution of algebraic equation: Bisection method, iteration method, Newton Raphson method, Muller method. Interpolation and extrapolation: Finite difference, forward difference, backward difference, central differences, Lagrange method. Curve Fitting: Least-square curve fitting, straight line and polynomial fits.	**15**
Unit-III	**Title: DIFFERENTIATION & INTEGRATION** Differentiation: Taylor series method, numerical differention using Newton's forward difference formula, strilling formula. Integration: Trapezoidal rule, Simpson 1/3 rule, Gaussian Quadrature, Legendre-Gauss Quadrature, Numerical double integration	**15**
Unit-IV	**Title: NUMERICAL SOLUTION OF DIFFERENTIAL EQUATION** Numerical solution of ordinary differential equation: Taylor series method, Eulers methods, forth order Runga Kutta method. Second order differential equation: Initial and boundary value problem, Numerical solution of radial Schrödinger for hydrogen atom using forth order RungaKutta method (when eigen value is given).	**15**

LEARNING OUTCOME:

1. Basic Computer Organization/programming
2. Various numerical method techniques to apply in some scientific problems or data processing

Learning Resources	
Text Book	1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co.) 2. Computational: Physics an introduction, RC Verma, PK Ahulawalia and K C Sharma (New Age International Publisher) 3. Introduction to Numerical Analysis, F b Hilderbrand(Tata McGraw Hill) 4. Programming with Fortran 95, Schaum's outline series, William E. Mayo and Martin Cwiakala(McGraw-Hill.Inc). 5. Fortran Programming and Numerical methods, R C Desai (Tata McGraw Hill). 6. Computer Applications in Physics, Suresh Chandra (Narosa Publishing House). 7. Introductory methods of numerical methods of numerical Analysis, S S Sastry (Prentice Hall of India). 8. Computer oriented Numerical Method, V Rajaraman (Prentice Hall of India). 9. An Introduction to numerical analysis, John Wiley and Sons.

		L	T	P	C
20MSP 109	**PHYSICS LAB – I (General)**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least six experiments in a semester. List of experiments may be amended.

1. Matrix summation, subtraction and multiplication
2. Linear curve fitting and calculation of linear correlation coefficient
3. To find the root of algebraic equation Newton Raphson method.
4. To fit a straight line through given data using Least square method.
5. To fit the given data using polynomial fitting.
6. Solution of transcendental or polynomial equations by the Newton Raphson method
7. Lagrange interpolation based on given input data
8. Numerical integration using the Simpson's method
9. Solution of first order differential equations using the Rung-Kutta method
10. Numerical integration using the Gaussian quadrature method

		L	T	P	C
20MSP 202	**ELECTRODYNAMICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Learning the fundamental laws of electrodynamics.
2. Gain knowledge of electromagnetic wave propagation.
3. Learning compatibility between the classical electrodynamics and special theory of relativity.
4. Gain knowledge about how the electromagnetic waves are generated.

UNIT	Course contents	Contact Hours
Unit-I	**Title: REVIEW OF MAXWELL'S EQUATION** Maxwell's equations in free space and linear isotropic media, Boundary conditions on the fields at interfaces. Scalarand vector potentials. Gauge transformations. Coulomb and Lorentz gauges, Multipole expansion of (i) scalar potential and energy due to a static charge distribution (ii) vector potential due to a steady current distribution. Electrostatic and Magnetostatic energy. Poynting's theorem. Maxwell's stress tensor. Euler-Lagrange equation for the electromagnetic field. The field momentum. Equation of motion in an electromagnetic field.	**15**
Unit-II	**Title: ELECTROMAGNETIC WAVES** Plane EM wave in free space and dielectric media, Reflection and Transmission at dielectric interface, Normal and Oblique incidence, Fresnel's law, Brewster angle, Polarization by reflection and Total internal reflection, Waves in a conducting media: Absorption and dispersion, Skin depth, Reflection at conducting surface, Wave guides: TE mode, TM mode, cut off wavelength. Coaxial transmission line.	**15**
Unit-III	**Title: RELATIVISTIC ELECTRODYNAMICS** Electromagnetic field tensor, Covariance of Maxwell's equations; Lorentz transformation for the electromagnetic fields; Field invariants; Covariance of Lorentz force equation and conservation laws, Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field and the equation of motion of a charged particle in an electromagnetic field.	**15**
Unit-IV	**Title: RADIATIONS :** Radiation from localized sources and multipole expansion in the radiation zone. Lienard-Wiechert potentials; Fields due to a charge moving with uniform velocity; Fields due to an accelerated charge; Radiation at low velocity; Larmor's formula. its relativistic generalization; Radiation when velocity (relativistic) and acceleration are parallel, Bremsstrahlung; Radiation when velocity and acceleration are perpendicular, Synchrotron radiation; Thomson scattering. Cherenkov radiation (qualitative treatment only). Abraham-Lorentz formula for the radiation reaction force.	**15**

LEARNING OUTCOME:

1. Knowledge about the fundamental laws of electrodynamics and electromagnetic wave propagation.
2. Knowledge of covariance laws of classical electrodynamics.
3. Knowledge about radiation

Learning Resources	
Text Book	1. Introduction to Electrodynamics, David J. Griffiths, (Prentice Hall India). **2.** Classical Electrodynamics, J.D. Jackson, (Wiley Eastern). 3. Classical Electromagnetic Radiation, J.B. Marion and M.A. Heald, (Academic Press). 4. Classical Electricity & Magnetism: W. K. H. Panofsky and M. Phillips.

		L	T	P	C
20MSP 204	**ELECTRONICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on semiconductor devices.
2. To introduce the working and characteristics of Field Effect Transistors.
3. To develop the understanding of the electric signal generators.
4. To introduce the principle and working of operational amplifier

UNIT	Course contents	Contact Hours
Unit-I	**Title: BASIC SEMICONDUCTOR DEVICES:** Drift and diffusion current, Generation and recombination of charges, continuity equation, p-n junction, junction diode characteristic, Capacitance of p-n junctions, Varactors, switching diodes, Clippers & Clampers, photoconductors, photodiode, light emitting diodes.	**15**
Unit-II	**Title: FIELD EFFECT TRANSITORS:** Junction Field Effect Transistor (JFET): Basic structure & Operation, pinch off voltage, single ended geometry of JFET, Volt Ampere characteristic, Transfer Characteristics. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, comparison of p & n Channel FET, SCR.	**15**
Unit-III	**Title: OPERATION AMPLIFIER:** Operational Amplifiers: Block diagram, open and close loop configuration, inverting & non-inverting amplifier, Op-amp with negative feedback Voltage series feedback, Effect of feedback on closed loop voltage gain, Input resistance, output resistance, band width, output offset voltage, Measurements of Op-amp parameters. Op-amp Application: d.c. and a.c. amplifier, summing, scaling and Averaging amplifier, Integrator, Differentiator, Electronic analog computation comparator	**15**
Unit-IV	**Title: OSCILLATOS AND WAVE GENERATORS:** Oscillators: Principles, Types, frequency stability, Phase shift oscillator, Wein bridge oscillator, LC tunable oscillator, Square wave, Triangular wave and pulse generator, Monostable, Bistable & Astable, Multivibrators, Sample and Hold circuits, Principle of Phase Locking	**15**

LEARNING OUTCOME:

1. Understanding of the electronic conductivity in semiconductor and its applications.
2. Understanding of the different configuration of Field effect transistor and its characteristics.
3. The ability to understand the principles behind oscillators and signal generators.
4. Becomes familiar with the working of operation amplifier and its application.

Learning Resources	
Text Book	1. Semiconductor Devices - Physics and Technology, S.M. Sze (John Wiley), 2002. 2. Solid State Electronic Devices, Ben Streetman, Sanjay Banerjee (Prentice Hall India) 6th Edition, 2005. 3. Electronic Principles, A.P. Malvino (Tata McGraw, New Delhi), 7th edition, 2009. 4. Integrated Electronics, J. Millman, C. Halkias and C.D. Parikh, Tata McGraw Hill, 2nd edition, 2015 5. Linear and Non-linear Circuits, Chua, Desoer and Kuh (Tata McGraw), 1987. 6. Circuit theory Fundamentals and Applications, Aram Budak (Prentice-Hall) 1987. 7. Integrated Electronics, Millman and Halkias (Tata McGraw Hill) 1991. 8. Electronic Devices and Circuits Theory, Boylested and Nashelsky,(Pearson Education) 10th ed. 2009. 9. OPAMPS and Linear Integrated circuits, Ramakant A Gayakwad (Prentice Hall), 1992. 10. Operational amplifiers and Linear Integrated circuits, R.F. Coughlin and F.F. Driscoll, (Prentice Hall of India, New Delhi), 2000. 11. Principals and Applications in Electronics: A.P. Malvino, D.P. Leach, (Tata Mcgraw- Hill, N.Delhi,1993) 12. Electronic Fundamentals &Applications: John D. Ryder (Prentice Hall of India, N. Delhi)

		L	T	P	C
20 MSP 206	**QUANTUM MECHANICS – II**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire knowledge on time dependent perturbation theory.
2. To develop the understanding of the scattering theory.
3. To introduce the symmetry element and identical particles in quantum mechanics.

UNIT	Course contents	Hours
Unit-I	**Title: TIME DEPENDENT PERTURBATION THEORY** Time-dependent perturbation theory, interaction picture, first order perturbation, harmonic perturbation, transition probability, ionization of a hydrogen atom, density of final states, ionization probability, second order perturbation, adiabatic approximation, choice of phases, connection with perturbation theory, discontinuous change in H, sudden approximation, distribution of an oscillator, Constant and harmonic perturbations, Fermi's Golden rule, Sudden and Adiabatic Approximation	**15**
Unit-II	**Title: SCATTERING THEORY:** Basic concept of scattering, scattering cross-section, scattering amplitude, scattering by spherically symmetric potentials, partial wave analysis and phase shifts, Ramsauer-Townsend effect; Relation between sign of phase shift and attractiveor repulsive nature of the potential; Scattering by a rigid sphere and square well; Coulombscattering;Formal theory of scattering: Green's function in scattering theory; Lippman-Schwinger equation; Born approximation, applications toYukawa potential and other simple potentials. Electron scattering by an atom.	**15**
Unit-III	**Title: SYMMETRY IN QUANTUM MECHANICS ANDIDENTICAL PARTICLES** Conservation laws and degeneracy associated with symmetries, Discrete symmetries: CPT symmetry, Continuous symmetries: space and time translations, rotations; Identical particles: indistinguishability of identical particles and its consequences, Symmetric and antisymmetric wave functions, Pauli's exclusion principle, connection with statistical mechanics, collisions of identical particles.	**15**
Unit-IV	**Title: RADIATION AND RELATIVISTIC QUANTUM MECHANICS:** Absorption and induced emission: Maxwell equation, plane electromagnetic wave, use of perturbation theory, transition probability, interpretation in terms of absorption and emission, electric dipole transitions, forbidden transitions, classical radiation field, asymptotic form, radiated energy, dipole radiation, angular momentum, dipole case, conservation from classical to quantum, Planck's distribution formula, line breadth, selection rules for a single particle, polarization of emitted radiation, Relativistic quantum mechanics: Klein – Gordon equation, Dirac equation and its plane wave solutions, concept of spin.	**15**

LEARNING OUTCOME:

1. Understanding of the time dependent perturbation theory.
2. Understanding of the scattering theory and its application.
3. The ability to deal the radiation emission by quantum perturbation theorem.
4. Becomes familiar with the symmetry elements and identical particles.

Learning Resources	
Text Book	1. Quantum Mechanics, L.I. Schiff (Tata McGraw-Hill) 2. Quantum Physics, S. Gasiorowicz (John Wiley& Sons Ltd.) 3. Quantum Mechanics, B. Craseman and J.D. Powell (Narosa Publishing House) 4. Quantum Mechanics, A. Messiah (Dover Publications) 5. Modern Quantum Mechanics, J.J. Sakurai (Addison Wesley) 6. Advanced Quantum Mechanics, J.J. Sakurai (Addison Wesley) 7. Relativistic quantum mechanics, J. D. B.Jorken and S. D. Drell(McGraw-Hill) 8. A Text book of Quantum Mechanics, P. M. Mathews & K. Venkatesan (Tata McGraw Hill) 9. Quantum Mechanics, B. H. Bransden and C. J. Joachain (Pearson Education)

		L	T	P	C
20MSP 208	**STATISTICAL MECHANICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

**COURSE OBJECTIVE **

1. The correlation between thermodynamic quantities and statistical parameters.
2. Thermodynamic behaviour of different basic systems using different ensembles.
3. Applicability of classical and quantum statistics for different particle systems.
4. Phase transition and its explanation based on different models.

UNIT	Course contents	Contact Hours
Unit-I	**Title: STATISTICAL BASIS OF THERMODYNAMICS** Objective of statistical mechanics, Central Limit Theorem, Microstates, Macrostates, Phase space and ensembles, Ensemble average and time average, Ergodic hypothesis, Postulatesof equal a-priori probability, Contact between statistics and thermodynamics: Boltzmann's postulate of entropy, Classical ideal gas, Entropy of Mixing, Gibbs paradox and its solution, Liouville's theorem.	**15**
Unit-II	**Title: CLASSICAL STATISTICAL MECHANICS** Theory of Microcanonical, Canonical, and Grand Canonical ensembles. Partition function Contact with thermodynamics, Helmholtz and Gibbs free energies, Applications to classical ideal gas andsystems of harmonic oscillators. Equipartition and Virial Theorems. Density and energy fluctuations,Chemical equilibrium and SahaIonization Equation.	**15**
Unit-III	**Title: QUANTUM STATISTICS OF IDEAL GASES** Quantum states and phase space, Density matrices, Density matrix in statistical mechanics, Quantum Liouville theorem, Some simple applications (Harmonic oscillators, Free particles in a box).Statistical Mechanics ofIdeal Bose and Fermi gases, Bose-Einstein Condensation, Phonon gas, Electron gas in a Metal,White Dwarf Stars, Chandrasekhar Mass Limit.	**15**
Unit-IV	**Title: RECENT TRENDS IN STATISTICAL MECHANICS** Review of condensation in a van der Waals gas, Critical exponents, Introduction to mean-field theory of phase transitions, One- and two-dimensional Ising model, Explanation of second order phase transition in magnetic materials. Calculation of exponents from Landau theory of phase transition. Rudiments of Real Space Renormalization GroupTransformations. Brownian motion, Fokker-Planck Equation, Introduction to non-equilibrium processes, Fluctuation-Dissipation Theorem.	**15**

LEARNING OUTCOME:

1. Know various statistical terms and their relations with thermodynamic quantities.
2. Understand different ensembles and partition function.
3. Analyze thermodynamics of ideal gas using different ensembles.
4. Understand thermodynamic behaviour of Bosons and Fermions.
5. Explain first and second order phase transitions based on various theories

Learning Resources	
Text Book	1. Statistical Mechanics, R.K. Patharia and P. D. Beale (Elsevier). 2. Fundamentals of statistical and thermal physics, F. Reif (Waveland Press). 3. Statistical Mechanics, K. Huang (Wiley Eastern, New Delhi). 4. Statistical Mechanics, B.K. Agarwal and M. Eisner (Wiley Eastern). 5. Elementary Statistical Physics, C. Kittel (Wiley). 6. Statistical Mechanics, L.D. Landau, E.M. Lifshitz (Butterworth-Heinemann). 7. Equilibrium Statistical Physics, M. Plischke and B. Bergersen (World Scientific). 8. Statistical Mechanics A set of lectures, R. P. Feynman (The Benjamin/Cummings Publishing Co, Inc.)

		L	T	P	C
20MSP 210	**PHYSICS LAB – II**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least six experiments in a semester. List of experiments may be amended.

1. To determine charge to mass ratio of electron by using Magnetron.
2. To study the Magnetostriction effect in a metallic rod.
3. To study the frequency response of an operational amplifier.
4. To study the use of operational amplifier for different mathematical operation.
5. To study the use of operational amplifier for voltage to current conversion.
6. To study the use of operational amplifier for current to voltage conversion.
7. To design an (i) inverting amplifier and (ii) non-inverting amplifier, of a given gain using operational amplifier.
8. To study the characteristic of SCR and its application as a switching device.
9. Verification of Norton's theorem.
10. Verification of Thevenin's theorem.

		L	T	P	C
20MSP 301	**ATOMIC AND MOLECULAR PHYSICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Atomic Physics
2. Molecular Spectroscopy
3. Laser principle and Laser based Fluorescence Spectroscopy

UNIT	Course contents	Contact Hours
Unit-I	**Title: ATOMIC PHYSICS** One electron atomic systems: Hydrogenic atomic systems, Fine structure and hyperfine structure, Determination of nuclear spin using hyperfine structure, Interaction with electromagnetic fields: Zeeman, Paschen-Bach and Stark effect. The ground state of two-electron atoms – perturbation theory and variational methods. LS and J-J couplings schemes, Briet's scheme. Many-electron atoms – Central Field Approximation. The Hartree-Fock equations. The spectra of alkali using quantum defect theory. Selection rules for electric and magnetic multipole radiation. Auger process.	**15**
Unit-II	**Title: MOLECULAR PHYSICS** Microwave spectroscopy: Diatomic molecule as rigid rotator; its energy level and spectra, Intensity of rotational lines, Diatomic molecule as non-rigid rotator. Isotope effect in rotational spectra; Infrared spectroscopy: Diatomic molecules as harmonic and anharmonic oscillator, Diatomic molecule as vibrating rotator, Energy levels and spectrum, thermal distribution of quantum states, Isotope effect in vibration spectra; Raman spectroscopy: Introduction, Pure rotational Raman spectra, Pure Vibrational Raman spectra, Raman rotational vibrational spectra.	**15**
Unit-III	**Title: ELECTRONIC BAND SPECTRA** Salient features of electronic band spectra, Born Oppenheimer approximation, Vibrational coarse structure of electronic bands, progression and sequences, Rotational fine structure of electronic bands, The Fortrat parabola. Intensity of electronic bands: Franck Condon principle (absorption and emission), quantum mechanical treatment of Franck Condon principle.	**15**
Unit-IV	**Title: LASER PHYSICS & FLUORESCENCE SPECTROSCOPY** Laser: Spontaneous and stimulated emission, Einstein A & B coefficient, optical pumping, population inversion, rate equation, modes of resonator and coherence length. Fluorescence and Phosphorescence, Kasha's rule, quantum yield, nonradioactive transition, Jablonski diagram, Time resolved fluorescence and determination of excited state life-time.	**15**

LEARNING OUTCOME:

1. Atomic Physics and Molecular Spectroscopy
2. Electronic band spectra
3. Physics of Laser action and its application in Fluorescence Spectroscopy

Learning Resources	
Text Book	1. Introduction to Atomic spectra, H.E. White 2. Fundamental of Molecular spectroscopy, C.N. Banwell 3. Atomic spectra & Structure, G. Herzberg 4. Physics of Atoms and Molecule, Bransden and Joachain 5. Molecular spectroscopy, J. M. Brown 6. Introduction to Molecular spectroscopy, G. M. Barrow 7. Spectra of Atoms and Molecule, P.F. Bemath 8. Laser- Theory and Application, K. Thyagrajan and A. K. Ghatak 9. Principle of Fluorescence spectroscopy, Lacowicz 10. Theory & Interpretation of Fluorescence and Phosphorescence, Ralph S Beck

		L	T	P	C
20MSP 303	**SOLID STATE PHYSICS**	**4**	**0**	**0**	**4**
Core Subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Different structural parameters & Lattice vibrations and phonon interactions.
2. Free electron theory and Fermi gas.
3. Basic conduction mechanisms& Basic concepts of superconductivity.
4. Magnetism associated with materials.

UNIT	Course contents	Contact Hours
Unit-I	**Title: CRYSTAL STRUCTURE** Crystalline solids, Direct lattice, translational vectors, two and three – dimensional Bravais lattices, Miller Indices, Closed packed structures. Interaction of X- Rays with matter, absorption of X-Rays, Elastic scattering from a perfect lattice. Reciprocal lattice, Bragg's Law, Ewald construction, Brillouin zones and applications of reciprocal lattice to diffraction techniques. Experimental method in X-ray Diffraction - Laue method, powder method and rotating crystal method, structure factor, bonding in solids.	**15**
Unit-II	**Title: LATTICE VIBRATION, PHONONS AND FREE ELECTON THEORY OF METALS** Lattice Modes of Vibration, Elastic Vibrations of continuous media, Vibrations of 1D monatomic and diatomic linear lattice. Phonon Modes, Lattice vibration Spectrum, phonon momentum, Inelastic scattering by phonons. Classical theory of Free electron, Fermi gas, energy levels and density of orbitals, Fermi-Dirac distribution function, Quantum theory of free electrons in a 3Dbox, electronic specific heat of a metal.	**15**
Unit-III	**Title: BAND THEORY OF SOLIDS AND SUPERCONDUCTIVITY** Electrons in a periodic lattice: Bloch theorem, band theory in metals, semiconductor, insulator, effective mass. Tight binding approximations. Fermi surface, Conduction in Semiconductors (both Intrinsic and Extrinsic), quantum Hall effect. Basic Properties of Superconductors, Meissner Effect, Transport Behavior, Types of Superconductors, London's equations, penetration depth, coherence length, energy gap parameter, Josephson Effects, BCS theory of Superconductivity, Introduction to high temperature superconductors.	**15**
Unit-IV	**Title: MAGNETISM:** Langevin's theory of Dia- and Para-magnetism, Weiss Theory of paramagnetism and Ferromagnetism, Quantum theory of Ferromagnetism, Heisenberg's theory of magnetism. Ferromagnetic domains, Anti-ferromagnetism, Ferrimagnetism and Bloch-wall. Structure of Ferrites.	**15**

LEARNING OUTCOME:

1. Know crystal parameters and their analysis.
2. Understand lattice vibrations and phonon modes & Know the electron conduction mechanism in solids.
3. Zero resistance phenomena and associated effects.
4. Explain different theoretical considerations for magnetic properties in materials.

Learning Resources	
Text Book	1 Introduction to Solid State Physics,C. Kittel(Wiley, New York) 2 Quantum Theory of Solids,C. Kittel (Wiley, New York) 3 Crystallography for Solid-State Physics,Verma and Srivastava 4 Principles Of the Theory of Solids,J. Ziman(Cambridge University Press, Cambridge) 5 Introduction to Solids,Azaroff 6 Elementary Solid-State Physics,Omar 7 Solid State Physics,Aschroft&Mermin (Reinhert& Winston, Berlin) 8 Principles of Condensed Matter Physics,Chaikil&Lubensk 9 Introduction to Superconductivity,M. Tinkham 10 Solid State Physics,S. O. Pillai (New Age International Publisher) 11 Soild State Physics,M. A. Wohab (Narosa).

		L	T	P	C
20MSPDSE301	**CRYSTALS AND DEFECTS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. The basic crystal structure and crystal parameters.
2. X-ray diffraction method for crystalline properties of materials.
3. Defects and dislocations in materials.
4. Detection of trace elements using spectroscopy techniques.

UNIT	Course contents	Contact Hours
Unit-I	**Title: CRYSTAL STRUCTURE** Elementary concepts of space group and its relevance to crystalline structure. Principle powder Diffractometer. Interpretation of powder photograph, Analysis indexing: Ito's method. Accurate determination of lattice parameters-least-square method. Application of powder method. Liquid crystals and quasi crystals.	**15**
Unit-II	**Title: DIFFRACTION ANALYSIS** Interpretation of oscillation photograph, X-ray method of orienting crystals about a crystallographic direction, Bernal chart, Indexing of reflections, Burger's precession method. Determination of relative structure amplitude from measured intensity (Lorentz and Polarization factors).	**15**
Unit-III	**Title: IMPERFECTION OF CRYSTALS:** Point Defects (Schottkey and Frankel) and their thermodynamics, Color Centres F, M, R, V and H, Ploarons and Excitons, Edge dislocation and screw dislocation, Mechanism of plastic deformation, Stress and strain fields of screw and edge dislocation, Elastic energy of dislocations, Forces between dislocations, Dislocations in fcc, hcp and bcc lattices .	**15**
Unit-IV	**Title: DEFECT ANALYSIS:** Partial dislocations and stacking faults in closed-packed structures. Experimental method of detecting dislocations and stacking faults in closed packed structures, Electron Microscopy: Kinematic theory of diffraction contrast and line imaging. Optical techniques for the observation of defects: Photoluminescence (PL), Fourier Transform Infra-Red (FTIR) and Raman spectroscopy.	**15**

LEARNING OUTCOME:

1. Define crystal parameters.
2. Analyze diffraction data for crystal structure.
3. Define types of defects and dislocations in crystals.
4. Analyze data of experimental techniques for crystal defects.

Learning Resources	
Text Book	1. Crystallography for Solid State Physics, Verma and Srivastava. 2. X-ray Crystallography, Azraf. 3. Elementary Dislocation Theory, Weertman and Weerdtman. 4. Crystal Structure Analysis, Burger 5. Electron Microscopy of Thin Cryslals, Hirsh.

		L	T	P	C
20MSPDSE 303	**CHARACTERIZATION OF MATERIALS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. The basic structural analysis using X-ray and neutron diffraction.
2. Role of electron microscopy for material characterization.
3. Optical techniques used for material characterization.
4. Techniques for crystal defect analysis.

UNIT	Course contents	Contact Hours
Unit-I	**Title: STRUCTURAL ANALYSIS:** X-ray characterization of imperfections in crystals, Basic concepts of small angle X-ray scattering and its application in evaluation of shape and size of surface particles. Neutron scattering and diffraction with reference to light elements and magnetic structures.	**15**
Unit-II	**Title: ELECTRON SPECTROSCOPY TECHNIQUES:** LEED (Low Energy Electron Diffraction) for surface structures, Surface Topography, Elementary Concepts of Scanning and Scanning Tunneling Microscopic Techniques for chemical analysis. Methods. RBS (Rutherford Back Scattering)	**15**
Unit-III	**Title: OPTICAL SPECTROSCOPIC TECHNIQUES:** Double Beam IR Spectrometers, Basic Concepts of Raman Spectrography in Solids, Sensitive Detectors such as CCD Camera, Concept of Space Group and Point Group, Identification and Analysis of Optic and Acoustic Modes in Solids. Electronic Absorption Study for Band Gap determination.	**15**
Unit-IV	**Title: ANALYSIS OF TRACE ELEMENTS:** Basic of nuclear magnetic resonance (NMR) and electronic spin resonance (ESR) spectroscopy, Mossbauer spectroscopy, Microwave spectroscopy, Photo acoustic spectroscopy and their applications. Laser as a source of radiation and its characteristics Laser fluorescence and absorption spectroscopy, Multiphoton ionization and separation of isotopes.	**15**

LEARNING OUTCOME:

1. Analyze the results of diffraction techniques for material properties.
2. Know the basic working of electron microscopic techniques.
3. Analyze optical properties of materials.
4. Analyze the results of spectroscopy techniques for detection of trace elements.

Learning Resources	
Text Book	1. Analytical Techniques for Thin Films-Treatise on Material Science and Technology, Vol. 27, K.N. Tu and R. Rosenberg (ed). 2. Electron Microprobe Analysis, S.J.B. Reed. 3. Topics in Applied Physics, Vol. 4: R. Gomer (ed.). 4. Analysis of high Temperature Materials, Van Der Biest (ed.)

		L	T	P	C
20MSPDSE 305	**SOFT MATTER PHYSICS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Basic materials in soft matter physics.
2. Properties of polymers.
3. Elastic properties of soft materials.
4. Various interactions involved in soft matter physics

UNIT	Course contents	Contact Hours
Unit-I	**Title: SOFT MATERIALS** Amorphous materials, Brownian motion, Diffusion, Connection between Diffusion and random walks, Langevin equation. Order parameters in liquids, Long-and short-range order, Liquid crystals, Liquid crystal order parameter, Polymers, Colloids, Quasi-crystals, Granular Materials.	**15**
Unit-II	**Title: POLYMERS** Polymer statistics: Single chain statistics; Chain under external action; Flory theory; Polymer solutions: Dilute, Semi-dilute and melts; Osmotic pressure; Scaling laws; Segregation in polymer mixtures; Polymers near the interfaces: Adsorption; Depletion layer; Steric repulsion; Dynamics of a polymer chain: Rouse model; Normal modes; Motion of monomers; Hydrodynamic interactions.	**15**
Unit-III	**Title: ELASTICITY AND FLUID MECHANICS** Elasticity, Nonlinear elasticity, Rubber elasticity, Larger extensions of rubber, Linear elasticity, Solids of cubic symmetry, Isotropic solids. Newtonian fluids, Euler's equation, Navier-stokes equation, Polymeric solutions, Plasticity, Super-fluid ^{4}He, Two-fluid hydrodynamics, Second sound, Origin of super-fluidity.	**15**
Unit-IV	**Title: INTERFACIAL INTERACTIONS** Van der Waals interaction; non-retarded interaction; interactions of many molecules; Electrostatic interaction; screening; Colloidal dispersions; Interfacial tension; Laplace pressure; Surface-active agents; interface free energy; thermal fluctuations of interfaces; fluctuations of fluid membranes; persistence length; steric repulsion; micelles; critical micelles concentration; vesicles; micro-emulsions	**15**

LEARNING OUTCOME:

1. Aware about materials viz. liquid crystals, colloids, polymers etc.
2. Different statics involved in polymer materials.
3. Understand the elastic properties of soft materials.
4. Aware about fluid dynamics of Newtonian fluids.
5. Understand interfacial interactions in soft matter physics.

Learning Resources	
Text Book	1. Statistical thermodynamics of Surfaces, Interfaces, and Membranes", Samuel A. Safran, CRC Press. 2. Scaling Concepts in Polymer Physics, Pierre-Gilles de Gennes , Cornell University Press 3. The Theory of Polymer Dynamics, M. Doi, S. F. Edwards, Oxford Science Publication. 4. Theory of Polymer Dynamics, W.J. Briels. 5. Condensed Matter Physics, 2nd Edition, Michael P. Marder, Wiley 6. Oxford Master Series in Condensed Matter Physics, Richard A.L. Jones.

		L	T	P	C
20MSPDSE 307	**LASER PHYSICS & APPLICATIONS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Basic principles and properties of Laser
2. Various types of Laser
3. Laser applications

UNIT	Course contents	Contact Hours
Unit-I	**Title: LASER FUNDAMENTALS:** Rate equations, Einstein Coefficients, lasing action, Population Inversion, Principles and characteristics of Laser-Directionality, Coherence, polarization, width and profile of spectral lines, Intensity- Laser Components, Three & Four level Lasers, Q-Switching, Mode Locking. spectral characteristics of laser emission, single and multi-mode lasers, line broadening mechanisms, thermal broadening, doplar broadening, collision broadening, broadening due to impurities in solids.	**15**
Unit-II	**Title: DIFFERENT LASERS** Principle and Working of Ruby, Nd-YAG, Helium Neon laser, Argon Laser, Nitrogen laser, Carbon dioxide (CO_2) laser, Dye laser, Excimer laser, Titanium-sapphire laser-Threshold condition for oscillations., Qualitative Description of Longitudinal and TE laser systems. Thresholdcondition for Oscillation in Semiconductor Laser. Bipolar and Unipolar semiconductor laser, energy band engineering, condition for Gain in bipolar semiconductor laser, Homojunction and heterojunction semiconductor lasers, GaAs quantum well, GaAs/AlGaAs hetero structure fabrication for lasing applications, Free electron laser.	**15**
Unit-III	**Title: NON-LINEAR PROCESSES** Propagation of Electromagnetic Waves in Nonlinear medium, Self-Focusing, Phase matching condition, Fiber Lasers,Stimulated Raman Scattering and Raman Lasers, CARS, Saturation and Two photon Absorptions. Phase matching condition, Frequency doubling, Optical mixing. Time resolved laser spectroscopy: Generation and measurement of ultra-short pulses andlifetime measurements with lasers, pump and probe techniques	**15**
Unit-IV	**Title: NOVEL APPLICATIONS OF LASER** Cooling and Trapping of Atoms, Principles of Doppler and Polarization Gradient Cooling, Qualitative Description ofIon Traps, Optical Traps and Magneto-Optical Traps, Evaporative Cooling and Bose Einstein Condensation. Optical tweezing, Health Monitoring-Endoscopy, Clinical diagnostic. Military applications, Industrial applications. Laser based optical diagnostic techniques-Raman, Laser Induced Fluorescence, Laser Induced Breakdown Spectroscopy (LIBS).	**15**

LEARNING OUTCOME:

1. Principles of Laser operation
2. Nonlinear processes
3. Novel applications of Laser

Learning Resources	
Text Book	1. Laser Spectroscopy and Instrumentation, W. Demtroder. 2. Principles of Lasers, O. Svelto. 3. Laser Cooling and Trapping, P.N. Ghosh. 4. Frontiers in Atomic, Molecular and Optical Physics, S.P. Sengupta.

		L	T	P	C
20MSPDSE 309	**NANOPHOTONICS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Photonics operative at a nano scale
2. Concepts of near field and their application in microscopy
3. Plasmonics and elementary concept of photonic crystals

UNIT	Course contents	Contact Hours
Unit-I	**Title: INTRODUCTION** Overview of Nanophotonics, Confinement of Photons and electrons, Bandgap-Tunneling, Localization under periodic potential, Quantum Confinement Effects-Quantum wells/wire/dots, Nanoscopic interaction dynamics, Dielectrics confinement effects, Superlattices.	**15**
Unit-II	Title: **NEAR-FIELD INTERACTION & MICROSCOPY** Near-Field Optics, Near-Field Microscopy, Example of Near-Field Studies-Single Molecule Spectroscopy & Nonlinear Optical Processes. Nano-scale enhancement of optical interactions-Surface Enhanced Raman Scattering Spectroscopy. Time and Space-Resolved studies of Nanoscale Dynamics.	**15**
Unit-III	**Title: PLASMONICS& PHOTONIC CRYSTALS** Metallic Nanoparticles-Spherical, Nano rods and Nano shells, Local Field Enhancement, Subwavelength AperturePlasmonics, Nanostructure and excited states, Basic concepts of Photonic crystals, Nonlinear Photonic crystals, Photonic crystal sensors, Nanocomposites as photonic media.	**15**
Unit-IV	**Title: MATERIALS & APPLICATIONS IN BIOTECHNOLOGY** Nanocomposites, Bioderived Materials, Biotemplates, Bacteria as Bio-synthesizers, Near-Field Bioimaging, Optical Diagnostics, Nanoclinics for Targeted Therapy and Gene delivery. Photodynamic Therapy for killing cancer cells, Nanomedicine.	**15**

LEARNING OUTCOME:

1. Have an idea of the field of nanophotonics
2. Know about near field interaction and their application in microscopy
3. Understand Plasmonics and photonic crystals

Learning Resources	
Text Book	1. Biophotonics,P. N Prasad 2. Introduction to Nanophotonics, S. V. Gaponenko 3. Principles of Nano-optics, Lukas Novotny 4. Diffractive Optics &Nanophotonics, V. A. Soifer

		L	T	P	C
20MSPDSE 311	**NONLINEAR SPECTROSCOPY**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To introduce different nonlinear phenomenon that takes place in light matter interaction.
2. To make the students able to understand the difference between linear and non-linear spectroscopy
3. To introduce concept of Coherent Raman spectroscopy and Coherent Anti Raman scattering (CARS) spectroscopy.
4. To develop the basic knowledge about four wave mixing.

UNIT	Course contents	Contact Hours
Unit-I	**Title: INTRODUCTION** Prologue: Linear Spectroscopy, Brief introduction to tunable laser sources and linear spectroscopy, The Density Matrix for a Two-Level System, the Interactions and the Hamiltonian, Relaxation, the Master Equation and the Vector Model, the Nonlinear Polarization Density and Nonlinear Susceptibility, Physical principles underlying various spectroscopic techniques and line broadening phenomena, Inhomogeneous Broadening, Effective Operators for Multiquantum Transitions.	**15**
Unit-II	**Title: SATURATION SPECTROSCOPY** Burning and Detecting Holes in a Doppler-Broadened Two-Level System, Crossover Resonances and Polarization Spectroscopy, Coupled Doppler-Broadened Transitions, Experimental Methods of Saturation Spectroscopy in Gases, Ramsey Fringes in Saturation Spectroscopy, The Line-Shape Problem in Saturation Spectroscopy, Experimental Results in Saturation Spectroscopy of Gases, Multiphoton and Double-Resonance Saturation Techniques, Saturation Techniques for Condensed Phases, Applications of Saturation Techniques	**15**
Unit-III	**Title: COHERENT RAMAN SPECTROSCOPY** Introduction, Driving and Detecting a Raman Mode, Symmetry Considerations, Relationship between χR and the Spontaneous Cross Section, Wave-Vector Matching, Coherent Anti-Stokes Raman Spectroscopy, Raman-Induced Kerr Effect Spectroscopy, Stimulated Raman Gain and Loss Spectroscopy, Four-Wave Mixing, Applications.	**15**
Unit-IV	**Title: MULTIPHOTON ABSORPTION AND NON LINEAR SPECTROSCOPY** Introduction, Doppler-Free Two- and Three-Photon Absorption, Multiquantum Ionization, Nonlinear Mixing, Applications, Optical Coherent Transients, The Optical Free-Induction Decay, Optical Nutation, The Photon Echo, the Stimulated Echo, Ramsey Fringes, Second Harmonic generation, Third- and Higher-Order Sum and Harmonic generation, Raman Shifting, Spontaneous XUV Anti-Stokes, Infrared Spectrophotography, multiphoton ionization methods; life time measurements, Quantum beat spectroscopy, Hanle effect; Pico second and femto second spectroscopic techniques for probing ultra fast dynamics, four wave mixing for determining dephasing times using intense incoherent light.	**15**

LEARNING OUTCOME:

1. The ability to explain different physical principles underlying in various spectroscopic techniques.
2. Understanding of the broadening mechanism in saturation spectroscopy.
3. A broad and up-to-date knowledge of the basic ideas of non-linear spectroscopes will be introduced.

Learning Resources	
Text Book	1. Introduction to Nonlinear Spectroscopy, M. D. Levenson 2. Nonlinear Laser Spectroscopy, V. S. Letokhov& V. P. Chebotayev 3. Laser Induced Dynamic Gratings, H. J. Eicher, P. Gunter & D. W. Pohl

		L	T	P	C
20MSP 313	**ANALOGUE COMMUNICATION**	**4**	**0**	**0**	**4**
Core subject	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on microwave electronics and Radar communication.
2. To develop understanding of the analog signal transmission.
3. To introduce the principle and working behind the satellite communication

UNIT	Course contents	Contact Hours
Unit-I	**Title: MICROWAVE ELECTRONICS** Microwave characteristic features & applications, Wave guide and cavity resonators, Two cavities Klystron, Reflex Klystron, Gunn diode characteristics, microwave antenna, Detection of microwave, Dielectric constant measurement, Isolator and circulator, PIN diode modulator	**15**
Unit-II	**Title: RADAR COMMUNICATION** Basic Radar systems, Radar range equation and performance factor, Radar Cross-section, Pulsed, Radar system, Duplexer, Radar display, Doppler Radar, CWIF Radar, FMCW Radar, Moving Target Indicator (MTI), Blind Speeds.	**15**
Unit-III	**Title: ANALOG SIGNAL TRANSMISSION** Introduction, Amplitude, Frequency & phase modulation; AM, FM modulating and e modulating circuits; AM, FM Receivers functioning (Block Diagram) and characteristic features; Pulse modulation; Sampling Processes, PAM, PWM and PPM modulation and demodulation, Quantization noise.	**15**
Unit-IV	**Title: SATELLITE COMMUNICATION** Principle of Satellite communication, Satellite frequency allocation and band spectrum, Satellite orbit, trajectory and its stability, Satellite link Design, Elements of Digital Satellite Communication, Multiple Access Technique, Antenna system.	**15**

LEARNING OUTCOME:

1. Understanding of the Microwave characteristics and its detection techniques.
2. Understands the basic Radar communication and its performances.
3. The ability to understand the signal transmission by Amplitude and phase modulations.
4. Becomes familiar with the satellite communication techniques.

Learning Resources	
Text Book	1. Communication System, Simon Haykin. 2. Electronic Communication, Roddy and Coolen. 3. Microwave and Radar Engineering,M.Kulkarni. 4. Digital and Analog Communication systems, K. San Shanmugam. 5. Satellite Communication, Pratt and Bosterin. 6. Microwave, K.C. Gupta**.**

		L	T	P	C
20MSPDSE 315	**DIGITAL COMMUNICATION**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on digital communication system and noise control.
2. To develop understanding of the signal communication in computer and network system.
3. To introduce the information theory and coding.
4. To make familiar with the principle involved in optical fiber communication.

UNIT	Course contents	Contact Hours
Unit-I	**Title: SIGNALS, SYSTEMS AND NOISE** Basics Elements of Communication Systems, Fourier Representation of Periodic and Non-Periodic Signals, Impulse And Step Response of Systems, Time and Frequency Domain Analysis of Systems, Ideal and Real Filters, Noise in Communication Systems, Signal To Noise Ratio, Noise Equivalent Band Width and Noise Figure.	**15**
Unit-II	**Title: INFORMATION THEORY AND CODING** Introduction, Amount of Information, Average Information, Shannon Encoding Algorithm, Communication Channels, Rate of Information And Capacity of Discrete Memory Less Channels, Shanon-Hartley Theorem. Linear Block Cyclic Codes.	**15**
Unit-III	**Title: DIGITAL SIGNAL (DATA) TRANSMISSION** Introduction, Optimum Receiver For Binary Digital Modulation Schemes, Binary ASK, Binary FSK, Binary PSK And Differential PSK Signalling Schemes, Serial Data Communication in Computers USART 8251, Basics Communication Networks(LAN,WAN,MAN) And Its Topology.	**15**
Unit-IV	**Title: FIBRE OPTIC COMMUNICATION** Basic Optical Communication System, Wave Propagation in Optical Fibre Media, Step and Graded Index Fiber, Material Dispersion And Mode Propagation, Losses in Fibre, Optical Fibre Sources (LEDs and LASERs) And Detectors (PIN Photodiode, APD Photodiode), Optical Joints And Couplers	**15**

LEARNING OUTCOME:

1. Understanding of the basic elements of communication system and kinds of noises involves.
2. Understands the working principle behind LAN, WAN, MAN and topology.
3. The ability to understand the signal transmission in optical fibers.
4. Becomes familiar with the working and application of LED and diode LASERS.

Learning Resources	
Text Book	1. Digital and Analog Communication Systems, K. San Shanmugam. 2. Communication Systems, Simon Haykin. 3. Optical Fibre Communication, Kaiser.

		L	T	P	C
20MSPDSE 317	**OPTOELECTRONICS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on optical wave guides and optical fibers.
2. To develop understanding of the optoelectronic effects.
3. To develop the understanding of the imaging and signal detection by photo detectors.
4. To introduce the principle and working behind the semiconductor lasers.

UNIT	Course contents	Hours
Unit-I	**OPTICAL WAVEGUIDES:** Planar slab waveguide and circular waveguide (optical fiber); modes, numerical aperture; attenuation and dispersion in waveguides; fabrication and characterization of waveguides; coupling between optical sources and waveguides, Basic semiconductor and device physics, optical properties of semiconductors, p-n junctions, optical absorption, amplification, semiconductor lasers, photo-detectors and noises, quantum well devices	**15**
Unit-II	**DIELECTRIC WAVEGUIDES AND OPTICAL FIBERS** Symmetric planar dielectric slab waves, modal and waveguide dispersion in planar waveguides, step index optical fiber, step index optical fiber, Numerical Aperture, dispersion in single mode fibers, dispersion modified fiber and compensation, Bit rate, dispersion and electrical and optical bandwidth, the Graded index optical fiber, attenuation in optical fibers	**15**
Unit-III	**OPTOELECTROINCS EFFECTS AND PHOTO DETECTORS** Polarization, light propagation in anisotropic medium, Birefringent optical devices, optical activity and circular birefringence, Liquid crystal displays, Electro-optic effect, Pockel's effect, Kerr effect, Integrated optical modulators, acousto optic modulators, Faraday Rotation and optical isolator, Principle of the pn unction photodiode, Shockley Ramo theorem and external photocurrent, Quantum efficiency and responsively, the pin photodiode, avalanche photodiode, heterojunction photodiodes, Schottky junction photo detectors, phototransistors, basic photodiode circuits, noise in photo detectors, image sensors.	**15**
Unit-IV	**STIMULATED EMISSION DEVICES: OPTICAL AMPLIFIER AND LASERS** Stimulated emission, photon amplification and laser, stimulated emission rate and emission cross section, Erbium doped fiber amplifier, broadening of the optical gain curve and line width, principle of laser diode, heterostructure laser diodes, Quantum well devices, elementary laser diode characteristics, steady state semiconductor rate equations, single frequency semiconductor lasers, vertical cavity surface emitting lasers, semiconductor optical amplifier, direct modulation of laser diodes, holography	**15**

LEARNING OUTCOME:

1. Understanding of the wave guide characteristics and basic structures.
2. Understands the optical field confinement in the optical fibers.
3. The ability to understand the principles behind various optoelectronic devices.
4. Becomes familiar with the working of semiconductor lasers.

Learning Resources	
Text Book	1. Introduction to fiber optics, A. Ghatak and K. Thyagarajan(Cambridge University Press, Cambridge, UK 1998) 2. Fundamentals of photonics, B.A. Saleh and M.C. Teich(Wiley Interscience, NJ, USA 2007) 3. Fundamentals of optoelectronics, C.R. Pollock (Irwin Inc., USA 1995) 4. Quantum electronics / Optical electronics, A. Yariv 5. Optoelectronics, Wilson and Hawkes 6. Optoelectronics and Photonics, Kasap & Fiber optic communications, Palais

		L	T	P	C
20MSPDSEL 301	**CONDENSED MATTER PHYSICS (CMP) LABI**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least sixexperiments in a semester. List of experiments may be amended.

1. Measurement of lattice parameter and indexing of powder photograph.
2. Identification of unknown sample using powder diffraction method.
3. To study the ferroelectric transitions in TGS crystal and measurement of Curie temperature.
4. To measure the superconductivity transition temperature and transition width of a high temperature superconductor.
5. Band gap measurement of oxide film using UV spectroscopy
6. To study the heat capacity of solids.
7. To study electric properties of thin films of metals & oxides.
8. To determine magneto resistance of a Bismuth crystal as a function of magnetic field.
9. To find the ‘g’ factor of DPPH using electron spin resonance .
10. To determine Hall Voltage, concentration of charge carrier and the type of semiconductor in the Hall effect experiment.
11. Study of crystalline properties of materials using XRD
12. B-H Curve of magnetic material.

		L	T	P	C
20MSPDSEL 303	**LASER &SPECTROSCOPY LABI**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least six experiments in a semester. List ofexperiments may be amended.

1. Verification of Hartmann formula for prism spectrogram
2. Measurement of optical spectrum of an alkali atom
3. Determination of metallic component of an inorganic salt
4. To determine the variation of refractive index of the material of prism with wavelength and to verify Cauchy's dispersion formula.
5. To determine the wavelength of laser using Michelson Interferometer.
6. Measurement of optical spectrum of alkaline earth atoms
7. Measurement of Band positions and determination of vibrational constants of AlO molecule
8. Measurement and analysis of fluorescence spectrum of I_2vapour
9. Determination of characteristic parameters of an optical fiber
10. Measurement of Raman spectrum of CCl_4.

		L	T	P	C
20MSPDSEL 305	**ELECTRONICS LAB I**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least six experiments in a semester. List of experiments may be amended.

1. To obtain the intensity modulation of given sinusoidal optical fiber signal.
2. To obtain the intensity modulation of given digital optical fiber signal.
3. Study of the low pass, high pass and band pass filters using the passive elements and active elements.
4. (i) To study the power dissipation in the SSB and DSB side bands of AM wave. (ii) To
5. study the demodulation of AM wave. (iii) To study various aspects of modulation and demodulation.
6. Design of Regulated power supply and study of its characteristics.
7. To study various displays and drivers on a bread-board – Assembling circuits on breadboard.
8. To study the effect of noise on various analogue system, calculate signal to noise ratio,
9. noise figure, noise power and noise power spectral density.
10. Microwave characteristics and measurements.
11. To study the characteristic, propagation modes, wavelength and phase velocity in a
12. wave guide.
13. PLL characteristics and its applications.
14. A/D converter interfacing and AC/DC voltage/current measurement using microprocessor 8085/8086.
15. PPI 8251 interfacing with microprocessor for serial communication.
16. To setup logic conditions for the input and the output at data bus port of BBCmicrocomputer.

		L	T	P	C
20MSP 402	**NUCLEAR & PARTICLE PHYSICS**	**4**	**0**	**0**	**4**
Core	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. Learning about the properties of nucleus.
2. Developing understanding the structure of the nucleus and different nuclear models.
3. Gain knowledge about the interactions between the nucleii and different types of nuclear reactions.
4. Gain basic knowledge of nuclear energy and source of energy of the stars.
5. Gain basic knowledge about the elementary particles.

UNIT	Course contents	Hours
Unit-I	**BASIC PROPERTIES AND STRUCTURE OF NUCLEUS:** Rutherford scattering, nuclear size, nuclear radius and charge distribution, nuclear form factor, mass and binding energy, Angular momentum, parity and symmetry, Magnetic dipole moment and electric quadrupole moment. Radioactive decay: Gamow theory of Alpha decay; Fermi theory of beta decay, Fermi-Kurie plot, Fermi and Gamow-Teller transitions; Gamma decay, selection rule, Internal conversion. Nuclear structure: Liquid drop model, Magic number, Bethe-Weizsácker binding energy/mass formula, Single particle shell model (including Mean filed approach, spin orbit coupling), Physical concepts of the unified model (Collective Model).	**15**
Unit-II	**TWO NUCLEON SYSTEMS & NUCLEAR FORCE** Two-body bound state: Properties of deuteron, Schródinger equation and its solution for ground state of deuteron, rms radius, spin dependence of nuclear forces, electromagnetic moment and magnetic dipole moment of deuteron, Central and tensor forces. Two-body scattering problem: Experimental n-p scattering data, Partial wave analysis and phase shifts, scattering length, magnitude of scattering length and strength of scattering, Significance of the sign of scattering length; Scattering from molecular hydrogen and determination of singlet and triplet scattering lengths, effective range theory, low energy p-p scattering, Nature of nuclear forces: charge independence, charge symmetry and isospin invariance of nuclear forces. Meson theory.	**15**
Unit-III	**NUCLEAR REACTIONS** Different types of reactions, Q value, Resonance scattering and reactions - Breit-Wigner dispersion relation; Compound nucleus formation and break-up, Statistical theory of nuclear reactions and evaporation probability, Optical model; Principle of detailed balance, Transfer reactions, Nuclear fission: Experimental features, spontaneous fission, liquid drop model, barrier penetration, statistical model. Elementary ideas about astrophysical reactions, Nuclear fusion & thermonuclear reactions, Nucleosynthesis and abundance of elements.	**15**
Unit-IV	**ELEMENTARY PARTICLES:** Relativistic kinematics, Classification: spin and parity determination of pions and strange particles. Gell-Mann Nishijima scheme. Properties of quarks and their classification. Elementary ideas of SU(2) and SU(3) symmetry groups and hadron classification. Introduction to the standard model. Electroweak interaction-W & Z Bosons.	**15**

LEARNING OUTCOME:

1. Knowledge of basic properties, structures of nucleus and nuclear models.
2. Understanding different types of nuclear reactions.
3. Basic knowledge of nuclear energy and source of energy of stars.
4. Basic knowledge of elementary particles.

Learning Resources	
Text Book	1. Concepts of Nuclear Physics, B. L. Cohen (Tata McGraw-Hill). 2. Nuclear Physics, I. Kaplan(Narosa Publishing House). 3. Nuclear Physics,R. R. Roy &B. P. Nigam (New Age International Publisher). 4. Nuclear Physics, S. N. Ghoshal (S. Chand) 5. Nuclear Physics, M. K. Pal (Affiliated East West Press Pvt. Ltd.). 6. Nuclear Physics,J. M. Blatt and V. F. Weisskopf (John Wiley & Sons).

		L	T	P	C
20MSPDSE 402	**RENEWABLE ENERGY SOURCES**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

The content of the course is designed in order to make students able to understand:

1. Energy production in photovoltaic cell.
2. Different types of solar cell.
3. The phenomena of photo-electrolysis.
4. Storage and application of hydrogen fuel.

UNIT	Course contents	Contact Hours
Unit-I	**SOLAR ENERGY: FUNDAMENTAL AND MATERIAL ASPECTS** Fundamentals of photovoltaic Energy Conversion Physics and Material Properties, Basic to Photovoltaic Energy Conversion: Optical properties of Solids. Direct and indirect transition semiconductors, interrelationship between absorption coefficients and band gap recombination of carriers.	**15**
Unit-II	**SOLAR ENERGY: DIFFERENT TYPES OF SOLAR CELLS:**Types of Solar Cells, p-n junction solar cell, Transport Equation, Current Density, Open circuit voltage and short circuit current, Brief description of single crystal silicon and organic and Polymer Solar Cells, Elementary Ideas of Advanced Solar Cells e.g. Tandem Solar cells, Solid Liquid Junction Solar Cells, Nature of Semiconductor, Principles of Photo-electrochemical Solar Cells.	**15**
Unit-III	**HYDROGEN ENERGY: FUNDAMENTALS, PRODUCTION AND STORAGE:** Relevance in relation to depletion of fossil fuels and environmental considerations. Solar Hydrogen through Photo electrolysis, Physics of material characteristics for production of Solar Hydrogen. Brief discussion of various storage processes, special features of solid hydrogen storage materials, Structural and electronic characteristics of storage materials. New Storage Modes.	**15**
Unit-IV	**HYDROGEN ENERGY: SAFETY AND UTILIZATION:** Various factors relevant to safety, use of Hydrogen as Fuel, Use in Vehicular transport, Hydrogen for Electricity Generation, Fuel Cells, Various types of Fuel Cells, Applications of Fuel Cell, Elementary concepts of other Hydrogen- Based devices such as Hydride Batteries.	**15**

LEARNING OUTCOME:

After going through the syllabus students will be able to:

1. Understand the energy production in solar cells.
2. Know different ways of solar energy production.
3. Analyze the material properties for hydrogen production and storage.
4. Understand the applications of fuel cells.

Learning Resources	
Text Book	1. Solar Cell Devices- Physics,Fonash 2. Fundamentals of Solar Cells Photovoltaic Solar Energy,Fahrenbruch&Bube 3. Photoelectrochemical Solar Cells,S.Chandra 4. Hydrogen as an Energy Carrier Technologies Systems Economy, Winter &Nitch (Eds.) 5. Hydrogen as a Future Energy Carrier, Andreas Zuttel, Andreas Borgschulte and Louis Schlapbach

		L	T	P	C
20MSPDSE 404	**NANO SCIENCE &TECHNOLOGY**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

The content of the course is designed in order to make students able to understand:

1. The variation of properties of materials at nano-scale.
2. The synthesis methods of nano-particles.
3. The characterization techniques useful to characterize nano-materials.
4. Some basic carbon based nano-materials.
5. Applications of nano-particles.

UNIT	Course contents	Hours
Unit-I	**Physics of Nanomaterials** Significance of nanoscale materials-surface area & quantum confinement effect, Degrees of freedom and Quantum confinement confinement-Quantum well, wire and dot, Size dependent properties-chemical, electronic, optical, and magnetic. Band gap engineering, Brus Equation for Quantum dots.	**15**
Unit-II	**Nanofabrication Techniques:** Top down and bottom up approaches to nanofabrication,Optical& electron beam lithography, Dip pen lithography, Ball Milling, Thin films deposition, Sputtering, Electrodeposition and sol Gel Tech, Plasma assisted chemical vapor deposition.	**15**
Unit-III	**Characterization of Nanomaterials:** Contact &Non-contact methods of surface characterization, AFM, TEM, SEM, STM and Near field microscopy, Surface plasma resonance techniques, Electron spectroscopy techniques – AES, XPS.	**15**
Unit-IV	**Nanomaterials & APPLICATIONS:** Carbon based nanomaterials, carbon nanotubes, Fullerens, Graphene, Nano composites, Semiconductor Nanoparticles, Carbon nano motors, Application of nanomaterials: Medical, Drug delivery, Hydrogen storage, Transport. Future of nano science.	**15**

LEARNING OUTCOME:

After going through the syllabus students will be able to:

1. Correlate material properties with size in nano-region.
2. Synthesize different nano-size particles.
3. Analyze particle properties using analytical equipments/ techniques.
4. Aware about some recent carbon based nano-materials.
5. Apply their knowledge and seek applications of nano-materials.

Learning Resources	
Text Book	1. The Physics of Low Dimensional Semiconductors, John H. Davies (Cambridge University Press) 2. Nanotechnology- An Introduction, J.J. Ramsden, William Andrew Elsevier 3. Nano-optoelectronics Sensors & Devices, Ning Xi, King w. Chiu Lai, and William Andrew Elsevier 4. Quantum Heterostructures- Microelectronics & Optoelectronics,(V.V. Mitin, V.A. Kochetp& M.A. Stroscio, Cambridge University Press 5. Nanostructures & Nanomaterials, Synthesis, Properties & Applications, G. Cao (Imperial College Press) 6. Introduction to Nanotechnology, C.P.Poole Jr. & F.J. Owens (John Wiley & Sons) **7.** Nanotechnology, M. Wilson, K. Kannangara, G. Smith, M. Simmons & B. Raguse (Overseas Press)

		L	T	P	C
20MSPDSE 406	**THIN FILMS TECHNOLOGY**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire knowledge of thin films and their significance
2. To learn techniques of thin film preparation
3. To get familiar with the characterization techniques of thin films

UNIT	Course contents	Contact Hours
Unit-I	**BASICS OF THIN FILMS AND THIN FILM GROWTH MECHANISM** Thick films, thin films, ultrathin films, multilayers, nanostructures, quantum well. Role of thin films in devices: solar cell, sensor, memory devices.Thin film growth modes: Vapor condensation and adsorption, surface diffusion, sticking coefficient, formation of thermodynamically stable cluster, theory of nucleation, Growth modes: Island growth, Volmer weber, Layer growth, Van VawlerMegrue, Stranski – Kransmode.Epitaxy,Evolution of stresses and strainin thin films.	**15**
Unit-II	**BASICS OF VACUUM TECHNOLOGY** Principles of vacuum pumps in range of 10 -2 torr to 10-11 torr, Principle ofdifferent vacuum pumps: rotary pump, diffusion pump, turbo molecular pump, cryogenic-pump, ion pump, Ti-sublimation pump, Measurement of Pressure, Concept of different gauges: Pirani, Penning and pressure control.	**15**
Unit-III	**THIN FILM DEPOSITION METHOD** Physical Vapor Depostion techniques: Thermal evaporation, e-beam evaporation, Electron beam evaporation, Pulsed LASER Deposition (PLD), Magnetron sputtering, Ion beam sputtering. Chemical vapor deposition techniques.	**15**
Unit-IV	**CHARECTERIZATION OF THIN FILMS** X-ray diffraction, Reciprocal space mapping, Rutherford back scattering, Atomic probe microscopy,Profilometer, UV-vis spectroscopy, Squid, Four probe resistivity.	**15**

LEARNING OUTCOME:

1. Students are expected to have basic ideas of thin film preparation, characterization methods and their applications

Learning Resources	
Text Book	1. Thin Film Phenomenon,K. L. Chopra, McGraw-Hill 2. Methods of Experimental Physics (Vol 14), G. L. Weissler and R.W. Carlson 3. A User’s Guide to vacuum Technology, J. F. O’Hanlon, John Wiley, and Sons 4. Evaporation: Nucleation and Growth Kinetics”, J.P. Hirth and G. M. Pound, Pergamon Press

		L	T	P	C
20MSPDSE 408	**FIBER OPTICS SENSORS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on optical fibers structure and principle of wave guiding.
2. To introduce the dispersion phenomenon in fiber optics signals.
3. To make familiar with the optical fiber sensor applications.

UNIT	Course contents	Contact Hours
Unit-I	**FUNDAMENTALS OF FIBER OPTICS** Optical Fiber: Principles-Physical structure, Wave guide parameter (V-Number), Optical FiberTypes: Multi mode and single mode optical fibers. Optical Fiber Profiles-Step Index & Parabolic Index, Concept of optical modes-Field Patterns of some low order guided modes, Fabrication of optical fiber.	**15**
Unit-II	**DISPERSION IN OPTICAL FIBER** Pulse Dispersion in Multimode Optical fiber-Ray & Material Dispersion in Step Index fiber, Laser optimized multimode optical fiber. Pulse Dispersion in Multimode Optical fiber-Intramodal Dispersion, Waveguide dispersion, Optical Fibers for dispersion compensation, Polarization mode Dispersion, Fiber Amplifiers.	**15**
Unit-III	**TECHNIQUES IN OPTICAL FIBERSENSOR (OFS)** Intrinsic & Extrinsic Sensors, Basic Optical Fiber Sensor Components-Isolators, Couplers, Modulators. Optical Fiber Sensor (OFS) based on principles: Fiber Braggs Grating, Evanescent Wave, Raman Spectroscopy, SERS, Laser Induced Fluorescence (LIF) Spectroscopy.	**15**
Unit-IV	**OPTICAL FIBER SENSOR (OFS) APPLICATIONS** Health Monitoring-Endoscopy, Photo Dynamic Therapy (PDT), Fiber Optic Current Sensor, Photonic Crystal Fibers- Refractive Index Sensing & Clinical Diagnostic. Fiber Optic Micro Bend Sensors, Spectroscopy based OFS: Molecular Markers & Detector	**15**

LEARNING OUTCOME:

1. Understanding of the wave guide characteristics and basic structures of optical fibers.
2. Understands the principle behind the signal dispersion of the guided mode of optical fiber
3. The ability to understand the principles behind spectroscopic application of optical fibers.
4. Becomes familiar with the optical fiber applications in health and other monitoring systems.

Learning Resources	
Text Book	1. Fiber Optic Sensors: Principles and Applications, B. D. Gupta 2. Introduction to Fiber Optics, A.Ghatak and K.Thyagrajan 3. Fiber Optic Essentials, A. Ghatak and K.Thyagrajan 4. Optical Fiber Sensors: Advanced Techniques and Applications, G. Rajan 5. Fiber Optics: Physics and Technology,F. Mitsch

		L	T	P	C
20MSPDSE 410	**APPLIED OPTICS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic concepts of Physical Optics
2. To learn about Photonic crystals and Meta materials
3. To learn about optical and imaging techniques

UNIT	Course contents	Contact Hours
Unit-I	**Physical optics** Wave motion, superposition of waves, interference, diffraction, basics of coherence theory, temporal and spatial coherence, Michelson and Fabry-Perot interferometer, statistical properties of laser speckle patterns.	**15**
Unit-II	**Photonic crystals and metamaterials** Photonics crystals- 2D & 3D, colloidal photonic crystals, light propagation through disordered media, localization of light, photonic glass, optical metamaterials, negative index metamaterials, nonlinear optics with metamaterials.	**15**
Unit-III	**Applications of optical techniques** Mie scattering technique, static & dynamic light scattering technique, optical tweezers, AFM colloidal probe technique, knife edge scanning to measure laser beam profile.	**15**
Unit-IV	**Optical microscopy & imaging techniques** Basics of optical microscopy, bright field and dark field microscopy, polarizing microscopy, fluorescence microscopy, fluorescence confocal microscopy, nonlinear optical microscopy, two photon fluorescence microscopies.	**15**

LEARNING OUTCOME:

1. Understanding of basic concepts of Physical optics
2. Understands the light behavior in Photonic crystals and Meta materials
3. Familiar with optical and imaging techniques

Learning Resources	
Text Book	1. Optical Electronics, A. Ghatak and K.Thyagrajan 2. Principles of Optics, M. Bornand, E. Wolf 3. Optics, A. Ghatak 4. Optical Metamaterials: Fundamentals & Applications, V. Shalaevand , W. Cai 5. Modern Optical Engineering, W.J. Smith 6. Optics, E. Hecht

		L	T	P	C
20MSPDSE 412	**ROTATIONAL & VIBRATIONAL MOLECULAR SPECTROSCOPY**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To learn about Group Theory
2. To learn about Rotational and Vibrational Spectroscopy of molecules.

UNIT	Course contents	Contact Hours
Unit-I	**MOLECULAR SYMMETRY & GROUP THEORY** Elements of Symmetry-n-fold axis of symmetry, Plane of symmetry Centre of inversion, n-fold rotation-reflection axis of symmetry, Identity element of symmetry. Point Groups (C_n, S_n,C_{nv}, D_n, C_{nh}, D_{nd}etc), Character tables for C_{2v}, C_{3v} point groups, Symmetry and dipole moments.	**15**
Unit-II	**ROTATIONAL SPECTROSCOPY** Linear, symmetric rotor, spherical rotor and asymmetric rotor molecules, Rotational infrared, millimeter wave and microwave spectra-Diatomic & linear polyatomic molecules, Symmetric & asymmetric rotor molecules. Rotational Raman spectroscopy-Theory, Rotational Raman spectra of diatomic, linear polyatomic, symmetric and asymmetric rotor molecules	**15**
Unit-III	**VIBRATIONAL SPECTROSCOPY OF DIATOMIC MOLECULES** Diatomic molecules-Infrared spectra, Raman spectra, Anharmonicity- electrical anharmonicity, mechanical Anharmonicity. Vibration-rotation spectroscopy- Infrared spectra, Raman spectra, Transition rules.	**15**
Unit-IV	**VIBRATIONAL SPECTROSCOPY OF POLYATOMIC MOLECULES** Group vibrations, Number of normal vibrations of each symmetry species-Non-degenerate and Degenerate vibrations. Vibration selection rules for infrared and Raman spectra. Vibration-rotation spectroscopy-Infrared spectra of linear molecules, symmetric, spherical and asymmetric rotors. Anharmonicity-Potential energy surfaces, vibrational term values.	**15**

LEARNING OUTCOME:

1. Understanding of Molecular Symmetry and Group Theory
2. Familiar with Rotational and Vibrational Spectroscopy of diatomic/polyatomic molecules
3. Various Selection Rules in Raman and Infrared Spectroscopy.

Learning Resources	
Text Book	1. Modern Spectroscopy, J. M. Hollas 2. Fundamental of Molecular spectroscopy, C.N. Banwell 3. Physics of Atoms and Molecule,Bransden and Joachain 4. Molecular spectroscopy, J. M. Brown 5. Introduction to Molecular spectroscopy, G. M. Barrow 6. Spectra of Atoms and Molecule, P.F. Bemath

		L	T	P	C
19MSPDSE 414	**NOVEL AND SMART MATERIALS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To learn about Electronic, Nano and Magnetic Materials
2. To learn about Integrated Circuit Fabrication

UNIT	Course contents	Contact Hours
Unit-I	**PHYSICAL MECHANISM IN ELECTRONIC MATERIALS** Crystal Structures of Electronic materials (Elemental, III-IV and VI semiconductors), Energy band consideration in solids in relation to semiconductors, Direct and Indirect bands inSemiconductor, Electron/Hole concentration and Fermi energy in Intrinsic/Extrinsicsemiconductor, continuity equation, Carrier mobility in Semiconductors, Carrier Trapping andrecombination/generation in semiconductors, Shockley theory of recombination, Defect related electronics states characterization by C-V characteristics of electronic junction devices.	**15**
Unit-II	**INTEGRATED CIRCUIT FABRICATION:** Introduction to IC technology, Basic monolithic integrated circuit epitaxial growth, diffusion of impurities, masking and etching, Fabrication of monolithic ICs, Active and Passive components, advantages of IC s, MSI, LSI, Application of IC and Clean Room Specification.	**15**
Unit-III	**NANOMATERIALS** Introduction to Nanomaterial, comparison of properties of nano-and bulk materials, top-down and bottom up approach, methods used for synthesis of nano-materials. Nano-thin films: development and applications, Carbon Nano-tubes: synthesis and properties. Applications of nano-materials.	**15**
Unit-IV	**ENGINEERING MAGNETIC MATERIALS** Hard and soft Magnetic materials, ferrites, Types of Ferrites, Rare earth compounds and bonded magnets. Materials forantenna, inductor and transformer cores. Magnetic recording fundamentals. Particulate and thin film recording media. Recording heads: ferrite heads, metal in gap heads, thin film heads andmagneto resistive heads. Fundamentals opto magneto opto recording. Magneto optic recordingmedia and heads. Introduction to magnetic bubbles.	**15**

LEARNING OUTCOME:

1. To have conceptual idea about the Physics of Electronic, Nano and Magnetic Materials
2. Familiar with Integrated Circuit (IC) Technology and their Fabrication

Learning Resources	
Text Book	1. Physics of Semiconductor Devices, S.M. Sze 2. Semiconductor Devices Basic Principles, Jaspreet Singh 3. Metal/Semiconductor Schottky Barrier Junction and their Applications, B.L. Sharma. 4. Encyclopedia of Applied Physics, G.L. Trig Vol. 9, G.L. Trigg (V.CH Publishers). 5. Linear Integrated Circuits, D. Roy Choudhury and SahilB. Jain, (New Age Int. Pub). 6. Integrated Electronics,Millman and Halkias (Tata McGraw-Hill).

		L	T	P	C
20MSPDSE 416	**MICROPROCESSOR AND INTERFACING**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on architecture and programming in microprocessor 8085
2. To acquire basic knowledge on architecture and programming in microprocessor 8086
3. To make familiar with the programmable and nonprogrammable ICs.

UNIT	Course contents	Contact Hours
Unit-I	**MICROPROCESSOR 8085** Introduction to microcomputer, Microprocessor (μP) 8085 Architecture, addressing modes, memory interfacing, interfacing I/O device. Instruction set and classification, op code and operand, fetch and execute cycle, timing diagram for memory read and memory write, machine cycle, instruction cycle and T states, Assembly language Programming examples.	**15**
Unit-II	**MICROPROCESSOR 8086** Architecture, Pin description for minimum and maximum modes, internal operation, Instruction Execution timing diagram, Addressing modes, Instruction format for constructing machine language codes. Instruction set and directives, Stacks, Procedures, Macros and interrupts. I/O interfacing and data transfer scheme. Programming example.	**15**
Unit-III	**PROGRAMMABLE AND NON PROGRAMMABLE ICS** Introduction to microcontroller 8051. Block diagram and PSW for: - 8253(timer and counters controllers), 8259 (interrupt controller), 8279 (keyboard and display controller). Brief idea of Architecture and memory management of 80286.	**15**
Unit-IV	**MICROPROCESSOR BASED MEASUREMENT/CONTROL CIRCUITS** D/A and A/D Converters, PPI 8255 Data Acquisition and storage, Microprocessor based traffic light controller, Temperature and water level indicator/controller. DC and steper motor speed measurements, Waveform generation and frequency measurement.	**15**

LEARNING OUTCOME:

1. The ability to program in microprocessor 8085.
2. The ability to program in microprocessor 8086.
3. Understands the working with ICs 8051, 8253, 8259 and 8279.
4. Becomes familiar to use microprocessor in the application of temperature, water level, traffic light control etc.

Learning Resources	
Text Book	1. Fundamentals of Microprocessor and Microcomputer, B. Ram. 2. Microprocessor System the 8086/8088 Family, Liu and Gibson. 3. Microprocessor Architecture Programming and Application, R.S. Goanker. 4. Introduction to microprocessor, A.P. Mathur. 5. Microprocessor and Interfacing, D.V. Hal

		L	T	P	C
20MSPDSE 418	**SEMICONDUCTOR PHYSICS**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on band theory of solids and conductivity in semiconductors.
2. To develop understanding of the role Fermi level in semiconductors.
3. To develop the understanding of the various semiconductor device working.
4. To introduce IC fabrication technology.

UNIT	Course contents	Contact Hours
Unit-I	**BAND THEORY OF SOLIDS** Kronig-Penny model, Bandgaps in semiconductors - Holes and effective mass concept, Fermi distribution and energy - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Bandgap engineering.	**15**
Unit-II	**CURRENTS IN SEMICONDUCTOR** Thermal motion of carriers, Carrier motion under electric field, Drift current, Mobility and conductivity, Velocity saturation, Diffusion of carriers, General expression for currents in semiconductor, Carrier concentration and mobility, and the Van der Pauw technique. drift current density – mobility effects – conductivity – carrier diffusion – diffusion current density – total current density – graded impurity distribution – induced electric field – Einstein relation – Hall Effect.	**15**
Unit-III	**CARRIER DYNAMICS IN SEMICONDUCTORS:** Electronic transitions in semiconductor, Radiative transition, Direct and indirect bandgap semiconductors, Roosbroeck-Shockley relationship, Radiative transition rate at non-equilibrium, Minority carrier lifetime, Localized states, Recombination center and trap, Shockley-Hall-Reed recombination, Surface recombination, Auger recombination, Derivation of continuity equation, Non-equilibrium carrier concentration, Quasi-Fermi level, Current and quasi-Fermi level, Non-uniform doping, and Non-uniform bandgap.	**15**
Unit-IV	**SEMICONDUCTOR DEVICES AND IC FABRICATION TECHNOLOGY** Metal-semiconductor and Semiconductor heterojunctions – Schottky Barrier Diode – metal-semiconductor ohmic contacts – heterojunctions – bipolar transistor – Metal-Oxide semiconductor Field-Effect Transistor – Junction Field-Effect Transistor – MOSFET (n-MOS, p-MOS) and CMOS. Static and dynamic RAM, nonvolatile memories. Optical and magnetic memories Solar cell- basic characteristics – spectral response – recombination current and series resistance. MOSFET fabrication process. Substrate, dielectric, conducting and resistive layers. Lithography. Diffusion of impurities and deposition techniques.	**15**

LEARNING OUTCOME:

1. Understanding of the conductivity in intrinsic and extrinsic semiconductors.
2. Understanding of the concept of direct and indirect band gap semiconductors
3. Becomes familiar with the conductivity at the metal semiconductor interface.
4. The ability to understand the principles behind FET, MOSFET, JFET, CMOS, RAM.
5. Becomes familiar with the basics of IC fabrication.

Learning Resources	
Text Book	1. Semiconductors, R.A. Smith (Academic Publishers). 2. Semiconductor Physics And Devices, Donald A. Neamen(Tata McGraw-Hill). 3. Fundamentals of Semiconductor Devices by Joseph Lindmayer, Charles Y. Wrigly(Litton Educational Publishing Inc.). 4. Physics of Semiconductor Devices, S.M.Sze (John Wily & Sons). 5. The Physics of Semiconductors, K. F. Brennan (Cambridge Univ.Press). 6. Fundamentals of Semiconductors, P. Y. Yu and M. Cardona, (Springer).

		L	T	P	C
20MSPDSEL 402	**CONDENSED MATTER PHYSICS (CMP) LAB II**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least six experiments in a semester. List of experiments may be amended.

1. Measurement of lattice parameter and indexing of powder photograph.
2. Identification of unknown sample using powder diffraction method.
3. To study the ferroelectric transitions in TGS crystal and measurement of Curie temperature.
4. To measure the superconductivity transition temperature and transition width of a high temperature superconductor.
5. Band gap measurement of oxide film using UV spectroscopy
6. To study the heat capacity of solids.
7. To study electric properties of thin films of metals & oxides.
8. To determine magneto resistance of a Bismuth crystal as a function of magnetic field.
9. To find the ‘g’ factor of DPPH using electron spin resonance .
10. To determine Hall Voltage, concentration of charge carrier and the type of semiconductor in the Hall effect experiment.
11. Study of crystalline properties of materials using XRD
12. B-H Curve of magnetic material.

		L	T	P	C
20MSPDSEL 404	**LASER &SPECTROSCOPY LAB II**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least six experiments in a semester. List of experiments may be amended.

1. Verification of Hartmann formula for prism spectrogram
2. Measurement of optical spectrum of an alkali atom
3. Determination of metallic component of an inorganic salt
4. To determine the variation of refractive index of the material of prism with wavelength and to verify Cauchy's dispersion formula.
5. To determine the wavelength of laser using Michelson Interferometer.
6. Measurement of optical spectrum of alkaline earth atoms
7. Measurement of Band positions and determination of vibrational constants of AlO molecule
8. Measurement and analysis of fluorescence spectrum of I_2vapour
9. Determination of characteristic parameters of an optical fiber
10. Measurement of Raman spectrum of CCl_4.

		L	T	P	C
20MSPDSEL 406	**ELECTRONICS LAB II**	**4**	**0**	**0**	**4**
Discipline Specific Elective	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

Note: Students will be required to perform at least six experiments in a semester.

1. To obtain the intensity modulation of given sinusoidal optical fiber signal.
2. To obtain the intensity modulation of given digital optical fiber signal.
3. Study of the low pass, high pass and band pass filters using the passive elements and active elements.
4. (i) To study the power dissipation in the SSB and DSB side bands of AM wave. (ii) To
5. study the demodulation of AM wave. (iii) To study various aspects of modulation and demodulation.
6. Design of Regulated power supply and study of its characteristics.
7. To study various displays and drivers on a bread-board – Assembling circuits on breadboard.
8. To study the effect of noise on various analog system, calculate signal to noise ratio,
9. noise figure, noise power and noise power spectral density.
10. Microwave characteristics and measurements.
11. To study the characteristic, propagation modes, wavelength and phase velocity in a
12. wave guide.
13. PLL characteristics and its applications.
14. A/D converter interfacing and AC/DC voltage/current measurement using microprocessor 8085/8086.
15. PPI 8251 interfacing with microprocessor for serial communication.
16. To setup logic conditions for the input and the output at data bus port of BBCmicrocomputer.

		L	T	P	C
20MSPGE 204	**MATLAB**	**4**	**0**	**0**	**4**
Generic Elective Course	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To learn basic tools of MATLAB
2. To develop skills of MATLAB programming

UNIT	Course contents	Contact Hours
Unit-I	**MATLAB basics** The MATLAB environment, Basic computer programming, Variables and constants, operators and simple calculations, Formulas and functions, MATLAB toolboxes.	**15**
Unit-II	**Matrices and vectors** Matrix and linear algebra review, Vectors and matrices in MATLAB, Matrix operations and functions in MATLAB.	**15**
Unit-III	**Computer programming** Algorithms and structures, MATLAB scripts and functions (m-files), Simple sequential algorithms - Control structures (if…then, loops).	**15**
Unit-IV	**MATLAB programming** Reading and writing data, file handling, personalized functions, Toolbox structure, MATLAB graphic functions,Numerical methods: Solution of nonlinear equations, system of linear equations. Numerical integration.Numerical simulations Reference	**15**

LEARNING OUTCOME:

1. Students are expected to apply MATLAB programming for scientific data processing, atleast at an elementary level.

Learning Resources	
Text Book	1. MATLAB: An Introduction with Applications, Amos Gilat (Wiley). 2. MATLAB for Engineers, Holly Moore(Pearson). 3. Matlab: A Practical Introduction to Programming and Problem SolvingStormy Attaway (Butterworth-Heinemann) 4. Matlab for Beginners:A gentle Approach, Create space Independent Publishing Platform, Peter I. Kattan

		L	T	P	C
20MSPGE 103	**BIOPHYSICS**	**4**	**0**	**0**	**4**
Generic Elective Course	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To learn and solve Biological problems with a Physics point of view

UNIT	Course contents	Contact Hours
Unit-I	**LENGTH AND TIME SCALES IN BIOLOGY:** Types, sizes and roles of biomolecules - metabolites, proteins, RNA, and DNA. Ranges of cell sizes and interdivision time scales. Ranges of organism sizes and lifetimes. Scaling laws in biology. Complexity of living systems. Timeline of life on Earth. Time scales in biological evolution	**15**
Unit-II	**Cellular dynamics** Dynamical systems. Coupled ordinary differential equations. Experiments on cellular physiology. Phenomena and models of intracellular chemical dynamics, metabolism and gene regulation, cell growth and division.	**15**
Unit-III	**The brain&Information in living systems** Dynamics of a single neuron. Neural networks. Learning. Memories as attractors of neural network dynamics. Probability, entropy and information. Applications of information theory in genetics, neuroscience, and ecology.	**15**
Unit-IV	**Ecosystems** Growth of a bacterial colony. Ecological interactions. Lotka-Volterra and other ecological dynamics. Models of ecosystems.	**15**

LEARNING OUTCOME:

1. Students are expected to be familiar with Biological concepts/ dynamics from a Physics perspective

Learning Resources	
Text Book	1. Physics in Molecular Biology; Kim Sneppen and Giovanni Zocchi (CUP 2005). 2. Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004). 3. Biophysics: Searching for Principles; William Bialek (Princeton University Press, 2012). 4. Physical Biology of the Cell (2nd Edition), Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013). 5. An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013). 6. Mathematical Biology: I. An Introduction (3rd Edition); J. D. Murray (Springer, NY, 2004).

		L	T	P	C
20MSPGE 202	**PROGRAMMING IN C**	**4**	**0**	**0**	**4**
Generic Elective Course	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To learn basic tools of C Programming
2. To develop skills of C Programming

UNIT	Course contents	Contact Hours
Unit-I	An overview of Programming, Programming Language, Classification, Basic structure of a C Program, C language preliminaries, Operators and Expressions, Two's compliment notation, Bit–ManipulationOperators, Bitwise Assignment Operators, Memory Operators.	**15**
Unit-II	Arrays and Pointers, Encryption and Decryption, Pointer Arithmetic,Passing Pointers as Function Arguments, Accessing Array Elements throughPointers, Passing Arrays as Function Arguments, Multidimensional Arrays, Arrays of Pointers, Pointers to Pointers.	**15**
Unit-III	Storage Classes –Fixed vs Automatic Duration, Scope, Global Variables, Definitions and Allusions, The register Specifier, ANSI rules for the Syntax andSemantics of the Storage-Class Keywords, Dynamic Memory Allocation, Structures and Unions, declarations, Passing Arguments to aFunction, Declarations and Calls, Automatic Argument Conversions, Prototyping, Pointers to Functions.	**15**
Unit-IV	The C Preprocessors, Macro Substitution, Include Facility, Conditional Compilation, Line Control, Input and Output –Streams, Buffering, Error Handling, Opening and Closing a File, Reading and Writing Data, Selecting an I/O Method, Unbuffered I/O, Random Access, The Standard Library for I/O.	**15**

LEARNING OUTCOME:

2. Students are expected to apply C Programming for scientific data processing/modelling, atleast at an elementary level

Learning Resources	
Text Book	1. Peter A. Darnell and Philip E. Margolis, C: A Software Engineering Approach,Narosa Publishing House (Springer International Student Edition) 3rd edition 1996. 2. Samuel P. Harkison and Gly L. Steele Jr., C: A Reference Manual, Second Edition, Prentice Hall, 2008. 1. Brian W. Kernighan & Dennis M. Ritchie, The C Program Language, Second Edition, Prentice Hall, 2017. 2. Balagurusamy E., Programming in ANSI C, Third Edition, Tata McGraw-Hill Publishing Co. Ltd. 3. Byron, S. Gottfried, Theory and Problems of Programming with C, Second Edition, Tata McGraw-Hill Publishing Co. Ltd., 1990. 4. Venugopal K. R. and Prasad S. R.: Programming with C, Tata McGraw-Hill Publishing Co. Ltd.

		L	T	P	C
20MSPGE 101	**SATELLITE COMMUNICATION AND REMOTE SENSING**	**4**	**0**	**0**	**4**
Generic Elective Course	**Pre-requisite**				
	Co-requisite				
	Designed by department of PHYSICS				

COURSE OBJECTIVE

1. To acquire basic knowledge on satellite communication and its design.
2. To develop understanding of the digital signal transmission.
3. To develop the understanding of the remote sensing.

UNIT	Course contents	Contact Hours
Unit-I	**PRINCIPLE OF SATELLITE COMMUNICATION & LINK DESIGN** General and Technical characteristics, Active and Passive satellites, Modem and Codec. General link design equation, Atmospheric and Ionospheric effect on link design, Earth station parameter.	**15**
Unit-II	**Satellite Analog Communication** Baseband analog signal, FDM techniques, S/N and C/N ratio in FM in satellite link.	**15**
Unit-III	**Digital Satellite Transmission** Advantages, Elements of digital satellite communication, Digital base band signal, Digital modulation Techniques, Digital link Design, TDM, TDMA, Some applications of satellite communications.	**15**
Unit-IV	**Concept and Foundations of RemoteSensing** ElectromagneticRadiation (EMR), interaction of EMR with atmosphere and earthsurfaceApplicationareaofRemote SensingGround, Air & Space platforms, Return Beam Vidicon, Multispectral Scanner, Brief idea of Digital Image Processing. Radar Remote Sensing, Microwave Sensing, Lidar (Single and double ended system).	**15**

LEARNING OUTCOME:

1. Understanding of the characteristics and various effects in satellite communication.
2. Understands the digital modulations, TDM and TDMA in signal communication.
3. The ability to understand the principles behind remote sensing.

Learning Resources	
Text Book	1. Physics of Semiconductor Devices: S.M. Sze. 2. Semiconductor Devices Basic Principles: Jaspreet Singh. 3. Physics and Technology of Semiconductor Devices: A.S. Grove. 4. Metal/Semiconductor Schottky Barrier Junction and their Applications: B.L. Sharma. 5. Metal/Semiconductor Contact: Rhoderick

Core Courses (Theory)

1. Mathematical Physics (20MSP 101)
2. Classical Mechanics (20MSP 103)
3. Quantum Mechanics I (20MSP 105)
4. Computational Physics (20MSP 107)
5. Electrodynamics (20MSP 202)
6. Electronics(20MSP 204)
7. Quantum MechanicsII (20MSP 206)
8. Statistical Mechanics(20MSP 208)
9. Atomic & Molecular Physics(20MSP 301)
10. Solid State Physics(20MSP 303)
11. Nuclear and Particle Physics (20MSP 402)

Discipline Specific Elective (DSE) Courses

1. Crystals & Defects(20MSPDSE 301)
2. Characterization of Materials (20MSPDSE 303)
3. Soft Matter Physics(20MSPDSE 305)
4. Laser Physics & Applications(20MSPDSE 307)
5. Nano Photonics (20MSPDSE 309)
6. Nonlinear Spectroscopy (20MSPDSE 311)
7. Analog Communication(20MSPDSE 313)
8. Digital Communication (20MSPDSE 315)
9. Optoelectronics(20MSPDSE 317)
10. Renewable Energy Sources(20MSPDSE 402)
11. Nano Science & Technology(20MSPDSE 404)
12. Thin Film Technology (20MSPDSE 406)
13. Fiber Optics Sensors (20MSPDSE 408)
14. Applied Optics (20MSPDSE 410)
15. Rotational & Vibrational Molecular Spectroscopy (20MSPDSE 412)
16. Novel and Smart Materials(20MSPDSE 414)

17. Microprocessor & Interfacing (20MSPDSE 416)
18. Semiconductor Physics (20MSPDSE 418)

Lab Courses

1. Physics LabI (General) (20MSP 109)
2. Physics LabII (General) (20MSP 210)
3. CMPLabI (20MSPDSEL 301)
4. Laser&Spectroscopy Lab I (20MSPDSEL 303)
5. ElectronicLabI (20MSPDSEL 305)
6. CMPLabII (20MSPDSEL402)
7. Laser & Spectroscopy LabII (20MSPDSEL404)
8. Electronics LabII (20MSPDSEL406)

Generic Elective (GE) Theory Courses

1. Satellite Communication and Remote Sensing (20MSPGE 101)
2. BioPhysics (20MSPGE 103)
3. Programming in C (20MSPGE 202)
4. MatLab (20MSPGE 204)