NATIONAL INSTITUTE OF TECHNOLOGY, DURGAPUR

DEPARTMENT OF PHYSICS

Revised Curriculum and Syllabi for the Degree of 2 Yr. M. Sc. in PHYSICS

(To be effective from the batches admitted in the Academic Session 2020-2021 Onwards)
Revision Approved in PGAC meeting on 28/08/2020

Date: 28th August, 2020

TABLE OF CONTENTS

PROGRAM OBJECTIVES*

PO1: Ability to independently carry out research/investigation and development work to solve scientific problems.

PO2: Ability to communicate effectively, i.e., write and present a substantial scientific report/document.

PO3: Ability to demonstrate a degree of mastery in the field of Physics at a level higher than that for a bachelor program.

PO4: Ability to solve scientific (experimental and theoretical) tasks both as a member of a team and as a leader of the team.

PO5: Ability to identify and use the appropriate knowledge, skills, and tools to offer scientific solutions to physics problems.

*The POs have been prepared in accordance with the Self Assessment Report (SAR) format of the National Board of Accreditation (NBA)

FIRST SEMESTER COURSES

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	PH1101	MATHEMATICAL METHODS OF PHYSICS	3-1-0	4
2	PH1102	CLASSICAL MECHANICS	2-1-0	3
3	PH1103	QUANTUM MECHANICS- I	3-1-0	4
4	PH1104	CONDENSED MATTER PHYSICS-I	3-1-0	4
5	PH1105	ELECTRONICS	2-1-0	3
6	PH1151	GENERAL PHYSICS LAB	0-0-6	4
7	PH1152	CONDENSED MATTER PHYSICS LAB	0-0-3	2
TOTAL				**24**

SECOND SEMESTER COURSES

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	PH2101	ELECTRODYNAMICS	2-1-0	3
2	PH2102	NUCLEAR AND PARTICLE PHYSICS	3-1-0	4
3	PH2103	QUANTUM MECHANICS- II	3-1-0	4
4	PH2104	CONDENSED MATTER PHYSICS-II	3-1-0	4
5	PH2105	PHOTONICS	2-1-0	3
6	PH2151	ELECTRONICS LAB	0-0-6	4
7	PH2152	NUCLEAR PHYSICS LAB	0-0-3	2
TOTAL				**24**

NB: L= Lecture, T = Tutorial, P = Practical

THIRD SEMESTER COURSES

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	PH3101	STATISTICAL MECHANICS	2-1-0	3
2	PH3102	NUMERICAL AND NONLINEAR ANALYSIS	2-1-0	3
3	PH3103	GENERAL THEORY OF RELATIVITY AND COSMOLOGY	2-1-0	3
4	PH91XX	ELECTIVE - I	2-1-0	3
5	PH91XX	ELECTIVE - II	2-1-0	3
6	PH3151	DISSERTATION - I	0-0-2	2
7	PH3152	SEMINAR NON PROJECT	0-0-1	1
8	PH3153	OPTOELECTRONICS LAB / ADVANCED CONDENSED MATTER PHYSICS LAB	0-0-6	4
TOTAL				**22**

FOURTH SEMESTER COURSES

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	PH4101	ATOMIC AND MOLECULAR SPECTROSCOPY	2-1-0	3
2	PH91XX	ELECTIVE - III	2-1-0	3
3	PH91XX	ELECTIVE - IV	2-1-0	3
4	PH4151	DISSERTATION – II WITH SEMINAR	0-0-9	9
5	PH4152	GRAND VIVA		2
TOTAL				**20**

LIST OF ELECTIVE PAPERS

ELECTIVE PAPERS	**Group-I: Condensed Matter Physics Specialization**		**Group-II: Opto-Electronics Specialization**	
	Paper code	Name of the Paper	Paper code	Name of the Paper
Elective-I	PH9111	CONDENSED MATTER PHYSICS-III	PH9121	OPTOELECTRONICS
Elective-II	PH9112	PHYSICS OF NANOMATERIALS	PH9122	CIRCUIT ANALYSIS AND INTEGRATED CIRCUITS
Elective-III	PH9113	INTRODUCTORY MATERIALS SCIENCE	PH9123	NONLINEAR OPTICS
Elective-IV	PH9114	X-RAYS IN CONDENSED MATTER PHYSICS	PH9124	COMMUNICATION TECHNOLOGIES

LIST OF CORE PAPERS WITH THEIR DEVELOPERS' NAMES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
PH1101	MATHEMATICAL METHODS OF PHYSICS	3-1-0	4	Dr. S. Basu
PH1102	CLASSICAL MECHANICS	2-1-0	3	Prof. A. K. Meikap, Dr. A. Mondal
PH1103	QUANTUM MECHANICS- I	3-1-0	4	Dr. S. Sahoo, Dr. S. Das
PH1104	CONDENSED MATTER PHYSICS-I	3-1-0	4	Prof. P. Kumbhakar, Dr. A. Mondal, Dr. H. Subramanian
PH1105	ELECTRONICS	2-1-0	3	Dr. M. K. Mandal, Dr. H. Chaudhuri, Dr. A. Ghosh
PH2101	ELECTRODYNAMICS	2-1-0	3	Dr. S. Basu
PH2102	NUCLEAR AND PARTICLE PHYSICS	3-1-0	4	Prof. A. K. Chakraborty, Dr. S. Das
PH2103	QUANTUM MECHANICS- II	3-1-0	4	Dr. S. Sahoo, Dr. S. Das
PH2104	CONDENSED MATTER PHYSICS-II	3-1-0	4	Prof. A. K. Meikap
PH2105	PHOTONICS	2-1-0	3	Prof. P. Kumbhakar, Dr. A. Mondal
PH3101	STATISTICAL MECHANICS	2-1-0	3	Prof. A. K. Meikap
PH3102	NUMERICAL AND NONLINEAR ANALYSIS	2-1-0	3	Dr. M. K. Mandal, Dr. H. Chaudhuri, Dr. S. Ghosh
PH3103	GENERAL THEORY OF RELATIVITY AND COSMOLOGY	2-1-0	3	Dr. S. Sahoo
PH4101	ATOMIC AND MOLECULAR SPECTROSCOPY	2-1-0	3	Dr. S. Basu

LIST OF ELECTIVE PAPERS WITH THEIR DEVELOPERS' NAMES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER(s)
PH9111	CONDENSED MATTER PHYSICS-III	2-1-0	3	Dr. S. Basu, Dr. H. Chaudhury
PH9112	PHYSICS OF NANOMATERIALS	2-1-0	3	Prof. A. K. Chakraborty
PH9113	INTRODUCTORY MATERIALS SCIENCE	2-1-0	3	Prof. A. K. Chakraborty
PH9114	X-RAYS IN CONDENSED MATTER PHYSICS	2-1-0	3	Dr. H. Chaudhuri, Prof. A. K. Chakraborty
PH9121	OPTOELECTRONICS	2-1-0	3	Prof. P. Kumbhakar Dr. A. Ghosh
PH9122	CIRCUIT ANALYSIS AND INTEGRATED CIRCUITS	2-1-0	3	Dr. M. K. Mandal
PH9123	NONLINEAR OPTICS	2-1-0	3	Prof. P. Kumbhakar
PH9124	COMMUNICATION TECHNOLOGIES	2-1-0	3	Dr. M. K. Mandal

LIST OF LABORATORY & SESSIONAL PAPERS WITH DEVELOPERS' NAMES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER(s)
PH1151	GENERAL PHYSICS LAB	0-0-6	4	Dr. H. Chaudhuri Dr. S. Ghosh
PH1152	CONDENSED MATTER PHYSICS LAB	0-0-3	2	Dr. S. Basu Dr. H. Subramanian
PH2151	ELECTRONICS LAB	0-0-6	4	Dr. M. K. Mandal Dr. A. Ghosh
PH2152	NUCLEAR PHYSICS LAB	0-0-3	2	Dr. S. Sahoo Dr. S. Das
PH3153	OPTOELECTRONICS LAB OR ADVANCED CONDENSED MATTER PHYSICS LAB	0-0-6	4	Prof. P. Kumbhakar Dr. M. K. Mandal Dr. A. Ghosh OR Prof. A. K. Chakraborty Dr. A. Mondal

LIST OF PROJECT/DISSERTATION/SEMINAR PAPERS WITH DEVELOPERS' NAMES.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER(s)
PH3151	DISSERTATION - I	0-0-2	2	All Faculty Members
PH3152	SEMINAR NON PROJECT	0-0-1	1	All Faculty Members
PH4151	DISSERTATION – II WITH SEMINAR	0-0-9	9	All Faculty Members
PH4152	GRAND VIVA		2	All Faculty Members

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH1101	MATHEMATICAL METHODS OF PHYSICS	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (As per PG regulation)					
NIL		As per PG regulation					
Course Outcomes	On completion of the course the learner shall be able to: • CO1: Identify basic mathematical tools to solve physics problems. • CO2: Apply the mathematical tools, such as integral transforms and Matrix diagonalization, for solving fundamental and applied physics problems. • CO3: Formulate new mathematical approaches to analytically solve new and existing physics problems.						
Topics Covered	**Complex variables:** Analytic functions, Cauchy Riemann equations, integration in the complex plane, Cauchy's theorem, Cauchy's integral formula. Taylor and Laurent expansion, singular points and their classifications. Branch point and branch cut. Riemann's sheets. Application of residue theorem to the evaluation of definite integrals and the summation of infinite series. Integrals involving branch point singularity. **[13]** **Fourier and Laplace transforms:** Fourier and Laplace transforms, Inverse transform, convolution theorem, solution of ordinary and partial differential equation by transform method. **[10]** **Theory of ordinary and partial differential equations:** ordinary and partial differential equations of mathematical Physics. Hermite, Lagurre, Bessel and associated Legendre function and their recurrence relations. Integral representation and orthogonality. **[15]** **Integral equations:** Fredholm and Volterra equations of first and second kinds. **[8]** **Vector space:** Linear vector space, Subspaces, Linear independence, Basis and dimension. Linear transformation, Linear operators, Matrix representation. The algebra of matrices, special matrices, Rank of matrix, equivalent matrices, Eigen values and eigenvectors of matrices. The Cayley-Hamilton theorem. Function of matrices, diagonalisation of matrices, quadratic form, and principal axis transformation. **[10]**						
Text Books, and/or reference material	**TEXT BOOKS:** 1. G. Arfken (Academic Press), Mathematical Methods for Physicists 2. P. Dennery and A. Krzywicki (Harper and Row), Mathematics for Physicists **REFERENCE BOOKS:** 1. J. Mathews and R. I. Walker (Benjamin), Mathematical Methods of Physics 2. A. W. Joshi (Wiley Eastern), Matrices and Tensors						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	2	3
CO2	3	1	2	3	3
CO3	3	1	3	2	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th></tr>
<tr><td>PH1102</td><td>CLASSICAL MECHANICS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (As per PG regulation)</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">AS PER PG REGULATION</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1: Demonstrate knowledge of Lagrangian and Hamiltonian formalisms to solve the classical mechanical problems.
CO2: Analyze classic problems, such as the harmonic oscillator problem, using advanced mathematical approaches.
CO3: Formulate special Theory of Relativity in terms of Hamiltonian and Lagrangian formalisms.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Review: Hamilton's Principle and Lagrange's equation of motion, Legendre transformation and Hamilton's equations of motion. Physical significance.[6]

Canonical Transformations: The equations of canonical transformations. Integral invariant of Poincare. Lagrange and Poisson brackets as canonical invariants. The equations of motion in the Poisson bracket formulation. Infinitesimal contact transformations and conservation theorems. [8]

Hamilton–Jacobi Theory: Hamilton-Jacobi equation and application to harmonic oscillator. Action-angle variables. The Kepler problem. H-J theory. Geometrical optics and wave mechanics.[6]

Lagrangian and Hamiltonian formulations for continuous systems: Transition from a discrete to a continuous system. Lagrangian formulation for continuous system. The stress – energy tensor and conservation theorems. Hamiltonian formulation.[6]

Rigid body motion: The independent co-ordinates of a rigid body. Euler angles, Cayley-Klein parameters. Euler's theorem. Infinitesimal rotations, coriolis force.
Angular momentum and kinetic energy of motion of a rotating body. The inertia tensor and moment of inertia. Principal axis transformation, Euler equation, torque free motion of rigid body.[8]
Special Theory of Relativity in Classical Mechanics: Covariant four dimensional formulations. Minkowski's space. Force and energy equations in relativistic mechanics. Lagrangian formulation of relativistic mechanics. Hamiltonian formulation of relativistic mechanics. Covariant Lagrangian and Hamiltonian formulation. [8]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS:
1. H. Goldstein, Classical Mechanics
2. Rana & Jog, Classical Mechanics
REFERENCE BOOKS:
1. Corben&Stehle, Classical Mechanics
2. Landau and Lifshitz, Mechanics</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	2
CO2	2	1	2	3	2
CO3	2	1	3	1	2

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH1103	QUANTUM MECHANICS – I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					

Course Outcomes	On completion of the course the learner shall be able to: CO1:Explain the fundamental concepts of quantum mechanics. CO2: Solve different problems related to the dynamics of subatomic particles. CO3: Summarize different approximation methods for solvingquantum mechanical problems.
Topics Covered	**General Principles of Quantum Mechanics:** Linear vector space, ket and bra vectors. Scalar product of vectors and their properties. Linear operators, Adjoint operators, Unitary operators, Hermitian operators, Eigen values and eigenvectors. Degeneracy. Schmidt method of orthogonalization. Expansion theorem. Completeness and Closure property of the basis set. Representation of ket and bra vectors and operators in the matrix form. Unitary transformations of basis vectors and operators. [10] **Quantum Dynamics:** Time evolution of quantum states. Time evolution operator and its properties. Schroedinger picture, Heisenberg picture, Interaction picture. Equations of motion. Operator method solution of Harmonic oscillator, Matrix representation and time evaluation of creation and annihilation operators. Density matrix. [10] **Rotation and OrbitalAngular Momentum:** Angular momentum operators as the generators of rotation**,** rotation matrix. L_x, L_y, L_z, and L^2 and their commutator relations. Raising and lowering operators.L_x, L_y, L_z, and L^2 in spherical polar co-ordinates. [8] **Spin Angular Momentum**: Spin – ½ particles, Pauli spin matrices and their properties. Eigen values and Eigen functions. Spinor transformation under rotation. [4] **Addition of Angular Momentum:** Total angular momentum J. Addition of angular momenta and C. G. coefficients. Angular momentum states for composite systems in the angular momenta (½, ½) and (1, ½). [4] **Motion in a Spherically Symmetric Field:** Hydrogen atom. Reduction to equivalent one body problem. Radial equation. Energy eigenvalues and Eigen functions, degeneracy, radial probability distribution. Free particle problem incoming and

	outgoing spherical waves, expansion of plane waves in terms of spherical waves. Bound states of a 3-D square well, particle in a sphere. [8] **WKB Approximation and Variational Method:** The WKB approximation, Connection formulae, Bohr Sommerfeld quantization rule, Harmonic oscillator and cold emission. [6] The variational method and its application to simple problems (Ground state of the Hydrogen atom, He-atom, Harmonic oscillator, Hydrogen molecule etc.). [6]\
Text Books, and/or reference material	**SUGGESTED BOOKS:** 1. S. Gasiorowicz, Quantum Physics 2. David J. Griffiths, Introduction to Quantum Mechanics **REFERENCE:** 1. J. L. Powell and B. Craseman, Quantum Mechanics 2. L. I. Shiff, Quantum Mechanics 3. J. J. Sakurai, Modern Quantum Mechanics 4. P.A.M. Dirac, The Principles of Quantum Mechanics 5. S. Erkoc, Fundamentals of Quantum Mechanics

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	2	3
CO2	3	1	3	2	2
CO3	2	1	2	2	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH1104	CONDENSED MATTER PHYSICS-I	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods (As per PG regulation)
NIL	AS PER PG REGULATION
Course Outcomes	On completion of the course the learner shall be able to: • CO1: Demonstrate knowledge of various early semi-classical models, such as free electron theory and Sommerfeld theory, to understand properties of condensed matter systems. • CO2: Analyze and solve simple problems related to fundamental ideas of solid state physics. • CO3: Develop methods to study correlated electron systems exhibiting magnetism and superconductivity.
Topics Covered	**Free electron model:** Heat capacity; Transport properties; Electron-electron interaction, electron-phonon interactions, Polarons, Hall Effect; Elementary concepts of quantum Hall effect. **[8]** **Structure and Scattering:** Crystalline solids, liquids and liquid crystals, Nanostructures, Bucky balls. **[8]** **Electrons in a periodic potential:** Bloch's theorem; Nearly free electron Model, Tight-binding model; Motion of an electron in a dc electric field, Effective Mass, Concept of holes, Energy band structure of solids, Energy band properties of semiconductors**. [10]** **Crystal Binding**: Types of solids, Van der Waals solids, Ionic and Covalent solids, Metallic bonding, calculation of cohesive energy. **[8]** **Lattice Vibrations**: Lattice vibrations, Adiabatic & harmonic approximations. Vibrations of mono and diatomic lattices, Lattice Heat Capacity, Einstein and Debye models. **[6]** **Superconductivity:** Properties of Superconductors, Experimental Survey, Meissner effect, London's equation, Thermodynamics of superconductors, Cooper pair, BCS theory, Ginzburg-Landau theory, Flux quantization, Magnetism; Exchange interaction. **[7]** **Magnetism:** Diamagnetism, paramagnetism, Ferromagnetism, anti-ferromagnetism &Ferrimagnetism, Hund's rules, Pauli paramagnetism, Heisenberg model, Mean field theory, spin waves, Giant and Colossal magnetoresistance. **[9]**
Text Books, and/or reference material	**TEXT BOOKS**: 1. M. Ali Omar, Elementary Solid State Physics (Addison-Wesley) 2. C. Kittel, Solid State Physics (Wiley Eastern) 3. F. C. Phillips, An introduction to crystallography (Wiley)

	REFERENCE BOOKS: 1. Christman, Solid State Physics (Academic press)

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	2	3
CO2	3	1	3	3	3
CO3	3	1	3	2	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics

Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH1105	ELECTRONICS	PCR	2	1	0	3	3

Pre-requisites	Course Assessment methods (As per PG regulation)
NIL	AS PER PG REGULATION

Course Outcomes	On completion of the course the learner shall be able to: • CO1: Illustrate the basic concepts and applications of different modern electronic devices. • CO2: Apply fundamental concepts of digital electronics for construction of logic circuits. • CO3: Design different active and passive electronic circuits such as amplifiers and oscillators.
Topics Covered	**Semiconductor Devices:** Bipolar devices- Junction diode, bipolar junction transistor, Heterojunction devices. Unipolar devices- Metal-semiconductor contacts, JFET, MOSFET **[8]** **Active Circuits:** Amplifiers- Discrete component transistor amplifier design technique. Video amplifiers, RF amplifiers, Power amplifier design consideration. Oscillators- Feedback principle, OP-Amp based R-C phase shift, Wien bridge oscillators. OP-Amp circuits- Active filters, Butter worth filter.**[10]** **Passive Networks and Transmission Line:** Prototype LC frequency selective networks HF transmission lines Primary and secondary line constants, lnput impedance, VSWR, Distortion of e. m. wave in practical lines, Fault location in practical line. **[6]** **Digital Electronic Circuits:** Logic Circuits- Classification, Logic simplification, SOP and POS design of combinational circuits. Sequential Circuit- Flip-f1ops, Counters and Registers. Arithmetic Circuit- RCA, CLA, BCD adders, multipliers. **[10]** **Communication:** Classification of modulation- AM, FM, and PM and Comparative merits in the context of transmission bandwidth, Power utilization. AM and FM modulators and demodulators. Effect of Noise on Communication System- Characteristics of additive noise, Performance of AM, FM receivers in the face of noise.**[8]**
Text Books, and/or reference material	**TEXT BOOKS**: 1. S. M. Sze, Physics of semiconductor devices. 2. J. Millman& Grable, Microelectronics. 3. Fraser, Telecommunications. 4. Malvino and Leach, Digital Principles & Applications 5. V.C. Hamacher et. al. Computer organisation. **REFERENCE BOOKS**: 1. J. D. Ryder, Electronic fundamental and applications. 2. S. Soclof, Applications of analog integrated circuits. 3. J.D. Ryder, Networks lines and fields.

	4. R. Roddy and J. Coolen, Electronic communication.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	2
CO2	3	1	2	2	3
CO3	3	1	2	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="8">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>PH1151</td><td>GENERAL PHYSICS LAB</td><td>PCR</td><td>0</td><td>0</td><td>6</td><td>6</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CE+EA</td></tr>
</table>

Course Outcomes	On completion of the course the learner shall be able to: CO1: Demonstrate practical knowledge by applying the experimental methods to correlate with the General Physics theory. CO2: Use various electrical and optical instruments for relevant measurements. CO3: Learn advanced analytical techniques and graphical analysis to investigate and represent experimental findings. CO4: Develop intellectual communication skills to discuss scientific concepts in a group.
Topics Covered	1 Determination of Planck's constant with a Photocell. 2 Determination of quantization of energy by Franck-Hertz experiment. 3 Determination of thermoelectric power of thermocouple. 4 Digital-to-analog and analog-to-digital conversion. 5 Determination of the g-factor using ESR spectrometer. 6 Measurement of the particle size of a given sample by method of diffraction using laser. 7 Study of Gaussian beam distribution by laser 8 Study of Refractive index of liquid sample by Abbe Refractrometer.
Text Books, and/or reference material	**SUGGESTED BOOKS:** 1. Advanced Practical Physics for Students / B.L. Worsnop and H.T. Flint. / Publisher: Methuen 2. An Advanced Course in Practical Physics/ by D. Chattopadhyay and P. C. Rakshit / Publisher: New Central Book Agency **REFERENCE:** 1. Advanced Practical Physics / Basudev Ghosh and K G Mazumdar, / Publisher: Sreedhar Publishers 2. Advanced Practical Physics/ by Samir Kumar Ghosh / Publisher: New Central Book Agency

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1		1		1
CO2	1		1	1	1
CO3	1	2	1	1	1
CO4		2	1	2	

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH1152	CONDENSED MATTER PHYSICS LAB	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					

Course Outcomes	On completion of the course the learner shall be able to: CO1: design a complete experimental apparatus to implement advanced condensed matter physics experiments. CO2: acquires basic skills to critically elaborate and interpret experimental data CO3:apply the acquired knowledge through hands-on laboratory training to achieve advanced capabilities in equipment handling and experimental problem solving
Topics Covered	1. Determination of band gap of a given sample by four probe method. 2. Measurement of Hall coefficient of a semiconductor material 3. Study of Hysteresis Loop of a Ferromagnetic material using an Oscilloscope 4. Study of Magneto-resistance of n-type Ge crystal. 5. Study of Electrolytic conduction in ionic crystals. 6. Measurement of dielectric constant of a given sample. 7. Measuring the diameter of Human Hair by laser light diffraction method.
Text Books, and/or reference material	**SUGGESTED BOOKS:** 1. Building scientific apparatus J.Moore, C.Davis, M.Coplan Perseus Books Westview Press 2. Physical methods for material characterization P.Flewitt, R.Wild , IOP Bristol **REFERENCE:** 1. A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011,Kitab Mahal 2. Advanced Practical Physics for Students, B.L. Worsnop, H.T. Flint

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	3	2
CO2	3	2	3	2	2
CO3	3	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PH2101	ELECTRODYNAMICS	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (As per PG regulation)					
NIL		AS PER PG REGULATION					

Course Outcomes	On completion of the course the student shall be able to: • CO1: Interpret the physical origins of the Maxwell's equations and describe their symmetry and transformation properties, domain of validity, and limitations • CO2: Describe the formulae for the electromagnetic fields from very general charge and current distributions using electrodynamic potentials • CO3: Develop electromagnetic equations in a relativistically covariant form in four-dimensional space-time
Topics Covered	**Electrostatic and magnetostatic field Problems:** Uniqueness theorem, Green's reciprocation theorem, solution by Green's function, solution by inversion, Solution of Laplaces' equation. Magnetic circuits. Magnetic scalar potential and vector potential, use of vector potential in solution of field problems. **[8]** **Propagation of Plane Electromagnetic Waves:** Maxwell's equations, Plane electromagnetic waves in free space. Poynting vector for free space. Plane electromagnetic waves in matter. Plane electromagnetic wave propagation in non-conducting media and conducting media. Poynting vector in conducting media, Reflection and refraction at a plane boundary. **[6]** Greens function. Solution of Maxwell's equations. Lorentz and Coulomb gauge. Gauge invariance. Linear and Circular polarizations. Stoke's parameters. Frequency dispersion characteristics of dielectrics and conductors. Waves in dispersive medium. Kramer–Kronig relations. **[6]** **Wave Guides and Resonant Cavities:** Cylindrical cavities and wave guides. Modes in a rectangular wave guide. Resonant cavities. **[4]** **Radiation, Scattering and Diffraction:** Fields and radiation of a localised oscillating source. Electric dipole fields and Radiation. Scattering by a small dielectric sphere in long wavelength limit. Rayleigh scattering. Kirchoffs formulation of diffraction by a circular aperture. **[6]** **Radiation by Moving Charges:** Lienard–Wiechert potentials and fields for a point charge. Total power radiated by an accelerated charge. Larmor's formula. Thomson Scattering. **[6]** **Electrodynamics & Relativity:** Special theory of Relativity an Introduction, Lorenz Transformation, The structure of Space-time,Magnetism as relativistic phenomena, How the field transform, The field tensor, electrodynamics in tensor notation, relativistic potentials. **[6]**

Text Books, and/or reference material	**TEXT BOOKS:** 1. J. D. Jackson, *Classical Electrodynamics* 2. D. J. Griffiths, *Electrodynamics* **REFERENCE BOOKS:** 1. M. Born and E. Wolf, *Principles of Optics* 2. J. R. Reitz, F. J. Milford & R. W. Christy, *Foundations of Electromagnetic Theory* 3. Panofsky & Phillips, Classical *Electricity & Magnetism*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	3
CO2	2	1	2	2	3
CO3	3	1	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>PH2102</td><td>NUCLEAR AND PARTICLE PHYSICS</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1:Describe the properties of the nucleus and its constituents.
CO2: Explain the basic theories of nuclear models, radiations and reactions.
CO3: Interpret the fundamental forces and elementary particles of nature.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">General properties of Nucleus: Evidence of existence of nucleus, Rutherford's gold-leaf experiment, basic nuclear properties such as size, shape, density, mass, mass defects, binding energy, charge distribution, spin, parity, nuclear moments, etc. Nuclear forces, forms of nucleon-nucleon potential, charge independence and charge symmetry of nuclear forces.[12]

Nuclear models: Liquid drop model, semi-empirical mass formula, Single particle shell model and its validity and limitation, explanation of magic nuclei. [12]

Nuclear radiations: Theories of alpha, beta and gamma decays, selections rules, neutrino hypothesis, nuclear isomers, energy loss by charged particles and gamma rays. [10]

Nuclear reactions: Review of nuclear reactions, types of nuclear reactions, nuclear fission and fusion, reactions cross-section and yield, conservation rules, energy and mass distribution in nuclear reactions, threshold energy of nuclear reaction, reaction mechanism, Compound nucleus hypothesis and direct reactions. [10]

Elementary Particle Physics: Classification of fundamental forces, elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.), Gellmann-Nishijima formula, Quark model, baryons and mesons. CPT invariance, Symmetry arguments in particle reactions, Parity violation in weak interaction, Relativistic kinematics. [12]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">SUGGESTED BOOKS:
1. S.N. Ghoshal, Atomic & Nuclear Physics
2. D. C. Tayal, Nuclear Physics
3. V. K. Mittal, R. C. Verma, S. C. Gupta, Introduction to Nuclear and Particle Physics

REFERENCE:
1. David Griffiths, Introduction to Elementary Particles
2. Irving Kaplan, Nuclear Physics
3. B. L. Cohen, Concepts of Nuclear Physics</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	2	2
CO2	1	1	3	2	2
CO3	1	1	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH2103	QUANTUM MECHANICS – II	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
PH1103		CE+EA					

Course Outcomes	On completion of the course the learner shall be able to: CO1: Describe perturbation and scattering theories to solve quantum mechanical problems. CO2: demonstrate fundamental knowledge of relativistic quantum mechanics and quantum field theory. CO3: Develop second quantization method for free fields.
Topics Covered	**Perturbation Theory:** Time-independent perturbation theory for non-degenerate and degenerate states. First and second order perturbation, Applications to anharmonic oscillator, He atom, Linear and quadratic Stark effect, Normal and anomalous Zeeman effect. [8] Time-dependent perturbation theory, transition probability, constant and harmonic perturbation, Fermi golden rule, Electric dipole radiation and selection rules. [8] **Scattering:** Scattering amplitude and cross section. Born approximation. Application to Coulomb and Screened Coulomb potentials. Partial wave analysis for elastic and inelastic scattering, optical theorem, Black disc scattering, scattering from a hard sphere, Resonance scattering from a square-well potential. [12] **Relativistic Quantum Mechanics:** Klein-Gordon equation and its drawbacks, Dirac equation, properties of Dirac matrices, Non-relativistic approximation of Dirac equation, Free particle solution of Dirac equation, physical interpretation of free particle solution, projection operators for energy and spin, Lorentz covariance of Dirac equation. [8] Bilinear covariant in Dirac theory, Dirac operators in Heisenberg representation, Constants of the motion, Zitterbewegung and negative-energy solutions, Klein's paradox, Hole theory and charge conjugation, space reflection and time reversal symmetries of Dirac equation. [8] **Quantization of free fields:** Transition from discrete to continuous system, Lagrangian and Hamiltonian formulation for continuous systems, Noether's theorem, second quantization, quantization of scalar field, Dirac field and electromagnetic field. Electromagnetic interaction and gauge invariance. [12]

Text Books, and/or reference material	SUGGESTED BOOKS: 1. S.Gasiorowicz, Quantum Physics 2. David J. Griffiths, Introduction to Quantum Mechanics 3. J. J. Sakurai,Advanced Quantum Mechanics 4. F. Mandal and G. Shaw,Quantum Field Theory REFERENCE BOOKS: 1. J. L. Powell and B. Craseman, Quantum Mechanics 2. L. I. Shiff, Quantum Mechanics 3. J. D. Bjorken and S. D. Drell, Relativistic Quantum Mechanics 4. M. E. Peskin and D. V. Schroeder, An Introduction to Quantum Field Theory 5. L. H. Ryder, Quantum Field Theory

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	3
CO2	2	1	3	1	2
CO3	2	1	3	2	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

]Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH2104	CONDENSED MATTER PHYSICS II	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (As per PG regulation)					
PH1104		AS PER PG REGULATION					

Course Outcomes	On completion of the course the student shall be able to: CO1: Interpret the symmetry operation and distinguish between Crystalline and Non- Crystalline solids. CO2: Explain different defects in crystal lattice of the material. CO3: Apply the knowledge of symmetry operation and defects to analyse structure of solids.
Topics Covered	Topic-1: Symmetry operations and their classifications, Macroscopic Symmetry, Mirror plane, Rotation axis, Centre of symmetry, Roto Inversion symmetries and their examples, 32 Point Groups, Seven Crystal classes and their unit cells. **[10]** **Topic-2:** Bravais Lattices, density of packing, Microscopic Symmetry Elements, Screw axis and Glide plane of symmetries, Hermann- Mauguin Symbols, Space Groups. Basic introduction to the crystal structure analysis. Derivation of Laue and Bragg's reflection. Reciprocal lattice, the relation with direct lattice. Importance of reciprocal lattice, Ewald's sphere. **[12]** **Topic-3:** Deviation from perfect crystallinity, Defects in crystals and their classifications. Poly Crystals and their characteristics, Long range and short range order. Differences between polycrystals and single crystalline states of matter. Mechanical properties and deformation characteristics in polycrystals. Crystal defects and introduction to their analysis. Deviation from perfect poly crystallinity, Preferred orientations and their analysis.**[12]** **Topic-4:** Phase transformations, Diffusion mechanism, Diffusion less transformations, Time - temperature transformation for some important alloys **[6]** **Topic-5:** Non-crystalline solids. Localized states, Kubo-Greenwood formula, hopping mechanism, short range and long range order, structure of amorphous state-Mott transition. **[8]** **Topic-6:** Quasi Crystalline state of matter. Liquid crystals, the delicate state of matter. Different classification of Liquid crystals and their properties. Applications of liquid crystals in display devices. Plastic crystals. **[8]**
Text Books, and/or reference material	**TEXT BOOKS:** 1. L. V. Azaroff, *Introduction to solids* 2. F. C. Phillips, *An introduction to crystallography* 3. S. K. Chatterjee, *X-ray diffraction its theory and applications* **REFERENCE BOOKS:** 1. M. J. Burger, *Crystal structure analysis* 2. B. D. Cullity, *X-ray diffraction*

	3. B. E. Warren, *X-ray diffraction*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	2	2	2	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PH2105	PHOTONICS	PCR	2	1	0	3	3

Pre-requisites	Course Assessment methods (As per PG regulation)
NIL	AS PER PG REGULATION

Course Outcomes	On successful completion of the course the learner shall be able to: • CO1: Classify different types of laser, explain their lasing action, and electro-optic modulation techniques. • CO2: Illustrate the basic concepts and applications of different photonic devices and optical fiber. • CO3: Construct different types of holograms using the coherence property of lasers.
Topics Covered	**Basic principles of Laser:** Properties of Laser Radiation, Basic components of Laser, Classifications of Lasers, Spontaneous and stimulated emission. Einstein's coefficients and their relations, conditions of population inversion. Absorption and amplification of light in a medium, population inversion and threshold condition for a laser, gain coefficient. Laser Rate Equations, 2-level laser, 3-level and 4-level lasers. Line broadening mechanisms—(spontaneous transition, collision broadening and Doppler broadening).[11] **Modulation Techniques:** Propagation of EM waves in anisotropic dielectric medium, dielectric Tensor, Index ellipsoid. Electro-optic effect, electro-optic phase retardation, electro-optic amplitude modulation, phase-modulation of light.[6] **Photonic devices:** Light Emitting Diode (LED), quantum efficiencies (internal and external), responsivities, Characteristics and applications of various kinds of LEDs, dome type LED, homojunction LED, heterojunction LED, guided wave LED, edge-emitting LED, quantum cascaded LED, quantum dot LED, operational circuit and modulation of LEDs. Different types of coupling procedure of LED with optical fiber. Coupling coefficients and coupling loss. Photo diode, quantum efficiencies (internal and external), responsivities, Characteristics and applications of various kinds of photodetectors, P-I-N photodiode, Avalanche photodiode, Metal–Semiconductor-Metal (M-S-M) photodiode, quantum well photodetector, multiquantum well photodetector, infrared photodetector etc. Photomultipliers tubes. Charge coupled devices (CCD), solar cell.[14] **Fiber Optics:** Rectangular and cylindrical waveguides, propagation of radiation in dielectric waveguides. Step index and graded index fiber, modes in fiber, dispersion in multimode & single mode fiber, attenuation mechanisms in fibers, signal distortion, mode coupling, power launching and coupling, fiber parameter specifications. [8] **Holography**: Basics of holography, On-axis and off-axis hologram recording and reconstruction, transmission and reflection holograms, Amplitude and phase holograms, Thick and thin holograms, Recording materials, Applications of Holography.[3]

Text Books, and/or reference material	**TEXT BOOKS:** 1. A. Ghatak, K. Thyagarajan, *Optical Electronics, Cambridge* 2. S. M. Sze, *Physics of semiconductor devices.* 3. O. Svelto, *Principles of Lasers* 4. Franz and Jain, *Optical communication systems* 5. R.J.Collier, *An Optical holography, Academic Press.* **REFERENCE BOOKS:** 1. P. Bhattacharya, *Semiconductor opto-electronic devices*. 2. W. Koechner, *Solid State Laser Engineering* 3. J. M. Senior, *Optical fiber communications principles and practice* 4. S.O. Kasap, *Optoelectronics and Photonics principles and practices* 5. Martin A Green, *Solar Cells: Operating Principles, Technology, and System Applications*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	2	3
CO2	2	1	3	2	3
CO3	2	1	2	2	2

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>PH2151</td><td>ELECTRONICS LAB</td><td>PCR</td><td>0</td><td>0</td><td>6</td><td>6</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1: Learn how to handle electronic equipment such as DSO, Function generator, Spectrum analyzer, etc.
CO2: Design different electronic circuits and study their performances.
CO3: Examine the output results of different electronic components as well as complete circuit.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">To study the current mirror circuit
To study the frequency response of BJT amplifier in CE configuration and to investigate different related properties with and without feedback.
To study and design an R-C phase-shift oscillator.
To study the frequency response of two-port Network.
To make truth table for different gates using minimum number of NAND gates.
Generation of different wave-form using IC555.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">SUGGESTED BOOKS:
1. Microelectronics by Jacob Millman and Arvin Grabel.
2. Op-Amps and Linear Integrated Circuits by Ramakant A. Gayakwad</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	3
CO2	2	2	3	3	3
CO3	2	2	3	2	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>PH2152</td><td>NUCLEAR PHYSICS LAB</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1: Study the operation and characteristics of a detector
CO2: Understand the nature of radiation emitting from radioactive sources
CO3: Realize the randomness and properties of data obtained from the experiment.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. To determine the operating plateau for the Geiger tube
2. To measure Half - life of a given beta source
3. To verify inverse square law for a given source
4. To determine the distribution of statistical variation of data analysis for given beta source
5. To observe Gamma ray spectrum of a given source</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">SUGGESTED BOOKS/MANUALS:
1. Radiation Detection & Measurement, G. F. Knoll, John Willey & Sons
2. Nuclear Physics, S. N. Ghosal, S. Chand & Company Ltd.
3. GSPEC Series Instruction Manual, Version 2.5x
4. Laboratory investigations in Nuclear Science by Jerome L. Duggan, Department of Physics, University of North Texas, Denton Texas 76203 USA</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

COs \ POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	2	2	2	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of Contact Hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th></tr>
<tr><td>PH3101</td><td>STATISTICAL MECHANICS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (As per PG regulation)</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">AS PER PG REGULATION</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course students will be able to:
CO1: Explain the theoretical concepts used in Statistical mechanics.
CO2: Construct partition functions for different ensembles and apply them to solve different statistical physics problems.
CO3: Estimate different parameters (such as, magnetization and susceptibility) of materials by using statistical physics tools.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Scope and aim of Statistical Mechanics: Phase Space, Phase Points, Ensemble. Density of Phase Point and Liouville’s Equation, Stationary ensembles: Micro - Canonical, Canonical and Grand Canonical. Partition functions. Equilibrium Properties of Ideal System: Ideal gas, Harmonic Oscillators, Rigid rotators. Bose – Einstein and Fermi – Direct distribution functions, general equations of states for ideal quantum systems, Properties of ideal Bose - gas, Bose – Einstein condensation. [12]

Density Matrix: Statistical and Quantum mechanics approaches, Properties of mixed and Pure states, density matrix for stationary ensembles, Application of a free particle in a box, an electron in a magnetic field, Density matrix for a beam of spin ½ Particles, construction of density matrix for different spin states and calculation of the polarization vector. [8]
Statistical mechanics of interacting systems: Cluster expansion for a classical gas, Virial expansion of equation of state, Evaluation of the Virial coefficients, Exert treatment of the second Virial coefficients, Quantum cluster expansion. [7]
Strong Interacting system: Ising Model, Ideas of exchange interaction and the Heisenberg Hamiltonian, Ising Hamiltonian as a truncated Heisenberg Hamiltonian. [5]
Phase Transitions: General remarks, Phase transition and critical phenomena, critical indices, Landau’s order parameter theory of phase transition. [6]
Fluctuations: Fluctuations of fundamental thermodynamic quantities. Correlations of fluctuations in space and time. [4]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS:
1. R. K. Pathria, Statistical Mechanics
2. K. Huang, Statistical Mechanics

REFERENCE BOOKS:
1. L. D. Landen, E. M. Lifshitz and P. Pilaevskii, Statistical Physics (Pt.-I)
2. R. P. Feynaman, Statistical Mechanics, A set of lectures</td></tr>
</table>

	3. S. K. Ma, *Statistical Physics* 4. A Ishihara, *Statistical Physics* 5. M. Teda, R. Kubo, and N. Satto, *Statistical Mechanics*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	1
CO2	2	1	3	2	2
CO3	2	1	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th></tr>
<tr><td>PH3102</td><td>NUMERICAL AND NONLINEAR ANALYSIS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (As per PG regulation)</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">AS PER PG REGULATION</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
CO2: Apply numerical methods to obtain approximate solutions to mathematical and numerical problems.
CO3: Use scientific software like MATLAB for formulating and solving real life problems related to the properties of materials and applications.
CO4: Acquire knowledge on different tools for analyzing and interpreting data.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Numerical analysis: Numerical analysis and C++ programming to solve the problems in the following topics: (i) Solutions of nonlinear equations, (ii) Interpolation, (iii) Numerical integration and differentiation, (iv) Numerical solution of first and second order differential equations, (v) Systems of linear equations, (vi) Methods of least squares, etc. [15]
Introduction to nonlinear system: Introduction to dynamical systems; basic concepts of nonlinear dynamics using the simple pendulum, examples of linearity and nonlinearity in physics and other sciences – electronics, LASER, geophysics, biology, finance & economics; One and two dimensional nonlinear systems; Systems of differential equations with examples; control parameters; fixed points and their stability; phase space; periodic orbits; nonlinear oscillators and their applications; bifurcation and physical examples. [5]
Fractals and Chaos: Dynamical systems and fractals; Examples of fractals in nature; Fractal dimension - a non-integer dimension; Multifractal detrended fluctuation analysis (MFDFA) technique, Hurst exponent. Basic concept of chaotic system; Strange attractors; Evolution of phase space volume in chaotic and non-chaotic system; Chaotic time series [4]
Time series analysis: Concept of frequency domain and time domain for analysis of time series data, Continuous and discrete time series; Stationary and non-stationary data; Periodic and non-periodic signals; Frequency analysis of time series; Fourier series and Fourier Transform; Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Power law; Noises in signals – white noise, pink noise etc.; Signal Filtering process – concept of RMS analysis, SVD technique, Surrogate data. [6]
Software packages for the study of nonlinear system (Computation Lab): Introduction to software packages which are widely used in the study of nonlinear systems – Mathematica; Matlab. Methods and Applications of DFT & FFT</td></tr>
</table>

	algorithms; estimation of Hurst exponent using power law slope, R/S method. Methods and Applications of MFDFA algorithms. Analysis of Chaotic time series, estimation of Lyapunov exponent. **[6]**
Text Books, and/or reference material	**TEXT BOOKS:** 1. J H Mathews & K D Fink, Numerical Methods Using Matlab (ISBN 81-203- 2765-9). 2. S. H. Strogatz, Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry and Engineering, Perseus Books Publishing, 2000. **REFERENCE BOOKS:** 1. A Stevens & Clayton Walnum, C++ Programming Bible (ISBN 81-265-0005-0) 2. H. Kantz and T. Schreiber, Nonlinear Time Series Analysis, CUP 1998, 2nd edition

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1		2		
CO2	1		2	2	
CO3	1		2	1	2
CO4	2		2	2	2

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH3103	GENERAL THEORY OF RELATIVITY AND COSMOLOGY	PCR	3	0	0	3	3

Pre-requisites	Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))
NIL	CE+EA

Course Outcomes	On completion of the course the learner shall be able to: CO1: Explain tensor algebra and its applications in GTR and cosmology. CO2: Describe the fundamentals of GTR and discuss different stages of stars, and gravitational waves. CO3: Apply the cosmological concepts to understand the origin and evolution of the universe.
Topics Covered	**Tensor analysis:** Scalars, contravariant vectors, covariant vectors, tensors of higher rank, Tensor algebra, Christoffel symbols, covariant differentiation of vectors, higher rank tensors & fundamental tensors, Tensor form of gradient, divergence and curl, Riemann-Christoffel curvature tensor, Ricci tensor, scalar curvature, Bianchi identities. **[14]** **Gravitation:** Statement of the Principle of Equivalence, Gravitational force, Relation between $g_{\mu\nu}$ and $\Gamma^{\lambda}_{\mu\nu}$, Newtonian limit, Principle of general covariance, Derivation of Einstein field equations, Brans-Dicke theory, coordinate conditions, Cauchy problem, energy, momentum and angular momentum of gravitation, Experimental tests of the general theory of relativity, Brief introduction to black holes and gravitational waves. **[14]** **Cosmology:** The cosmological principle, Newtonian cosmology, Einstein universe, Expanding universe, Hubble's law, Robertson-Walker metric, red shift, measures of distance, red-shift versus distance relation. Density and pressure of the present universe, matter dominated era, observation of cosmic microwave radiation background, Elementary idea about dark matter and dark energy. **[14]**
Text Books, and/or reference material	**TEXT BOOKS:** 1. S. Weinberg– Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity 2. J. V. Narlikar– An Introduction to Cosmology **REFERENCE BOOKS:** *1.* J. V. Narlikar –An Introduction to Relativity *2.* T. Padmanabhan – Gravitation: Foundations and Frontiers

	3. J. B. Hartle – Gravity: An Introduction to Einstein's General Relativity 4. Ta-Pei Cheng – Relativity, Gravitation and Cosmology: A Basic Introduction 5. Relativity, Gravitation and Cosmology: A Basic Introduction – Ta-Pei Cheng

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	2	1	2	2	2
CO3	2	1	3	2	2

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH3151	DISSERTATION-I	PCR	0	0	2	2	2
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					
Course Outcomes	On completion of the course the learner shall be able to: CO1: Identify, summarize and critically evaluate relevant literature and write a review. CO2: Undertake problem identification and formulation. CO3: Effectively write scientific findings in a systematic and logical sequence.						
Topics Covered	To be notified separately.						
Text Books, and/or reference material	To be notified separately.						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2
CO2	2	2	2	2	2
CO3	3	3	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH3152	SEMINAR NON PROJECT	PCR	0	0	1	1	1
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					
Course Outcomes	On completion of the course the learner shall be able to: CO1: Effectively present the knowledge gain on a specific scientific topic through critical thinking. CO2: Develop oral skill for scientific communication and presentation CO3: Develop skill for performing the task through team work.						
Topics Covered	To be notified separately.						
Text Books, and/or reference material	To be notified separately.						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	3
CO2	2	3	2	2	3
CO3	3	3	2	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH3153	OPTOELECTRONICS LAB	PCR	0	0	6	6	4
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					
Course Outcomes	On completion of the course the learner shall be able to: CO1: Verify various theoretical concepts learned in the lecture class CO2: Measure the fundamental parameters and the performance of practical optoelectronic devices. CO3: Design some logic gates and filter circuits.						
Topics Covered	1. Design and study the ECL OR NOR gate. 2. Design of PLL and study of its properties. 3. Design and study of active band pass filter. 4. Microprocessor programming. 5. Determination of Si Solar Cell efficiency. 6. Measurement of beam-spot size, beam divergence and Gaussian shape characteristics of laser radiation. 7. Measurement of temporal coherence of He-Ne laser using Michelson's Interferometer. 8. Collimation testing using Shear Interferometry. 9. To study the Fraunhofer diffraction pattern at a pair of circular apertures and measure their separation.						
Text Books, and/or reference material	**SUGGESTED BOOKS:** 1. Microelectronics by Jacob Millman and Arvin Grabel. 2. Microprocessor architecture, programming and applications with 8085 by R. S. Gaonkar. 3. Fiber optics and optoelectronics by R. P. Khare						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	3	2
CO2	2	2	3	3	3
CO3	2	2	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="8">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>PH3153</td><td>ADVANCED CONDENSED MATER PHYSICS LAB</td><td>PCR</td><td>0</td><td>0</td><td>6</td><td>6</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods: (Continuous evaluation (CE) and End assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1: Synthesize metal and semiconductor nanostructures using some of the popular low-cost methods
CO2: Determine the band gap of a semiconductor nanomaterial from its interaction with UV-visible light
CO3: Determine the shape, size, thickness, etc. of the particles as well as their crystallinity
CO4: Select the appropriate method for synthesis and characterization of nanomaterials</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Synthesis of a semiconductor nanomaterial by a chemical method
2. Synthesis of a metallic thin film by a physical (sputter/thermal) evaporation method
3. Determination of the optical absorption properties and the band gap of the semiconductor nanomaterial by Tauc method
4. Determination of the particle/grain shape and size of the nanomaterial by Scanning Electron Microscopy
5. Determination of the microstructure and crystallinity of the nanomaterial by X-ray diffraction
6. Determination of the thickness and roughness of a nanostructured thin film using Atomic Force Microscopy
7. Determination of the activation energy of a semiconductor nanomaterial from its electrical transport properties
8. Determination of the applied-bias photon-to-current conversion efficiency (ABPE) of the semiconductor nanomaterial</td></tr>
<tr><td>Text Books, and/or Reference material</td><td colspan="7">SUGGESTED BOOKS:
1. Nanomaterials: An Introduction to Synthesis, Properties and Applications, Dieter Vollath, Wiley
2. Materials characterization: Introduction to Microscopic & Spectroscopic Methods, Yang Leng, Wiley</td></tr>
</table>

	3. Electronic Processes in Non-Crystalline Materials. N. F. Mott and E. A. Davis. Oxford University Press **REFERENCES:** 4. Optical properties and electronic structure of amorphous Ge and Si, J. Tauc, Materials Research Bulletin Vol 3: 37–46 (1968). 5. Introduction to Condensed matter physics, Vol 1, Feng Duan & Jin Guojun (https://doi.org/10.1142/9789812569226_0009) 6. Semiconducting materials for photoelectrochemical energy conversion, Kevin Sivula & Roel van de Krol, Nature Reviews Materials 1, 15010 (2016)

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	2
CO2	2	1	3	3	2
CO3	2	1	3	3	2
CO4	3	1	3	2	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH4101	ATOMIC AND MOLECULAR SPECTROSCOPY	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (As per PG regulation)					
NIL		AS PER PG REGULATION					

Course Outcomes	On completion of the course the student shall be able to: • **CO1:** Describe the atomic spectra of one and two valance electron atoms • **CO2:** Explain the change in behavior of atoms in external applied electric and magnetic field. • **CO3:** Interpret rotational, vibrational, electronic and Raman spectra of molecules
Topics Covered	**Atomic Spectroscopy:** Introduction to atomic spectroscopy, Introduction to quantum mechanics, One electron Atom problem, Interaction of one-electron atoms with electromagnetic radiations, Fine structure and hyperfine structure, Interaction of one-electron atom s with external electric and magnetic fields. Two electrons atoms. **[8]** **Introduction to Molecular spectroscopy:** Introduction to molecular spectroscopy, spin resonance spectroscopy, spin and applied fields, NMR and ESR spectroscopy. Born-Oppenheimer approximation and separation of electronic and nuclear motion in molecules. Band structure of molecular spectra. **[4]** **Microwave and infrared spectroscopy:** Rotational spectra of diatomic molecules in rigid and nonrigid rotator mode. Selection rules. Determination of bond length. Rotational spectra of polyatomic molecules (spherically symmetric, symmetric top and asymmetric top molecules). Isotope effect. **[4]** **Near Infrared spectroscopy:** Vibrational spectra of diatomic molecules in harmonic and anharmonic oscillator model. Morse potential and dissociation energy of diatomic molecule. Selection rules. Rotational–Vibrational spectra. Isotope effect. **[5]** **Electronic spectra of diatomic molecules:** Vibrational band structure of electronic spectra, Deslandre's table. Isotopic shifts of O-O and other bands. Determination of molecular constants. Rotational structure of vibronic bands. P, Q and R branches. Intensity distribution in the vibrational structure of electronic bonds. Frank-Condon Principle. **[5]** **Raman Spectroscopy:** Pure rotational Raman spectra, vibrational Raman spectra, and polarization of light and Raman effect. **[5]** **Spin Resonance spectroscopy:**Nuclecar magnetic resonance spectroscopy, Electron spin resonance spectroscopy **[5]**

Text Books, and/or reference material	**TEXT BOOKS:** 1. Bransden and Joachin, *Physics* of *Atoms and Molecules* 2. Banwell and McCash, *Fundamentals of Molecular Spectroscopy* 3. Walter S Struve *Fundamentals of Molecular Spectroscopy* **REFERENCE BOOKS:** 1. G. Herzberg, *Spectra of Diatomic molecules, Dores, NY* 2. G. M. Barrow, *Molecular Spectroscopy* 3. G. Herzberg, *Raman and Infrared Spectra van-Norstrand, NY*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	3
CO2	2	1	2	2	3
CO3	3	1	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
PH4151	DISSERTATION – II WITH SEMINAR	PCR	**0**	**0**	**9**	**9**	**9**
Pre-requisites		Course Assessment methods (As per PG regulation)					
NIL		AS PER PG REGULATION					
Course Outcomes	On completion of the course the learner shall be able to: CO1: Undertake problem identification, formulation and solution through scientific observation. CO2: Analyze and synthesize research findings and demonstrate capability of independent research. CO3: Effectively write and present scientific findings in a systematic and logical sequence.						
Topics Covered	Topics will be provided						
Text Books, and/or reference material	To be notified separately.						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	2
CO2	3	3	3	3	2
CO3	3	3	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>PH4152</td><td>GRAND VIVA</td><td>PCR</td><td></td><td></td><td></td><td></td><td>2</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (As per PG regulation)</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">AS PER PG REGULATION</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1: Ability to defend their knowledge to an expert committee.
CO2: Develop skill for presentation of overall scientific knowledge gained in the course of study.
CO3: Develop skill for thinking on their feet and to answer rapid fire questions.</td></tr>
<tr><td>Topics Covered</td><td colspan="7"></td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7"></td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	2
CO2	2	3	3	3	3
CO3	2	3	3	2	2

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low)　　2: Moderate (Medium)　　3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th></tr>
<tr><td>PH91XX

PH9111</td><td>ELECTIVE – I

CONDENSED MATTER PHYSICS-III</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (As per PG regulation)</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">AS PER PG REGULATION</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
• CO1: Learn the basics techniques to deal with interacting quantum systems, e.g. mean field theory, second quantized operators
• CO2: Explain the concept of energy bands and effect of the same on electrical properties.
• CO3: Predict electrical and thermal properties of solids and explain their origin
• CO4: Develop an ability to identify, formulate, and solve problems in condensed matter physics.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Crystal elasticity: Generalized Hooke's law, elastic stiffness and compliance coefficient, second and third order elastic constants.[3]

Lattice dynamics: Theory of lattice vibration in harmonic approximation, Born Karman cyclic condition, phonon frequency distribution, dispersion relations, diffraction of X-rays and neutrons by phonons, Debye Waller factor, Mossbauer effect and its applications. Thermodynamic functions and relations for a crystal. [9]

Electronic energy band theory:Recapitulation of the fundamentals of band theory of solids, Approximation methods for calculation of energy bands, Many-electron theory, Hartree-Fock approximations for exchange and correlation energies. [12]

Electronic and magnetic properties of solids:Boltzmann Transport Equation, Transport equation in presence of magnetic field, cyclotron resonance, energy levels and density of states in presence of magnetic field. Landau diamagnetism and deHass-van Alphen effect. Hall effect and magnetoresistance. Spin paramagnetism. [12]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS:
1. Born and Huang, Dynamical theory of crystal lattice
2. Rogalski & Palmer, Solid State Physics
3. Ashcraft &Mermin, Solid State Physics

REFERENCE BOOKS:
1. D. C. Wallace, Thermodynamics of crystals
2. Aniwalu, Intermediate Quantum theory of crystalline solids
3. Pines, Elementary excitations in Solids</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	2	1	2	2	3
CO3	2	2	3	2	2
CO4	3	1	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH91XX **PH9121**	ELECTIVE – I OPTOELECTRONICS	PCR	2	1	0	3	3

Pre-requisites	Course Assessment methods (As per PG regulation)
NIL	AS PER PG REGULATION

Course Outcomes	On completion of the course the learner shall be able to: • **CO1:** Calculate the condition of stability of optical resonator and analyse the propagation of beam within resonator by using ABCD-law (matrix method). • **CO2:** Describe the principles of operations and applications of different (solid state, gas, liquid and semiconductor) types of Lasers. • **CO3:** Illustrate the techniques for generation of pulsed Laser and applications.
Topics Covered	**Resonator:** Optical beam propagation and resonators, paraxial ray analysis, propagation and properties of Gaussian beam, Fundamental Gaussian beam in a lens like medium-ABCD Law, Gaussian beam focusing, stability of resonators, g parameters, various types of resonators. **[9]** **Different types of lasers:** Gas Lasers, He-Ne, CO_2 lasers. Solid-state laser, Ruby laser, Nd lasers, Ti:sapphire lasers. Liquid laser, Dye laser. Semiconductor lasers etc. **[9]** **Characteristics of laser radiation and techniques for generation of Pulsed Lasers:** Radiometry and measurement of electromagnetic radiation, spatial energy distributions at the laser output, laser beam divergence and focussing capability. Pulsed radiation, special mechanisms for creating pulses, "Q-switching & mode-locking, different methods of Q-switching, mechanisms and their comparison, methods of mode-locking. **[9]** **Laser Applications:** Optical Metrology- Surface profile and dimensional measurements. Laser Microscopy – Digital Holographic microscopy. Laser Spectroscopy- Laser-induced breakdown spectroscopy, Optogalvanic Spectroscopy. Medical Application – Optical coherence tomography. Defensive Application - Holographic weapon sight.**[9]**
Text Books, and/or reference material	**TEXT BOOKS:** 1. O. Svelto, *Principles of Lasers* 2. A Ghatak and K. Thyagarajan, *Optical Electronics, Cambridge University Press (2003)* 3. A Yariv, Quantum Electronics 4. K. Thyagarajan and A Ghatak, *Lasers Fundamentals and Applications* **REFERENCE BOOKS:** 1. W. Koechner, Solid State Laser Engineering 2. J. Wilson and J. F. B. Hawkes, Optoelectronics: An introduction,Prentice Hall of India Pvt. Ltd., 2nd ed.-2004 3. Claude Rulliere (Ed.), Femtosecond Laser Pulse, Principles and Experiments, Springer-Verlag, 1998

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	2
CO2	2	1	3	2	2
CO3	3	1	3	2	2

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th></tr>
<tr><td>PH91XX

PH9112</td><td>ELECTIVE – II

PHYSICS OF NANOMATERIALS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (As per PG regulation)</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">AS PER PG REGULATION</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course the learner shall be able to:
CO1: Describe the importance of studying nanomaterials and how their properties differ from the bulk solids.
CO2: Describe the most common methods for the synthesis of nanomaterials including their merits and demerits over each other.
CO3: Select and use the appropriate characterization technique for measuring specific properties of nanomaterials.
CO4: Describe the basic properties, and synthesis methods of some of the recently discovered carbon nanomaterials.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction to nanomaterials: What are nanomaterials, how their properties are altered from bulk solids, evolution of nanoscience and nanotechnology. [4]
Synthesis of nanomaterials: Classification of different methods of synthesis. Top-down vs. bottom up methods. Mechanical method, planetary ball-mill. Melt mixing. Thermal evaporation, Sputter deposition, physical vapour deposition, laser ablation, Chemical vapour deposition (CVD), Electric Arc deposition, ion-beam deposition, molecular beam epitaxy. Chemical methods - Sol-gel, hydrothermal, self-assembly, etc. [12]
Characterization of nanomaterials: Microscopy: SEM, TEM, STM, AFM. Spectroscopy: UV-Vis, IR, Raman, NMR, XPS, EDX, etc.[12]
Special nanomaterials: Fullerenes, carbon nanotubes, and graphene [6]
Applications of nanomaterials: Sensors, energy, medicines, electronics, and nanocomposites, etc. [4]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS:
1. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay & A. N. Banerjee,
1. Robert W. Kelsall , Ian W. Tlamley, Mark Geoghegan; Nanoscale Science and Technology
2. Graphene, Carbon Nanotubes, and Nanostructures: Techniques and Applications, James E. Morris, Krzysztof Iniewski ,.
1. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Yang Leng

REFERENCE BOOKS:
2. Nanocrystalline Materials- S. C. Tjong</td></tr>
</table>

	3. Handbook of Nanomaterials- Vajtai (editor) 4. Materials Characterization Techniques- Sam Zhang, Lin Li, Ashok Kumar 2. Nanomaterials from Research to Applications- Hoshino & Mishima

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	1	2
CO2	1	2	3	1	3
CO3	2	3	3	3	3
CO4	1	1	3	1	2

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of Contact Hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH91XX **PH9122**	ELECTIVE – II CIRCUIT ANALYSIS AND INTEGRATED CIRCUITS	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (As per PG regulation)					
NIL		AS PER PG REGULATION					

Course Outcomes	On completion of the course the learner shall be able to: **CO1:** Explain the different processes for producing device quality semiconductor materials. **CO2:** Design ADC, DAC, PLL, etc. using discrete electronics components and described their application in communication systems. **CO3:** Describe the working principle of TTL, ECL and MOS logic gets and apply them to design different digital logic circuits. **CO4:** Explain the internal structure of 8085µP and assembly language programming and interfacing.
Topics Covered	**Analysis of networks and systems:** Sample data system z-transforms and Laplace transforms. **[8]** **IC Technology:** Semiconductor material, Crystal growing technology- Czochralski, Epitaxial. **[6]** **Analog Integrated Circuits:** Voltage regulators. DAC and ADC circuits. Differential amplifier, PLL **[6]** **Digital Integrated Circuits:** Logic families -TTL, ECL, MOS; design of combinational and sequential circuits, registers, counters, gate arrays; programmable logic devices, Programmable gate arrays. Memories Sequential and Random access memories; RAM bipolar and MOS static and dynamic memories; programmable memories PROM, EPROM, EEPROM. **[8]** **Microprocessor and their applications:** Architecture of 8 bit (8085) and 16 bit (8086) microprocessors; addressing modes and assembly language programming of 8085 and 8086. 8086 machine cycles and their timing diagrams, and Interfacing. **[8]**
Text Books, and/or reference material	**TEXT BOOKS:** 1. S. M. Sze, Physics of semiconductor devices. 2. A Papoulis, Signal analysis. 3. Gray and Meyer, Analysis and design of analog integrated circuits. 4. R. S. Gaonkar, Microprocessor architecture, programming and applications with 8085/8085A(2nd Ed.) **REFERENCE BOOKS:** 1. J. D. Ryder, Networks lines and fields. 2. F. E. Terman, Electronic and radio engineering. 3. Geiger, Allen and Strader, VLSI design techniques for analog and digital

	circuits. 4. S. Soclof, Applications of analog integrated circuits. 5. A P. Mathur, Microprocessor. 6. D. V. Hall, Microprocessor and interfacing. 7. Liu and Gibson, Microprocessor.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2		
CO2	1	1	2	2	3
CO3	1	2	3	2	3
CO4		2	2	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH91XX **PH9113**	ELECTIVE – III INTRODUCTORY MATERIALS SCIENCE	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (As per PG regulation)					
NIL		AS PER PG REGULATION					

Course Outcomes	• **CO1:** Define and classify different types of materials such as polymers, metals ceramics and their composites based on their most interesting properties • **CO2:** Describe the general methods for the synthesis of different types of materials along with their properties and applications. • **CO3:** Select the appropriate material or material combination that would be required for a specific application as desired by customer/employer/client.
Topics Covered	**Introduction to Materials:** The material world, types of materials, Introduction to metals, ceramics, polymers, composites, semiconductors, their physical properties, and selection. **[3]** **Structural Materials**: Metals and alloys, Ferrous alloys, Steel, the Phase rule and phase diagrams of Fe-C system and common non-ferrous alloys, Eutectic, Eutectoid, Peritectic diagrams, the Lever rule. **[6]** **Polymers**: Types of polymers, polymerizations processes, step polymerizations and addition polymerization, degradation and stabilization of polymers, conducting polymers, common polymers, their properties and applications. **[6]** **Ceramics & glasses:** Types of ceramics, phase diagrams of common ceramic alloys, properties of common ceramics & glasses, their common applications. **[5]** **Composites:** Types of composites, conventional composites, fiber reinforced composites, nanocomposites, property averaging by Rule of Mixture, isostress&isostrain loading, Interfacial strength, mechanism of reinforcement. [**5]** **Electrical Materials**: Conductors, Conductivity and its temperature dependency, semiconductors, Superconductors.**[3]** **Magnetic Materials**: Dia-, Para-, Ferro-, Antiferro- and Ferimagnetic materials and their characteristics, Curie Temperature, Hysteresis, Common magnetic materials and their applications. **[4]** **Optical Materials**: Optical properties, color, luminescence, reflectivity, transparency, opacity, etc., optical systems and devices, Laser materials, optical fibers, liquid crystal displays, photoconductors. [**4]**
Text Books, and/or reference material	**TEXT BOOKS:** 1. J. F. Shackelford, M. K. Muralidhara, *Introduction to Materials Science for Engineers* 2. R. Balasubramaniam, *Callister's Materials Science & Engineering* 3. W.F. Smith, J. Hashemi, R. Prakash, *Materials Science & Engineering*

	4. A. K. Bhargava, *Engineering Materials* **REFERENCE BOOKS:** 1. Rolf E. Hummel, *Understanding Materials Science : History, Properties, Applications* 2. John Martin, *Materials for Engineering* 3. J. Simmons, K Potter, *Optical Materials* 4. Fuxi Gan, *Laser Materials*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	1	1
CO2	1	1	3	2	2
CO3	1	1	2	1	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of Contact Hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH91XX **PH9123**	ELECTIVE – III NONLINEAR OPTICS	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (As per PG regulation)					
NIL		AS PER PG REGULATION					
Course Outcomes	On completion of the course the learner shall be able to: • **CO1:** Acquire basic knowledge of nonlinear optical phenomenon. • **CO2:** Derive the expression of phase-matching angle for efficient generation of radiations by using different three-wave frequency mixing and phase-matching techniques. • **CO3:** Describe the principles for generation of ultrafast laser radiation by non-collinear optical parametric amplification technique and apply the principles of $X^{(3)}$ based techniques (namely, self-focusing, four-wave mixing, optical bistability and optical phase conjugation) to solve some real-life problems.						
Topics Covered	**Introduction to Nonlinear optics:** Descriptions of nonlinear optical interactions, nonlinear susceptibility, classical anharmonic oscillator, Miller's rule, coupled-wave equation, sum-frequency mixing, difference-frequency generation, and parametric amplification, Manley-Rowe relations. [7] **Phase-matchingTechniques**: Birefringence phase-matching, noncollinear phase-matching, noncritical phase-matching, tangential phase-matching, and quasi phase-matching techniques etc. [6] **Nonlinear optical interactions with focused Gaussian beams:** Second harmonic generation, conversion efficiency and parameters affecting doubling efficiency etc. Up conversion and down conversion: Sum-frequency mixing, limitation to up conversion, introductory theory, infrared detection, effects of phase-matching, image conversion. [7] **Nonlinear optical materials:** Organic, inorganic, and chalcopyrite materials and their linear and different nonlinear optical properties. [4] **Ultrafast phenomena (introductory):** Short pulsed laser, Ti:sapphire laser etc., different techniques and principles for the generation of ultrafast laser radiation by Non-collinear Optical parametric amplification technique, magic phase-matching condition. [6] **Higher order Nonlinear Optical Effects:** Nonlinear optical effects due to the third and higher order nonlinear susceptibility, Self-focusing, Self-defocusing effects, Critical intensity for waveguide like pulse generation, Four-wave mixing, Optical Phase Conjugation, Applications of nonlinear optical effects in designing logic gates etc. [6]						

Text Books, and/or reference material	**TEXT BOOKS:** 1. Y. R. Shen, The principles of Nonlinear Optics, Wiley, New York, 1984. 2. R. W. Boyd, Nonlinear Optics Academic Press Inc. 3. F. Zernike and J. E. Midwinter, Applied Nonlinear Optics, Wiley, New York, 1973. **REFERENCE BOOKS:** 1. Edited by C. L. Tang, Methods of Experimental Physics, vol. 15, Quantum Electronics, Part-B A Yariv and P. Yeh, Optical waves in crystals. 2. Femtosecond Laser Pulse, Principles and Experiments, Claude Rulliere (Ed.), Springer-Verlag, 1998 3. V. G. Dmitriev, G. G. Gurzadyan, and D. N. Nikogosyan, Handbook of Nonlinear Optical Crystals, 2nd ed. (Springer-Verlag, Berlin, 1997) 4. M. Born and Wolf, Principles of Optics, 6 th ed. (Pergamon press, Oxford 1980).

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	1	1
CO2	3	2	3	2	2
CO3	3	2	3	3	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th colspan="9">Department of Physics</th></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2" colspan="2">Title of the course</th><th rowspan="2">Program Core (PCR)/ Electives</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th></tr>
<tr><td>PH91XX

PH9114</td><td colspan="2">ELECTIVE – IV

X- RAYS IN CONDENSED MATTER PHYSICS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="6">Course Assessment methods (As per PG regulation)</td></tr>
<tr><td colspan="3">NIL</td><td colspan="6">AS PER PG REGULATION</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On completion of the course the learner shall be able to:
CO1: Demonstrate knowledge on X-ray diffraction techniques for characterizing materials (crystalline, amorphous, quasi-crystalline, polymer, nanomaterials).
CO2: List different techniques for extracting quantitative information about material structures by x-ray diffraction.
CO3: Develop an understanding of the theory of X-ray diffraction and to employ it to study novel material structures.</td></tr>
<tr><td>Topics Covered</td><td colspan="8">Topic-1: Discovery and importance of X-rays, X-ray production, origin of Halo and characteristic spectra, Fine structure of X-ray spectra, Short Wave length limit, Bremsstrahlung and Auger effect, Absorption of X-ray, Absorption edges, Filtering and monochromatization of X-ray radiation, Detection of X-rays; Photographic Techniques, X-ray counters. [8]

Topic-2: X-ray Diffraction, Bragg's Law,, diffraction directions, Diffraction methods; Comparison between Optical, X-ray diffraction, Electron diffraction, and Neutron diffraction techniques for structural analysis, Kinematical theory of X-ray diffraction. Scattering of X-rays by an independent electron. Thomson scattering expression, Scattering by an atom and atomic scattering factor, Systematic diffraction from different Bravais Lattices and their identification, diffraction pattern from liquids and amorphous solids,crystal structure factor [8]

Topic-3 : Rietveld refinement technique for the defect analysis in crystalline materials, Dynamical theory of X-ray diffraction and its application in large perfect crystals, Low angle scattering technique and the application in the study of fibre materials. [6]

Topic-4: X-Ray Diffraction methods (Single & Polycrystalline): Laue method, rotating crystal method, Cameras, X-Ray Diffractometer, Wavelength dispersive and energy dispersive analyses, Debye Scherrer method, Williamson-Hall method, Measurement of crystal size, crystal structure, lattice parameter, Details of sample preparation. [8]

Topic 5: X-Ray spectroscopies: X-ray photoelectron spectroscopy, X-ray fluorescence, X-ray absorption Spectroscopy, X-ray Emission spectroscopy, Synchrotron based X-ray absorption fine structure analysis (XANES).[8]</td></tr>
</table>

Text Books, and/or reference material	**TEXT BOOKS:** 1. M. M. Woolfson, *An introduction to X-ray crystallography* 2. L. V. Azaroff, *Elements of X-ray crystallography* 3. S. K. Chatterjee, *X-ray diffraction its theory and applications* 4. B. K. Agarwal, X-Ray Spectroscopy: An Introduction, Springer **REFERENCE BOOKS:** 1. M. J. Burger, *X-ray crystallography* 2. B. D. Cullity, *X-ray diffraction* 3. H. P. Klug and L. E. Alexander, *X-ray diffraction procedure* 4. C. Bonnelle and, C. Mande (Editors), Advances in X-ray Spectroscopy

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	3
CO2	3	1	2	2	3
CO3	3	1	3	1	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Physics								
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PH91XX **PH9124**	ELECTIVE – IV COMMUNICATION TECHNOLOGY	PCR	2	1	0	3	3

Pre-requisites	Course Assessment methods (As per PG regulation)
NIL	AS PER PG REGULATION

Course Outcomes	On completion of the course the learner shall be able to: **CO1:** Explain signal processing for different communication systems. **CO2:** Describe the working principle of mobile, radar and colour TV. **CO3:** Describe different types of computer network and their merits and demerits. **CO4:** Learn signal and data communication in optical communication system and quantitatively measure the signal losses.
Topics Covered	**Digital Modulation Techniques:** ASK, FSK, PSK, Principle, modulators and demodulators. **[4]** **TV Systems:** Color TV standards - NTSC, PAL. Transmission format of intensity and color signal. Transmitter and receiver systems of broadcast TV, Advanced TV, Cable TV. **[5]** **RADAR System:** Basic pulsed radar system-modulators, duplexer, CW radar, MTI radar. **[4]** **Mobile Communication:** Concepts of cell and frequency reuse description of cellular communication standards, Trans-receiver, Introduction to Satellite Communication, transponders. **[4]** **Computer communication:** Types of networks- Circuit message and packet switched networks, Features of network, Design and examples ARPANET, LAN, ISDN, Medium access techniques- TDMA, FDMA, ALOHA, Slotted ALOHA, Basics of protocol. **[7]** **Fiber optic communication systems:** Optical signal propagation in waveguide, signal losses and dispersion. Power budget equation, WDM and DWDM Multiplexing, optical communication systems and related devices. Incoherent reception, Signal-to-noise ratio, Basics of coherent techniques in FOC. **[12]**
Text Books, and/or reference material	**TEXT BOOKS:** 1. R Roddy and J Coolen, *Electronic communication* 2. Gulati, *Monochrome and color TV* 3. Taub and Schilling, *Principle of communication systems* **REFERENCE BOOKS:** *1.* A B Carlson, *Communication systems* 2. Kennedy and Davis, *Electronic communication systems* *3.* A Dhake, *Television and video engineering* 4. J M Senior, *Optical fiber communications principles and practice*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5
CO1	1		2		
CO2	1	1	2		
CO3		2	2	2	2
CO4			3	2	3

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)