Preamble

Physics has been evolving for the last three centuries and has answered some of the oldest and most profound questions asked by human beings. The laws of physics are applicable from the largest of the entities of this universe to the smallest of particles known. Physical science spans theory and application and it requires thinking both in abstract terms and concrete terms. The recent technological advances that have given us mobiles, laptops, air conditioners, etc. are based on physics.

The NEP-2020 is based on the principle that education must develop not only cognitive capacities - both the 'foundational capacities' of literacy and numeracy and 'higher-order' cognitive capacities, such as critical thinking and problem solving – but also social, ethical, and emotional capacities and dispositions. In a broader way, NEP envisions an education system rooted in Indian ethos that contributes directly to transforming India that is Bharat, sustainably into an equitable and vibrant knowledge society, by providing high-quality education to all, thereby making India a global knowledge superpower.

The Department of Physics offers the certificate, diploma, undergraduate B.Sc. (Honors) Physics program, and B.Sc. Physics program as well as general elective courses in Physics for students of Honors programs in disciplines other than Physics. The courses offered are aimed at undergraduate level training facilitating multiple career paths. Students who graduated can take up Ph.D. programs in Physics leading to research as well as R&D can be employable in industries or can pursue a teaching profession. B.Sc. and B.Sc. (Honors) aim at laying a strong foundation in physics at an early stage of their career. There are several employment opportunities after the successful completion of their course. Graduating students can fetch employment directly in companies as physicists, scientists, Lab assistants, scientific assistant, Research Associates, Subject Matter Experts, and Technicians. In addition to this graduates can also pursue their carrier as an Academic counselor and physics faculty.

Four Year Undergraduate Programme (FYUGP)~~/ Five Year Integrated Master Programme (FYIMP)~~- Program Objectives:

1. To develop an understanding and knowledge of the basic theory of Electricity and Magnetism, Mechanics, Electrodynamics, etc., and its applications using Electronics, Quantum Mechanics, etc.
2. To develop the ability to use this knowledge to analyze new situations in the application domain.
3. To acquire necessary and state-of-the-art skills to take up industry challenges. The objectives and outcomes are carefully designed to suit the above-mentioned purpose.
4. The ability to synthesize the acquired knowledge, understanding, and experience for a better and improved comprehension of real-life problems.
5. To learn skills and tools like mathematics, statistics, and electronics to find the solution, interpret the results and make predictions for future developments.
6. To formulate, model, design solutions, procedure and use software tools to solve real-world problems.

(Four Year Undergraduate Programme (FYUGP)~~/ Five Year Integrated Master Programme (FYIMP)~~ - PROGRAM SPECIFIC OUTCOMES

Upon completion of the undergraduate honors degree program in Physics at the Department of Physics, students will be able to:

1. Demonstrate a systematic and coherent understanding of basic Physics including the concepts, theories and relevant experimental techniques in the domains of Mechanics, Electricity and Magnetism, Waves and Optics, Thermal Physics, Quantum Mechanics, Statistical Mechanics, Mathematical Physics and their applications in other areas of Physics;
2. Demonstrate the ability to relate their understanding of physics to other sciences and hence orient their knowledge and work towards multi-disciplinary/inter-disciplinary contexts and problems
3. Demonstrate both an understanding and the practical application of ethical standards as well as scientific temperament in public and private life.
4. Demonstrate the ability to read, understand, and critically analyze the physical ideas presented in published textbooks and science magazines at the undergraduate level.

5. Demonstrate skills in areas of specializations of their elective subfields so that they can continue with higher studies and can relate their knowledge to current developments in those subfields.

Schematic Curriculum Framework For 4 years UG –Science Course as per Curriculum and Credit Framework (December-2022)

Semester	Disciplinary/Interdisciplinary Core Courses (Major) (88 Credit)	Disciplinary/Inter disciplinary (Minor) (38 credit)	Multi/Inter disciplinary courses –GE/OE (9 credit)	Ability Enhancement (8 credit)	Skill Enhancement (9 credit)+16	Common Value added (08)	Credits 176
I	MJC/DSC-1 (3) MJC/DSC-2 (3)	MNC/DSE-1 (3) **For:** **Other Department**	MDC-1 (3) **From:** From Other Departments (School) with multidisciplinary approach IC2 (**For Science-IC2, For Humanities & SS-IC1**) (3)	AEC1-English Communication (2) AEC2-Hindi /(MIL) Communication (2)	SEC1-Fundamentals of Computer (3)	VAC-1 (3) Water Harvesting/Other subjects from the basket	22
II	MJC/DSC-3 (3) MJC/DSC-4 (3)	MNC/DSE-2 (3)	MDC-2 (3)	AEC3-English Grammar & Literature (2) AEC4-Hindi Grammar & Literature /(MIL) Communication (2)	SEC2-AI/IT/AOT + Field Studies and Practices (3)	VAC-2 (3) NSS/NCC/Sports/Fitness/ES/Other subjects from the basket	22
III	MJC/DSC-5 (4) MJC/DSC-6 (4) Lab (2)	MNC/DSE- 3 (4)	MDC-3 (3) From Other Departments (School) with multidisciplinary approach (3)	--	SEC3- (3)	VAC-3 (2) Understanding India (2)	22
IV	MJC/DSC-7 (4) MJC/DSC-8 (4) MJC/DSC-9 (4)	MNC/DSE- 4 (4) Lab (2)			Summer Internship (2) (Minor)		22

	Lab (2)						
V	MJC/DSC-10(4) MJC/DSC-11(4) MJC/DSC-12 (4) Lab (2)	MNC/DSE- 5 (4) MNC/DSE- 6 (4)					22
VI	MJC/DSC-13 (4) MJC/DSC-14 (4) MJC/DSC-15 (4) Lab (2)	MNC/DSE- 6 (4) Lab (2)			Internship (2) (Major)		22
Credits	**64**	**30**	**09**	**08**	**13**	**8**	**132**

VII	MJC/DSC-16 (4) MJC/DSC-17 (4) MJC/DSC-18 (4) Lab (2)	MNC/DSE-7 (4) MNC/DSC-8 (4)					22
VIII	MJC/DSC-19 (4) MJC/DSC-20 (4) Lab (2)				Project Work (12)		22
Credit	**88**	**38**	**09**	**08**	**09+16=25**	**08**	**176**

BASKET OF MINOR SUBJECTS (May Add More by Departments)

NATURAL SCIENCES

S.N.	Major	Introductorv Subject/ Minor
1	Botany	Chemistry
		Geology
		Zoology
		Economics
		Geography
		Env. Sciences
	Zoology	Chemistry
		Geology
		Botany
		Economics
		Geography
		Microbiology

S.N.	Major	Introductory Subject/ Minor
2	Chemistry	Botany
		Mathematics
		Physics
		Geology
		Zoology
		Economics

S.N.	Major	Introductory Subject/ Minor
3	Mathematics	Chemistry
		Physics
		Geology
		Statistics
		Economics
		Commerce

S.N.	Major	Introductory Subject/ Minor
	Physics	Chemistry
		Mathematics
		Economics

4		Geography–

S.N.	Major	Introductory SubjecU Minor
5	Geology	Botany
		Chemistry
		Mathematics
		Physics
		Zoology
		Anthropology
		Economics
		Geography

S.N.	Major	Introductory SubjecU Minor
6	Environmental Sciences	Botany/Plant Science
		Chemistry
		Mathematics
		Physics
		Zoology/Life Science
		Biochemistry
		Geography
		Computer Science

S.N.	Major	Introductory SubjecU Minor
7	Statistics	Mathematics
		Economics
		Geography
		History
		Political Science
		Commerce

LIST OF VAC (Either 2/3 credits depends upon BoS recommendation)

Sl. No.	Course Title	Course Code	Total Credits
1	NSS		02
2	NCC		02
3	Ek Bharat ShresthaBharat		02
4	Environmental Ethics		02
5	Basic of Environmental Audits		02
6	E- waste management		02
7	Solid waste management		02
8	Non-violence and world peace		02
9	Digital marketing		02

10	Exercise, beauty & well ness		02
11	Personality development		02
12	News reporting and anchoring		02
13	Interpersonal skill development		02
14	Soft skills		02
15	Cyber security		02
16	Documentary film making		02
17	Financial literacy		02
18	Banking services & Insurance		02
19	Art of living and spiritualism		02
20	IPR		02
21	Women empowerment		02
22	Local dance (Chhau/Nagpuri/etc.)		02
23	Event management		02
24	Stress management		02
25	Web designing		02
26	Web development		02
27	Mobile app development		02
28	Tally accounting		02
29	Office automation		02
30	Data analysis		02
31	Basics of big data		02
32	Introduction to cloud computing		02
33	IoT(Basics only)		02
34	Creative writing		02
35	Value of games & sports		02
36	First Aid in Day to day Life		02
37	Floriculture and landscaping		02
38	Corrective rehabilitation		02
39	Constitutional Values and Fundamental Duties		02
40	Culture and Communication		02
41	Digital Empowerment		02
42	Emotional Intelligence		02
43	Yoga: Philosophy and Practice		02

44	Vedic Mathematics-I		02
45	The Art of Being Happy		02
46	Swachh Bharat		02
47	Sports for Life-I		02
48	Social and Emotional Learning		02
49	Reading Indian Fiction in English		02
50	Environmental and Society		02
51	National Cadet Corps-I		02
52	Ecology and Literature		02
53	Gandhi and Education		02
54	Ethics and Values in Ancient Indian Traditions		02
55	Fit India		02
56	Financial Literacy		02
57	Ethics and Culture		02
58	Environment and Society		02

Courses under Value Added, Summer Internship/ Apprenticeship/ Communityoutreach activities, etc., for all majors, may be of 2-credits or as appropriate

Courses from Other Disciplines (Multidisciplinary) (9 credits):

All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines given below. These courses are intended to broaden the intellectual experience and form part of liberal arts and science education. Students are not allowedto choose or repeat courses already undergone at the higher secondary level (12^{th} class)in the proposed major and minor stream under this category.

i. ***Natural and Physical Sciences:***
Biology
Botany
Zoology
Biotechnology
Biochemistry
Chemistry
Physics
Biophysics
Astronomy andAstrophysics
Earth and Environmental Sciences, etc.

ii. ***Mathematics, Statistics, and Computer Applications:*** Courses under this category will facilitate the students to use and apply tools and techniques in their major and minor disciplines. The course may include training in programming software like Python among others and applications software like STATA, SPSS, Tally, etc. Basic courses under this category will be helpful for science and social science in data analysis and the application of quantitative tools.

iii. **Library, Information, and Media Sciences:** Courses from this category will help the students to understand the recent developments in information and media science (journalism, mass media, and communication)

iv. ***Commerce and Management:*** Courses include

Business Management
Accountancy
Finance
Financial Institutions
Fintech, etc.,

v. ***Humanities and Social Sciences:*** The courses relating to Social Sciences:

Anthropology
Communication and Media
Economics
History
Linguistics
Political Science
Psychology
Social Work
Sociology, etc. will enable students to understand the individuals and their social behaviour, society, and nation. Students be introduced to survey methodology and available large-scale databases for India.

vi. The courses under humanities include

Archaeology
History
Comparative Literature
Arts & Creative expressions

Creative Writing and Literature,

Language(s)

Philosophy, etc. and interdisciplinarycourses relating to humanities.

vii. Interdisciplinarysubjects

Cognitive Science
Environmental Science
Gender Studies
Global Environment & Health
International Relations,
Political Economy and Development
Sustainable Development
Women's and Gender Studies, etc.

Semester	Disciplinary/Interdisciplinary Core Courses (Major) (80 Credit)	Disciplinary/Inter disciplinary (Minor) (32 credit)	Multi/Inter disciplinary courses (9 credit)	Ability Enhancement (8 credit)	Skill Enhancement (9 credit)	Common Value added (06-08)	Credits 144+16
I	**One IC1 for Science:** (EAS/IB/CEL) course related to their discipline may be adjusted herewith **One IC1 for Social Science/Humanities:** (UIC/UAIC/POE/PHR)	For Other Departments/ other specializations (**For Science-IC1, For Humanities & SS-IC2**) – (3)	From Other Departments (School) with multidisciplinary approach IC2 (**For Science-IC2, For Humanities & SS-IC1**) (3)	AEC1-English Communication (2) AEC2-Hindi /(MIL) Communication (2)	SEC1-Fundamentals of Computer (3)	Water Harvesting/FE/FNF/UM) (3) NSS/NCC/Sports/Fitness (3)	22

Credit Adjustment for the 1st Semester of Nov'22-March'23 Session as per Curriculum and Credit Framework (December-2022)

Proposed Credit Distribution to Award Degree under Each Category

S.No.	Broad Category of Course	As per UGC Minimum Credit Requirement		Proposed Credit distribution (CUJ)	
		3-year UG	4-Year UG	3-year UG	4-Year UG
1	Major (Core)- MJC/DSC	60	80	64	88
2	Minor Stream- MNC/DSE	24	32	30	38
3	Multidisciplinary-GE/OE	09	09	09	09
4	Ability Enhancement Courses (AEC)	08	08	08	08
5	Skill Enhancement Courses (SEC)	09	09	09	09
6	Value Added Courses common for all UG- VAC	06 - 08	06 – 08	08	08
7	Summer Internship	02 - 04	02 – 04	04	04
8	Research Project / Dissertation	-	12	-	12
	Total	120	160	132	176

Note:* Honours students’ not undertaking research will do 3 courses for 12 credits in lieuof a research project / Dissertation

Semester- I

1)	**Type of the Course**	Disciplinary Core Course (Major-1)
2)	**Name of the Course**	Mechanics
3)	**Course Code**	PHY01101
4)	**Total Credit**	L-T-P=4-0-0 = 4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This subject aims to introduce some of the basic properties of one-dimensional motion and the dependence of force on position, velocity, and time. It is designed to teach the important concepts of two-dimensional motion like that of projectile motion and three important properties of matter.
8)	**Programme/course Objectives**	This course aims to provide students with a comprehensive understanding of matter and its basic properties. Students will learn about the gravitation, special theory of relativity, etc..
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to- □ Understand the basic concepts of units and measurements, momentum, and energy. □ Describe the concepts of the special theory of relativity, laws of motion, and dynamics of rigid bodies. □ Learn about the elasticity, surface tension, gravitation, and viscosity. □ Apply the equation of motion to one or two dimensions of the system in order to understand the kinematics of the body under the various conditions of applied force.
10)	**Who can attend /course audience**	This course is suitable for students from physics background.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	

(i)	**Unit-I**	**Units and measurements:** System of units (CGS and SI), measurement of length, mass and time, dimensions of physical quantities, dimensional formulae. Minimum deviation, errors. **Momentum and Energy**: Work and energy, Conservation of momentum (linear). Conservation of energy with examples. Motion of rockets.
(ii)	**Unit-II**	**Laws of Motion:** Newton's Laws of motion. Dynamics of single and a system of particles. Centre of mass **Dynamics of Rigid bodies**: Rotational motion about an axis, Relation between torque and angular momentum, Rotational energy. Moment of inertia: M I of a rectangular Lamina and solid cylinders. Flywheel, Theory of compound pendulum and determination of g.
(iii)	**Unit-III**	**Special Theory of Relativity:** Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.
14)	**Text Books and References:**	
(i)	Properties of Matter by Brijlal & Subramanyam	
(ii)	Mechanics Berkeley Physics Course, Vol.1: Charles Kittel, *et.al*. Tata McGraw-Hill 2007	
(iii)	Mechanics by, New Edition, D. S. Mathur, S.Chand & Co., 2000	
(iv)	Mechanics and Relativity by 3rd Edition, Vidwan Singh Soni, PHI Learning Pvt. Ltd.	

1)	**Type of the Course**	Disciplinary Core Course (Major-2)
2)	**Name of the Course**	General Properties of Matter
3)	**Course Code**	PHY01103
4)	**Total Credit**	L-T-P=4-0-0 = 4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This subject aims to introduce some of the basic properties of one-dimensional motion and the dependence of force on position, velocity, and time. It is designed to teach the important concepts of two-dimensional motion like that of projectile motion and three important properties of matter.

8)	**Programme/course Objectives**	This course aims to provide students with a comprehensive understanding of matter and its basic properties. Students will learn about the gravitation, special theory of relativity, and will learn about properties of matter, like viscosity, surface tension etc..
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to- - Understand the basic concepts of units and measurements, momentum, and energy. - Describe the concepts of the special theory of relativity, laws of motion, and dynamics of rigid bodies. - Learn about the elasticity, surface tension, gravitation, and viscosity. - Apply the equation of motion to one or two dimensions of the system in order to understand the kinematics of the body under the various conditions of applied force. - Apply knowledge in understanding the flow of liquid and surface tension applied on the surface of the liquid.
10)	**Who can attend /course audience**	This course is suitable for students from physics background.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Gravitation:** Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's laws (statements). Satellite in a circular orbit.
(ii)	**Unit-II**	**Elasticity:** Hooke's law - Stress-strain diagram, elastic moduli-relation between elastic constants, Poisson's Ratio-expression for Poisson's ratio in terms of elastic constants. Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder. Torsional pendulum-Determination of rigidity modulus and moment of inertia - q, η and σ by Searle's method.
(iii)	**Unit-III**	**Surface tension:** Definition of surface tension. Surface energy, relation between surface tension and surface energy, pressure difference across curved surface example, excess pressure inside spherical liquid drop, angle of contact. **Viscosity:** Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poisulle's method, Stoke's

		method.
14)	**Text Books and References:**	
(i)	Mechanics Berkeley Physics Course, Vol.1: Charles Kittel, *et.al*. Tata McGraw-Hill 2007	
(ii)	Mechanics by, New Edition, D. S. Mathur, S.Chand & Co., 2000	
(iii)	General properties of matter by Newman and Searle	
(iv)	General properties of matter by Chatterjee and Sengupta	

Semester- II

1)	**Type of the Course**	Disciplinary Core Course (Major Course-3)
2)	**Name of the Course**	Waves and Oscillations
3)	**Course Code**	PHY01102
4)	**Total Credit**	L-T-P=4-0-0 = 4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This is basic physics course which is intended to give an overview of Waves and Oscillations. After taking this course, students will gain knowledge about vibrations, waves, transverse vibrations in stretched string, Doppler effect and ultrasonics and to be able to apply this knowledge to solve certain typical problems in physics.
8)	**Programme/course Objectives**	In this course students would be able to understand the topics that make the basis of Physics of Waves and Oscillations such as Linear harmonic oscillator, damped harmonic oscillator, generation of harmonics, dispersion in wave propagation, Velocity of acoustic waves in isotropic solids, liquids and gas, Basic principles of generation and detection of ultrasonic waves.

9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to- • Understand the Linear harmonic oscillator, damped harmonic oscillator, generation of harmonics, dispersion in wave propagation and its application. • Explain and apply the Linear equation of plane progressive wave motion in one, two and three dimension, expression for Doppler shift in frequency to solve various problems in physics. • Understand the Basic principles of generation and detection of ultrasonic waves.
10)	**Who can attend /course audience**	This course is suitable for students of 2nd semester with physics major.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Vibrations** Linear harmonic oscillator- differential equation and its solution, free and forced vibrations of a damped harmonic oscillator, resonance, sharpness of resonance. A pair of linearly coupled oscillators, eigen frequencies and normal modes, Lissajous figures, vibrations of a weakly an harmonic oscillator-generation of harmonics, frequency shift, basic principle underlying the production of combination tones.
(ii)	**Unit-II**	**Waves** Linear equation of plane progressive wave motion in one, two and three dimension, plane wave and spherical wave solution, intensity of a plane Progressive wave , dispersion in wave propagation-group velocity and phase velocity.
(iii)	**Unit-III**	**Transverse vibrations in stretched string** Wave equation in the linear approximation, eigen frequencies and eigen modes for plucked and struck strings, energy of transverse vibrations, bowed strings. Velocity of acoustic waves in isotropic solids, liquids and gases. Derivation of the respective expressions with explanation of the approximations made.
(iv)	**Unit-IV**	**Doppler effect and Ultrasonics** Derivation of expression for Doppler shift in frequency, Basic principles

		of generation and detection of ultrasonic waves.
14)	**Text Books and References:**	
(i)	Advanced Acoustics by D P Raychoudhury	
(ii)	Waves and oscillations , Berkeley Physics course	
(iii)	Waves and Oscillation by H G Pane	

1)	**Type of the Course**	Disciplinary Core Course (Major Course -4)
2)	**Name of the Course**	Vector Calculus
3)	**Course Code**	PHY01104
4)	**Total Credit**	L-T-P=4-0-0 = 4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This is basic physics course which is intended to give an overview of Vector Calculus. After taking this course, students will gain knowledge about vectors and scalars, differentiation and integration of vector, tensors, and curvilinear coordinate system and to be able to apply this knowledge to solve certain typical problems in physics.
8)	**Programme/course Objectives**	• In this course students would be able to understand the topics that make the basis of Mathematical Physics such as Vector differentiation and integration, gradient, divergence, curl and curvilinear coordinate system.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be

		able to- • Understand the Vector differentiation and integration and its application. • Explain and apply the Gauss divergence theorem, stokes theorem and greens theorem to solve various problem in physics. • Understand the Basic idea of curvilinear coordinate system
10)	**Who can attend /course audience**	This course is suitable for students of 2nd semester with physics major.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Vectors and Scalars** Vectors algebra, unit vectors, rectangular unit vectors i, j, k, linear dependence and linear independence, scalar field, vector field, vector addition, scalar multiplication.
(ii)	**Unit-II**	**Vector Differentiation and Integration** Transformation properties of vectors, scalar and vector products, differentiation and integration of vectors, concept of tensors, line integral, volume and surface integrals involving vector fields
(iii)	**Unit-III**	**Divergence Theorem, Stokes Theorem and Related Integral Theorems** Gradient, divergence and curl of a vector field and their physical interpretations, Gauss divergence theorem, Stokes theorem, green's theorem-applications.
(iv)	**Unit-IV**	**Curvilinear Coordinates** Orthogonal curvilinear coordinate systems, unit vectors in such systems, illustration by spherical and cylindrical polar coordinates. Gradient, divergence and curl in cylindrical and spherical polar Coordinate systems, basic identities involving gradient, divergence and curl. Application of vector calculus to various physical problems.
14)	**Text Books and References:**	
(i)	Vector Analysis by Murray R. Spiegel, Seymour Lipschutz and Dennis Spellman, 2nd Edition (2009), Tata McGraw Hill Education private Limited, New Delhi	
(ii)	Mathematical methods for physicists by Arfken and Weber.	

Semester- III

1)	**Type of the Course**	Disciplinary Core Course (Major Course -5)
2)	**Name of the Course**	Heat and Thermodynamics
3)	**Course Code**	PHY01201
4)	**Total Credit**	L-T-P=4-0-0 = 4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This is basic physics course which is intended to give an overview of Vector Calculus. After taking this course, students will gain knowledge about vectors and scalars, differentiation and integration of vector, tensors, and curvilinear coordinate system and to be able to apply this knowledge to solve certain typical problems in physics.
8)	**Programme/course Objectives**	• In this course students would be able to understand the topics that make the basis of Mathematical Physics such as Vector differentiation and integration, gradient, divergence, curl and curvilinear coordinate system.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to- • Understand the Vector differentiation and integration and its application. • Explain and apply the Gauss divergence theorem, stokes theorem and greens theorem to solve various problem in physics. • Understand the Basic idea of curvilinear coordinate system

10)	**Who can attend /course audience**	This course is suitable for students of 3rd semester with physics major.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Thermodynamics: Microscopic vs. macroscopic view, Thermodynamic equilibrium, Work, Heat and 1sr law of thermodynamics, Reversible, Irreversible and quasi-static process, Second law, Carnot's cycle and Carnot's theorem, Thermodynamic scale of. Temperature, Entropy, T-S diagram, TdS equations, Heat engines, Refrigerators, Thermodynamic functions, Internal energy, Enthalpy, Helmholtz function and Gibb's free energy, Maxwell's thermodynamic equations and their applications, Nernst heat theorem, Third law of thermodynamics.
(ii)	**Unit-II**	Kinetic Theory: Basic concepts, Maxwell distribution, Equation of state, der Waals equation,Brownian motion. Radiation: The blackbody spectrum, Wien's displacement law, Rayl Jean's law, Planck's quantum theory of radiation.
(iii)	**Unit-III**	Gradient, divergence and curl of a vector field and their physical interpretations, Gauss divergence theorem, Stokes theorem, green's theorem-applications.
(iv)	**Unit-IV**	Viscosity, thermal conduction and diffusion in gases, Brownian mo Einstein's theory, Perrin's work determination of Avogadro number. Nature of intermolecular interaction, isotherms of real gases, van der-Waa Equation of state, olther equations of state, critical constants of a gas, law of corresponding states, virial coefficients, Boyle temperature, limitations of van der-Waal's equation of state.
14)	**Text Books and References:**	
(i)	Heat and Thermodynamics: K.W. Zeemansky	
(ii)	Heat and Thermodynamics: BrijLal and N. Subramanyam	
(iii)	A Treatise on Heat: M.N. Saha and B.N. Srivastava.	
(iv)	Feynman Lectures first volume	

(v)	Thermal Physics: B.K. Agarwal

1)	**Type of the Course**	Disciplinary Core Course (Major Course -4)
2)	**Name of the Course**	**OPTICS**
3)	**Course Code**	PHY01203
4)	**Total Credit**	L-T-P=4-0-0 = 4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This is basic physics course which is intended to give an overview of Vector Calculus. After taking this course, students will gain knowledge about vectors and scalars, differentiation and integration of vector, tensors, and curvilinear coordinate system and to be able to apply this knowledge to solve certain typical problems in physics.
8)	**Programme/course Objectives**	• In this course students would be able to understand the topics that make the basis of Mathematical Physics such as Vector differentiation and integration, gradient, divergence, curl and curvilinear coordinate system.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to- • Understand the Vector differentiation and integration and its application. • Explain and apply the Gauss divergence theorem, stokes theorem and greens theorem to solve various problem in physics. • Understand the Basic idea of curvilinear coordinate system
10)	**Who can attend /course audience**	This course is suitable for students of 3rd semester with physics major.

11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Interference: Wavepropagation,1-0and3Ddimensional wave equations, Sinusoidal waves, Phase and Group velocities; Superposition of waves, Interference by division of wavefront, Concept of spatial and temporal coherence; Interference by division of wavefront: Fresnel Biprism, Interference by division of amplitude: Anti-reflecting films; Colour of thin films; Newton's rings; Michelson interferometer. Fabry Perot interferometer, Resolution and Free spectral range
(ii)	**Unit-II**	Diffraction: Fraunhofer diffraction: diffraction by a single slit, double circular aperture; Resolving power of microscopes and telescopes; Diffra grating, Resolving power and Dispersive power, Fressnel diffraction: plate, diffraction due to straight edge
(iii)	**Unit-III**	Polarization: Concept of linear, circular and elliptical polarizations; Brewster's law and Malus's law; Double refraction by crystals; Interference of polarized light, half wave and quarter wave plates; Analysis of polarized light; Kerr effect, Pockel's effect, Faraday effect, Fermat's Principle, Ray equation and its solution
14)	**Text Books and References:**	
(i)	Physical Optics: B.K.Mathur and T.P. Pandya.	
(ii)	A Textbook of Optics: N. Subrahmanyam, Brijlal and M.N.Avadhanulu	
(iii)	Geometrical and Physical Optics: Longhurst.	
(iv)	Optics: Ajoy K. Ghatak	
(v)	Optics:P.K. Srivastav	

List of Experiments to be performed in the Laboratory (Credits 2)

1.	Experiments on tracing of electric and magnetic flux lines for standard configuration.
2.	Determination of components of earth's magnetic field using a Ballistic galvanometer.
3.	Determination of capacitance of a condenser using B.G.
4.	Determination of high resistance by leakage using B.G.
5.	Determination of mutual inductance using BG.
6.	Charging and discharging of a capacitor (energy dissipated during charging and time constant measurements.
7.	Series and parallel resonance circuits (LCR circuits).
8.	Impedance of series RC circuits- determination of frequency of AC.
9.	Study the characteristics of a series RC and RL Circuit.
10.	Determination of self-inductance of a coil.
11.	Verification of laws of combination of capacitances and determination of unknown capacitance using de - Sauty bridge.
12.	Determination of B_H using Helmholtz double coil galvanometer and potentiometer.

SEMESTER-IV

1)	**Type of the Course**	Disciplinary Core Course (Major Course -7)
2)	**Name of the Course**	Classical Physics
3)	**Course Code**	PHY01202
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course, which concentrates on classical physics and special relativity, is normally taken by physics majors in their under-graduation. Topics include Einstein's postulates, the Lorentz transformation, relativistic effects and paradoxes, and applications involving electromagnetism and particle physics. This course also

		provides a brief introduction to some concepts of Newtonian mechanics and special relativity.
8)	**Programme/course Objectives**	• This course on classical dynamics aims to train the student in problem solving ability and develops understanding of physical problems. The emphasis of this course is to enhance the understanding of Classical Mechanics (Lagrangian and Hamiltonian Approach).
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Upon completion of this course, students are expected to- • Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations. • Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills. • Solve the problems of relativity.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 4th semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Constrained Motion:** System of particles, Constraints, Degrees of Freedom and Configuration space. Constrained system, Forces of constraint, Generalised coordinates, Principle of Virtual work and D'Alembert's principle. **Lagrangian Formalism:** Lagrange's equation, Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion, Velocity dependent potential of electro-magnetic field , Cyclic coordinates, symmetries and conservation laws, Calculus of Variation, Hamilton's principle, Lagrangian for simple systems, Lagrange's undetermined multipliers, Lagrange's equation for nonholonomic systems, Virial theorem. Lagrangian

		formulation in continuous medium.
(ii)	**Unit-II**	**Hamiltonian Formalism:** Legendre transformations and Hamilton's equations of motion, Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion, Comparison of Lagrangian & Hamiltonian formulations, Hamiltonian for a charge particle in Electro-magnetic field, Cyclic coordinates and conservation laws, Poisson Brackets, Jacobi Identity, Canonical transformation. Hamilton-Jacobi theory, Action-Angle variables, related problems.
(iii)	**Unit-III**	**Central Force:** Two body central force problem, reduction to the equivalent one body problem, Differential equation for the orbit and integrable power law potentials, Condition for stable circular orbit, Kepler problems.
14)	**Text Books and References:**	
(i)	Classical Mechanics: H. Goldstein.	
(ii)	Classical Mechanics : J C Upadhyaya	
(iii)	Introduction to Classical Mechanics: N. C. Rana and P. Joag.	
(iv)	Introduction to Special Relativity : Robert Resnick	

1)	**Type of the Course**	Disciplinary Core Course (Major Course -8)
2)	**Name of the Course**	Mathematical Physics –I
3)	**Course Code**	PHY01204
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This is basic physics course which is intended to give an overview of mathematical methods used in physical sciences. After taking this course, students will gain knowledge of series, Fourier analysis, distributions, vectors, tensors, complex analysis, and multidimensional integrals, and to be able to apply this knowledge to solve certain typical problems in physics.

8)	**Programme/course Objectives**	This subject explains about the mathematical tools that are useful to get the solution of physical problems. The subject covers the important topics that make the interpretation of physics easy.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to- • Solve definite integrals using residue theorem. • Understand knowledge about Fourier Transforms and Application of Fourier Transforms to differential equations. • Explain the Laplace Transform (LT) of Elementary functions and properties of LTs. • Solve differential equations using the Laplace Transform. • Establishing the limitations, advantages, and disadvantages of numerical method
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 4^{th} Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Complex Analysis** Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.
(ii)	**Unit-II**	**Integrals Transforms**: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric,Gaussian, finite wave train & other functions. Representationof Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations:

		One dimensional Wave and Diffusion/Heat Flow Equations. **Laplace Transforms**: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits
(iii)	**Unit-III**	**Errors in numerical Calculations**: Absolute, Relative and Percentage e General Error, Error in series approximation. **Solutions of Algebraic and Transcendental Equations**: Bisection method, position method, Newton-Raphson Method, Picard's iteration method. **Linear systems of equations**: Consistency of Linear System of equations, Solu of Linear Systems by direct method: Guassian elimination and computatic inverse of a matrix, Method of Factorization, Solutions of linear systems by iter methods: Jacobi method, Gauss-Siedel method.
(iv)	**Unit-IV**	**Interpolation and curve fitting**: Errors in Polynomial interpolation, F differences, Differences of a polynomial, Newton's forward and back interpolation, Central differences, Gauss, Stirling, Bessel's and Everett's Form Lagrange's Interpolation formula. **Numerical differentiation and integration:** Numerical differentiation, Nev Cotes Integration formula, Numerical integration by Trapezoidal rule, Simpsor Simpson's 3/8, and Romberg Integration.
14)	**Text Books and References:**	
(i)	Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press	
(ii)	Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications	
(iii)	Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press	
(iv)	First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett	
(v)	Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill	

1)	**Type of the Course**	Disciplinary Core Course (Major Course -7)
2)	**Name of the Course**	Quantum Mechanics
3)	**Course Code**	PHY01206
4)	**Total Credit**	L-T-P=4-0-0=4

5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course discusses how quantum theory arose in the fa certain discrepancies between 19th-century classical th and experiment. It tries to impart a set of mathematical needed to formulate problems in quantum mecha introducing methods of theoretical physics required to s them as needed.
8)	**Programme/course Objectives**	• After learning the elements of modern physics, in this course, students would be exposed to more advanced concepts in quantum physics.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. The students will be able to learn the following from this course: • Basics of quantum Mechanics. • Methods to solve time-dependent and time-independent Schrodinger equation and its applications. • Quantum mechanics of simple harmonic oscillator. • Non-relativistic hydrogen atom: spectrum and eigen functions.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 4th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Linear vector space** State space, Dirac notation and Matrix Representation of State Vectors and operators, Concept of Kets, Bras and Operators, Expectation Values, Superposition Principle, Orthogonality, Completeness, Expansion of State Vector, Non-commutating Observables, Uncertainty Relations, Commutation and Compatibility, Change of basis, Unitary operators. State function and its interpretation, Continuous Basis. Relation between

		a State Vector and its Wave function. Heisenberg matrix mechanics and applications to harmonic oscillator, Solution of the Linear Harmonic Oscillator with Operator Method, Coherent States.
(ii)	**Unit-II**	**Identity** symmetric and antisymmetric wave functions, Exchange Degeneracy, Particle Exchange Operator, Distinguishability of identical particles, Pauli's exclusion principle and Slater's determinant, Electron spin hypothesis and Pauli's spin matrices for electron, eigen values and eigen function, density operator and density matrices, symmetric and antisymmetric function of hydrogen molecule. Interaction Picture.
(iii)	**Unit-III**	**Angular momentum in Quantum Mechanics** Generalized angular momentum- Infinitesimal rotation, Generator of rotation, Commutation rules, Ladder operators, Eigen values and eigen functions, Matrix representation of angular momentum operators, Coupling of two angular momentum operators, Addition of angular momentum, Clebsch Gordon coefficients and Applications, Wigner-Eckart theorem, Central force problem; Solution of Schrödinger equation for spherically symmetric potentials; application in Hydrogen atom.
(iv)	**Unit-IV**	**Approximation methods** Time-independent perturbation theory for non-degenerate and degenerate states. Applications: Anharmonic oscillator, Helium atom, Stark effect in hydrogen atom, Variational methods: Helium atom. Time-dependent perturbation theory; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximations. Semi classical theory of radiation; Transition probability for absorption and induced emission; Electric dipole and forbidden transitions; Selection rules. Variational method; Helium and its excited states, Wentzel–Kram Brillouin (WKB) approximation; Central field approximation and tho fermi model of atoms, Hartree-Fock method of self consistent field and en state, Born approximation.
14)	**Text Books and References:**	
(i)	David J. Griffiths, Introduction to Quantum Mechanics	
(ii)	Nouredine Zettili, Quantum Mechanics: Concepts and Applications	
(iii)	B Crasemann and J.D. Powell, Quantum Mechanics (Addison Wesley)	
(iv)	J.J. Sakurai, Modem Quantum Mechanics	
(v)	Mathews and Venkatesan, Quantum Mechanics	

SEMESTER-V

1)	**Type of the Course**	Disciplinary Core Course (Major Course -10)
2)	**Name of the Course**	**ELECTRONICS-I**
3)	**Course Code**	PHY01301
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course, which concentrates on classical physics and special relativity, is normally taken by physics majors in their under-graduation. Topics include Einstein's postulates, the Lorentz transformation, relativistic effects and paradoxes, and applications involving electromagnetism and particle physics. This course also provides a brief introduction to some concepts of Newtonian mechanics and special relativity.
8)	**Programme/course Objectives**	• This course on classical dynamics aims to train the student in problem solving ability and develops understanding of physical problems. The emphasis of this course is to enhance the understanding of Classical Mechanics (Lagrangian and Hamiltonian Approach).
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Upon completion of this course, students are expected to- • Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations. • Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills. • Solve the problems of relativity.

10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 5th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Semiconductor devices: Semiconductor diodes: pn junction, characteristics, application in rectifiers, Zener diode and its applicat Bipolar Junction Transistor BJT): pnp and npn transistors, CB, CE CC configurations, Emitter follower. Field Effect Transistor (F Classification, construction, characteristics and biasing of JFET, Ide MOSFET.
(ii)	**Unit-II**	Analog Circuit: Small signal amplifiers, tuned voltage amplifier, push-pull amplifiers, power amplifiers, feedback amplifier (+ve and -ve), voltage and current series feedback circuits, Barkhausen criterion of oscillations, tuned collector oscillator, Hartley / Colpitt oscillator, phase-shift oscillator and multivibrators.
(iii)	**Unit-III**	Operational amplifiers: Block diagram, characteristics, offset parameters, slew rate, CMRR, open loop and close loop gain, inverting and non-inverting amplifier, Application of OPAMP in mathematical operations (addition, integration and differentiation). Modulation: Need and types, amplitude modulation, analyses of AM wave, modulator, demodulator circuits. Digital circuits: Binary numbers, binary-to-decimal conversion, Logic gates (AND, OR, NOT, NOR and NAND) and their realization using diodes and transistor, Booleanalgebra, Boolean equation of logic circuits, DeMorgan theorem, Method of realizing a circuit for a given truth table, Sum of product (SOP and Product of sum (POS) representations, Karnaugh map and simplification (elementary idea), Half adder 'and Full
14)	**Text Books and References:**	
(i)	P.Horowitz and W.Hill,The Art of Electronics.	
(ii)	R.Gayakwad,Op-AmpsandLinearIntegrated Circuits, 4thEd	
(iii)	P.Malvino and D.P. Leach,Principle of DigitalElectronics.	
(iv)	T.L.Floyd,Electronic Devices	
(v)	D.R.ChoudharyandS.B. Jain,LinearIntegrated Circuits	

1)	**Type of the Course**	Disciplinary Core Course (Major Course 11)
2)	**Name of the Course**	Electricity and Magnetism
3)	**Course Code**	PHY01303
4)	**Total Credit**	L-T-P=4-0-0 = 4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Electricity and Magnetism is a one-semester, calculus-based, college-level physics course, especially appropriate for students planning to specialize or major in one of the physical sciences or engineering. Students cultivate their understanding of physics through classroom study and activities as well as hands-on laboratory work as they explore concepts like change, force interactions, fields, and conservation.
8)	**Programme/course Objectives**	• The course describes electrostatics, magneto-statics and optics in such a way that students would be able to apply theories of static and moving charges and extend its applications to instruments involving electric and magnetic fields and to give idea on the fundamentals of electromagnetic conduction and electromagnetic waves.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to- • Recognize basic terms in electricity and magnetism. • Understand the laws of electrostatics and magnetostatics. • Apply theorems to construct and solve electrical circuits. • Design and conduct experiments as well as to analyze and interpret data. • Understand the Coulomb’s law, Gauss’s law, Laplace’s equation, electric fields in matter, multipole expansion. • Gain knowledge about steady current, charge conservation, Ohm’s law, electrical conduction in

		metals and semiconductors. • Understand the Biot-Savart's law, Ampere's law, Vector potential, Vector potential for a circular current loop, Lorentz force, Magnetic moment and Multipole expansion of vector potential. • Understand Magnetization in materials, methods of solving boundary value problems in magnetostatics, field of a permanent magnet, uniformly magnetized sphere and magnetic energy. • Understand the inference and diffraction of light and their applications.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 5th semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Electrostatics** Electric charge, Conservation of charge, Coulomb's law, Electric f Charge distribution, Flux and Gauss's law and applications. Electric Pote Energy associated with an electric field, Gauss's theorem and differential of Gauss's theorem, The Curl of electric field and Stokes' theorem, Work energy in electrostatics, Laplace's equation in one, two and three dimens Conductors and insulators, boundary conditions and uniqueness theo Method of images, Separation of variables in Cartesian, cylindrical spherical coordinates, Multipole expansion, Polarization
(ii)	**Unit-II**	**Electric currents and fields of moving charges** Electric current and current density, Ohm's law, electrical conduction in metals and semiconductors, Circuits and circuit elements, Energy dissipation in current flow, Electromotive force, Magnetic Circuits And Induction: Magnetic Circuits, Magnetic Materials and their properties, static and dynamic emfs and force on current carrying conductor, AC operation of Magnetic Circuits, Hysteresis and Eddy current losses.
(iii)	**Unit-III**	**Magnetostatics** Biot-Savart's law, Ampere's law and it's applications, Vector potential, Determination of vector potential from Biot-Savart's law, Force due to magnetic fields; Lorentz force, Force on a dipole in an external field, Magnetic moment, Multipole expansion of vector potential, Magnetization in materials, Magnetic boundary conditions, The field of a permanent magnet, electromagnetic induction.

14)	**Text Books and References:**	
(i)	Introduction to classical electrodynamics - Griffiths.	
(ii)	Classical electrodynamics Third Edition -John David Jackson	
(iii)	Electricity and Magnetism - Edward M. Purcell Berkeley Physics Course, Vol. 2	

1)	**Type of the Course**	Disciplinary Core Course (Major Course -9)
2)	**Name of the Course**	Solid State Physics
3)	**Course Code**	
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Solid-state physics is the most important when it comes to understand the materials we are surrounded with. This course will help to investigate how the large-scale properties of solid materials result from their atomic-scale properties.
8)	**Programme/course Objectives**	• This course aims to give insights of basics of solid state physics by covering the important topics like crystal structure, band structure of solids, lattice vibrations and quantum transport needed to expertise the field.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. At the end of this course the student will be able to: • Understand the crystal structure using reciprocal spaces. • Understand terminologies like Free electron gas, Particles and holes. • Learn and able to use the Density functional theory. • Explain the Bloch-Boltzmann semi-classical transport theory.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 5th Semester can attend the course.
11)	**Course eligibility/Pre-**	10+2 with science

	requisite	
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Crystal Structure**: Chemical bonding, Crystal lattices and symmetry groups, Real space vs. Reciprocal space, Fourier analysis, Crystal X-Ray diffraction **Fermi liquid:** Free electron gas, Particles and holes, Adiabatic mapping to Landau quasiparticles
(ii)	**Unit-II**	**Band Structure of Solids:** Metals, Fermi surface, Density functional theory, Insulators, Semiconductors, Doping, Examples: Graphite and Carbon nanotubes **Lattice Vibrations:** Normal modes, Phonons, Specific Heat, Thermal Conductivity, Quantum theory of neutron scattering **Phase Transitions and Many-Body Phenomena** Broken symmetries and classifications of phases, Classical vs. Quantum phase transitions, Mermin-Wagner theorem, Mott and Anderson insulators
(iii)	**Unit-III**	**Classical and Quantum Transport** Dynamics of Bloch electrons, Bloch-Boltzmann semi-classical transport theory, Magnetotransport and the Hall Effect, Quantum transport in nanostructures **Transistor biasing and Stabilization circuits:** Fixed Bias and Voltage Divider Bias. Thermal runaway, stability and stability factor. Transistor as a two-port network, h-parameter equivalent circuit for CE.
(iv)	**Unit-IV**	**Amplifier**: Small signal analysis of single stage CE amplifier using re-model. Input and Output impedances, Current and Voltage gains. Advantages of CC amplifier. Types of coupling, two stage RC Coupled Amplifier – circuit, working and its Frequency Response, loading effect, GBW product, Darlington transistor, Current gain. **Special semiconductor devices**: LED, LCD and solar cell – construc operation and applications, 7-segment display, concept of common anode common cathode types.
14)	**Text Books and References:**	
(i)	G. Grosso and G. P. Parravicini, Solid State Physics (Academic Press, San Diego, 2000). (notes of Ch 1. and Ch 2.)	
(ii)	L. Mihály and M. C. Martin, Solid State Physics Problems and Solutions (Wiley, New York,	

	1996).
(iii)	C. Kittel, Introduction to Solid State Physics, (8th edition, Willey & Sons, New York, 2005).
(iv)	E. Kaxiras, Atomic and Electronic Structure of Solids (Cambridge Univetsity Press, Cambridge, 2003).
(v)	N. W. Ashcroft and N. D. Mermin, Solid State Physics (International Thomson Publishing, 1976).

SEMESTER-VI

1)	**Type of the Course**	Disciplinary Core Course (Major Course -13)
2)	**Name of the Course**	**NUCLEAR PHYSICS**
3)	**Course Code**	PHY01302
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course, which concentrates on classical physics and special relativity, is normally taken by physics majors in their under-graduation. Topics include Einstein's postulates, the Lorentz transformation, relativistic effects and paradoxes, and applications involving electromagnetism and particle physics. This course also provides a brief introduction to some concepts of Newtonian mechanics and special relativity.
8)	**Programme/course Objectives**	• This course on classical dynamics aims to train the student in problem solving ability and develops understanding of physical problems. The emphasis of this course is to enhance the understanding of Classical Mechanics (Lagrangian and Hamiltonian Approach).
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Upon completion of this course, students are expected to- • Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the

		advantages of these formulations. • Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills. • Solve the problems of relativity.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6^{th} semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Nuclear Structure and Basic nuclear properties** Mass, Charge, Nuclear size and shapes, nuclear spin, parity, nuclear ang momentum, nuclear magnetic moment, Packing fraction, mass defect binding energy, binding energy of deuteron, variation of packing fraction mass number, binding energies of nuclei (plot of B/A against A), natu nuclear forces.
(ii)	**Unit-II**	**Elementary Ideas of alpha, Beta and Gamma Decays** α-decay, Range of α-particle, Geiger-Nuttal law and α-particle-spectra, Gamow theory of α-decay,β-decay, β-energy spectra and neutrino hypothesis, ϒ-decay, Origin of ϒ-rays, nuclear isomerism and internal conversion
(iii)	**Unit-III**	**Compound nucleus and Nuclear Reactions** Types of nuclear reactions and conservation laws, concept of compound direct reactions, compound nucleus, Q-value of the nuclear reaction, nu cross-section, nuclear energy, nuclear fission, nuclear reactors, type nuclear reactors, Breeder reactors, nuclear fusion, nuclear fusion in s nuclear fusion reactors
		Nuclear models Yukawa's Meson theory of nuclear forces and discovery of pion, Liquid model, Weizsacher's semi-empirical mass-formula, Shell Model and m numbers, Predictions of the Shell Model **Detectors for Nuclear Particles** Interaction between particles and matter, photoelectric effect, Compton ef pair production, ionization counter, Geiger-Muller counter, scintill counter, solid state or semiconductor detectors, Compton suppre germanium detectors, Cloud and Bubble chambers, Spark chambers
14)	**Text Books and References:**	
(i)	Concepts of nuclear physics by Bernard L. Cohen (New Delhi: Tata McGraw Hill, 1998).	

(ii)	Concept of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
(iii)	Nuclear Physics by R. R. Roy and B.P. Nigam
(iv)	Nuclear Physics-An Introduction by S. B. Patel
(v)	Nuclear Physics by D.C. Tayal
(vi)	Introductory Nuclear Physics by P.E. Hodgson

1)	**Type of the Course**	Disciplinary Core Course (Major Course -14)
2)	**Name of the Course**	**ATOMIC AND MOLECULAR PHYSICS-I**
3)	**Course Code**	PHY01304
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course, which concentrates on classical physics and special relativity, is normally taken by physics majors in their under-graduation. Topics include Einstein's postulates, the Lorentz transformation, relativistic effects and paradoxes, and applications involving electromagnetism and particle physics. This course also provides a brief introduction to some concepts of Newtonian mechanics and special relativity.
8)	**Programme/course Objectives**	• This course on classical dynamics aims to train the student in problem solving ability and develops understanding of physical problems. The emphasis of this course is to enhance the understanding of Classical Mechanics (Lagrangian and Hamiltonian Approach).
9)	**Course features and**	Classroom teaching, conducting lab practical (hands on

	Learning Outcomes	training). Audio video lecture using ICT. Online faculty for query solving. Upon completion of this course, students are expected to- • Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations. • Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills. • Solve the problems of relativity.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Atomic structure** Rutherford model of atom and its drawbacks, Bohr atom model, Ele orbits, Energy levels and spectra, Effect of nuclear motion on atomic spe Spectra of hydrogen-like atoms, Bohr's correspondence princ Ritzcombinationprinciple, Bohr-Sommerfeld Theory
(ii)	**Unit-II**	**Atoms in Electric and Magnetic Fields** Electron Angular Momentum.Space Quantization, Electron Spin and Angular Momentum.Larmor's Theorem. Spin Magnetic Moment, S Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Atom External Electric and Magnetic Fields (qualitative discussion only):No and Anomalous Zeeman Effect, Paschen Back and Stark Effect; Clas theory of normal Zeeman effect.
(iii)	**Unit-III**	**Many electron atoms** Pauli's Exclusion Principle, Periodic table, Fine structure, Spin orbit coupling, Spectral Notations for Atomic States, Total Angular Momentum, Vector Model, L-S and J-J couplings, Hund's Rule, Term Symbols, Spectra of Alkali Atoms, Clebsch-Gordon coefficients
(iv)	**Unit-IV**	**Molecular Spectra** Introduction, Theory of the origin of pure rotational spectra of a diat

		molecule as a rigid rotator and as a non-rigid rotator, isotope effect, Ra Effect, Experimental study, Characteristics of Raman Lines, Classical Quantum theory of Raman Effect
14)	**Text Books and References:**	
(i)	Concepts of Modern Physics 4thedition Arthur Baiser (Mc-Graw Hill International edition)	
(ii)	Introduction to Atomic spectra H. E. White (Mc-Graw Hill International edition)	
(iii)	Fundamentals of Molecular spectroscopy C.N.Banwell and E.M.McCash (Mc-Graw Hill International edition)	
(iv)	AtomicPhysicsJ. B. Rajam (S.Chand& Co.)	

1)	**Type of the Course**	Disciplinary Core Course (Major Course -15)
2)	**Name of the Course**	Statistical Physics
3)	**Course Code**	PHY01306
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This is an introductory course on Statistical Mechanics Thermodynamics given to 5th semester undergraduates. subject provides the student with an graduate level founda for any research involving thermodynamics and statis mechanics. This includes the theoretical basis, inclu quantum statistics, for more advanced topics.
8)	**Programme/course Objectives**	• The aim of this course is to impart knowledge of thermal physics and electronic devices by covering core topics of laws of thermodynamics, heat transfer, entropy, Maxwell's thermodynamic relations, and kinetic theory of gases, radiation.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. On successful completion of the module students should be able to • Explain the basic concepts of laws of thermodynamics,

		entropy, and state functions. • Describe the basic concepts of thermodynamics potentials and Maxwell's thermodynamic relations. • Understand and use the kinetic theory of gases and radiation. • Solve problems based on heat transfer, entropy, and thermal radiation
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6^{th} semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Thermodynamic Potentials:** Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization.
(ii)	**Unit-II**	**Maxwell's Thermodynamic Relations:** Derivations and applications of Maxwell's Relations (1) First order Phase Transitions with examples, Clausius-Clapeyron Equation (2) Values of Cp-Cv (3)Joule-Thomson Effect and J- T coefficient(Derivation) for Vander Walls gas.
(iii)	**Unit-III**	**Kinetic Theory of Gases:** Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas: Mean, RMS and Most Probable Speeds. Degrees of Freedom, Law of Equipartition of Energy (no derivation). Specific heats of Gases. **Radiation:** Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation (no derivation). Derivation of Planck's law, deduction of Stefan-Boltzmann law and Wien's displacement law from Planck's law.
(iv)	**Unit-IV**	**Macrostate & Microstate:** Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantization of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D. **Concept of Ensemble:** Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.

14)	**Text Books and References:**	
(i)	B.B.Laud,"FundamentalsofStatisticalMechanics",NewAgeInternationalPrivateLimited,2020,2e	
(ii)	Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, TataMcGraw-Hill	
(iii)	Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill	
(iv)	F.Reif,"StatisticalPhysics(InSIUnits):BerkeleyPhysicsCourseVol5",McGrawHill,2017,1e	
(v)	Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009,Springer	

Atomic and Molecular physics (Lab)
(Credits 2)

1. To determine Planck's constant by Cs photocell.
2. To determine Planck's constant by LED method.
3. Measurement of e/m of electron.
4. To determine the wavelengths of Blamer series in the visible region from hydrogen emission.
5. To Determine the Rydberg constant.
6. Study of the characteristic of a G.M. Tube and determination of its operating voltage, plateau length/slope etc
7. Determination of Linear & mass attenuation coefficient using gamma source (for Aluminium, Lead & Copper) using Geiger Muller (G. M.) detector or End Window Gieger Muller (G.M.) Detector.
8. Determination of Efficiency of the G.M. Detector using (a) Gamma Sources & (b) Beta Sources .
9. To measure experimentally the mass absorption coefficient of lead for 662 KeV gamma ray.
10. Determination of Efficiency of the Scintillation Detector using standard Gamma Sources.
11. Qualitative observation of the Compton Effect.
12. Verification of Inverse square Law for γ-rays.
13. Study of Cs-137 spectrum and calculation of FWHM & resolution for a given scintillation detector.
14. Study of Co-60 spectrum and calculation of resolution of detector in terms of energy.

Semester-VII

1)	**Type of the Course**	Disciplinary Core Course (Major-16)
2)	**Name of the Course**	Advanced Quantum Mechanics
3)	**Course Code**	PHY01401
4)	**Total Credit**	L-T-P=4-0-0=4

5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Quantum mechanics is an important tool to understand at the theoretical level the electronic structure of materials, thermodynamics, and other important phenomenons. Advanced Quantum Theory is a concised, comprehensive, well-organized text based on the techniques used in theoretical elementary particle physics and extended to other branches of modern physics as well.
8)	**Programme/course Objectives**	• This course aim to develop an understanding of the advance quantum mechanics. The aim of the course is that the students acquire in-depth knowledge about the foundations of quantum mechanics, as well as skills in applying quantum mechanics in advanced problems.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . At the end of this course the student will be able to: • Understand Klein-Gordon, Dirac relativistic equation and α and β matrices • Understand Negative energy state and negative probability density, Representation and properties Dirac gamma (γ) matrices • Learn the features the Dirac particle in an external electromagnetic field. • Learn the fundamentals Lagrangian field theory, Euler–Lagrange equations, Hamiltonian formalism and The complex Klein-Gordon field: complex scalar field • Learn about Dirac's hole theory and charge conjugation. Feynman-Stuckelberg interpretation of antiparticles.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 7^{th} Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	

(i)	**Unit-I**	Relativistic Notations, The Klein-Gordon equation, Physical interpretation, Probability current density & Inadequacy of Klein-Gordon equation, Dirac relativistic equation & Mathematical formulation, α and β matrices and related algebra, Properties of four matrices, True continuity equation and interpretation.
(ii)	**Unit-II**	Covariant form of Dirac equation, Dirac gamma (γ) matrices, Representation and properties, Trace identities, fifth gamma matrix, Solution of Dirac equation for free particle (Plane wave solution), Dirac spinor, Helicity operator, Explicit form, Negative energy state and negative probability density. The Dirac particle in an external electromagnetic field. The non-relativistic limit of the Dirac equation and the magnetic moment of the electron.
(iii)	**Unit-III**	Covariant form of Dirac equation. Lorentz covariance of the Dirac equation. Boost as hyper rotation Boost, rotation, parity and time reversal operation on the Dirac wave function. Boosting the wave function from the rest frame. Plane wave solutions of the Dirac equation and their properties. Energy and spin projection operators. Introduction to quantum field theory, Lagrangian field theory, Euler–Lagrange equations, Hamiltonian formalism, Quantized Lagrangian field theory, Canonical commutation relations, The Klein-Gordon field, Second quantization, Hamiltonian and Momentum, Normal ordering, Fock space, The complex Klein-Gordon field: complex scalar field.
(iv)	**Unit-IV**	Dirac's hole theory and charge conjugation. Feynman-Stuckelberg interpretation of antiparticles. Foldy–Wouthuysen transformations: Free particle transformation. The general transformation.
14)	**Text Books and References:**	
(i)	Relativistic Quantum Mechanics – J.D. Bjorken and S.D. Drell, McGraw-Hill, New York (1964).	
(ii)	Advanced Quantum Mechanics – J.J. Sakurai, Addison-Wesley Publishing Company, Inc. (1967).	
(iii)	Relativistic Quantum Mechanics and Quantum Fields – T-Y Wu and W-Y Pauchy Hwang, Allied Publishers Limited (2001).	
(iv)	Relativistic Quantum Fields - J. D. Bjorken and S. D. Drell, McGraw-Hill Book Company (1965)	
(v)	A First Book of Quantum Field Theory – A. Lahiri and P. B. Pal, Narosa Publishing House (2001).	

1)	**Type of the Course**	Disciplinary Core Course (Major Course -17)
2)	**Name of the Course**	Classical Electrodynamics
3)	**Course Code**	PHY01403
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course will help students to understand electromagnetic phenomena based on Maxwell's Equations. Also In this course, students will discuss the importance of electrodynamics not only for physicists. Students will see that electrodynamics provides a unique understanding of nature and is often the starting point for advanced studies.
8)	**Programme/course Objectives**	• Objective of this course is to learn atomic, molecular and spin resonance spectroscopy. This course is needed to have clear concept of Atomic, Molecular Physics and Modern Optics amongst students.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving. At the end of this course the student will be able to: • Understand electromagnetic wave propagation in conducting medium. • Understand scalar and vector potentials along with Coulomb gauge and Lorentz gauge and retarded potentials. • Learn the features of fields of a moving point charge and dipole radiations. • Learn the fundamentals of Radiation reaction, Radiation damping, Cherenkov radiation, Brehmstrahlung radiation • Learn about relativistic electrodynamics.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 7th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science

12)	**Course duration**		One Semester
13)	**Course Structure**		
(i)	**Unit-I**	Inhomogeneous wave equation: its solution. Lineard-Wiechert potentials. Field of a uniformly moving charge. Fields of an accelerated charge. Radiation from a charge at low velocity. Radiation from a charge at linear motion and circular motion or orbit. Bremsstrahlung-Cerenkov radiation. Relativistic electrodynamics. Covariant form of EM equations. Transformation law for the EM field. Lienard generalization of Larmor formula; a uniformly moving charge from Coulomb field.	
(ii)	**Unit-II**	Classical theory of electron: Radiation reaction from energy conservation: Lorentz theory. Self force. Scattering: free and bound electron. Dispersion and absorption: Lorentz electromagnetic theory. Kramers-Kronig relation.	
(iii)	**Unit-III**	Magnetohydrodynamics: Magnetohydrodynamic (MHD) equations, magnetic, viscosity, pressure, Reynold number, etc. MHD waves. Alfven waves and velocity, Hartmann flow and Hartmann number. Orbit theory of drift motions in a plasma. Pinch effect. Instability in pinched plasma columns. Plasma oscillations, short wavelength of plasma oscillation and Debye screening length.	
(iv)	**Unit-IV**	Propagation of EM waves through plasma. Effect of external magnetic field on wave propagations: ordinary and extraordinary rays. Multipole radiation.	
14)	**Text Books and References:**		
(i)	Jackson - Classical Electrodynamics		
(ii)	Marion - Classical Electrodynamics		
(iii)	Griffith – Electrodynamics		
(iv)	Panofsky & Phillips - Classical Electrodynamics		
(v)	Chen - Plasma Physics		

1)	**Type of the Course**	Disciplinary Core Course (Major-18)
2)	**Name of the Course**	Atomic and Molecular Physics –II
3)	**Course Code**	PHY01405

4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Through fundamental studies of atoms, students will better understand the construction of the matter. The physical foundation underlying the formation of molecular bonds will also be studied.
8)	**Programme/course Objectives**	• Objective of this course is to learn atomic, molecular and spin resonance spectroscopy. This course is needed to have clear concept of Atomic, Molecular Physics and Modern Optics amongst students.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Upon successful completion of this course it is intended that a student will be able to: • Describe the atomic spectra of one and two valance electron atoms. • Explain the change in behavior of atoms in external applied electric and magnetic field. • Learn about atomic spectra and discuss the relativistic corrections for the energy levels of the hydrogen atom • Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields i.e. Normal and Anomalous Zeeman Effect, Paschen Back and Stark Effect. • State and explain the key properties of many electron atoms and the importance of the Pauli exclusion principle • Discuss the importance of Vector Model, L-S and J-J couplings • State the rotational spectra of a diatomic molecule as a rigid rotator and as a non-rigid rotator, isotope effect, Raman Effect
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 5^{th} Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science

12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Atomic Physics:** Brief review of Bohr and Sommerfeld model of atoms. Effect of finite nuclear mass in relation to Rydberg constant. Idea of discrete energy levels and electron spin: Fanck – Hertz and Stern – Gerlach experiments, Significance of four quantum numbers and concept of atomic orbitals.Dipole selection rules (examples with derivation), Width and shape of spectral lines, Spinorbit coupling, Lamb shift and Retherford experiment, Hyperfine structure of lines, Normal andspecific mass shifts.
(ii)	**Unit-II**	**One valence electron atom:** Orbital magnetic dipole moment, Orbital, spin and total angular momenta, Larmor precession, Vector model of atom, Electronic configuration and atomic states, fine structure, Intensity of spectral lines, General selection rules, Normal Zeeman Effect. **Two valence electron atoms:** LS and JJ coupling schemes and resulting spectra, Idea of normal and inverted doublet, Anomalous Zeeman Effect, Basics of Paschen Back and Stark Effect.
(iii)	**Unit-III**	**Molecular Physics:** Vibrational structure and vibrational analysis, Theory of the origin of pure rotational spectra of a diatomic molecule as a rigid rotator and as a non-rigid rotator, isotope effect, Raman Effect, Characteristics of Raman Lines, Classical and Quantum theory of Raman Effect, Frank Condon Principle, Dissociation Energy
(iv)	**Unit-IV**	**Lasers:** Einstein coefficients, Requisites for producing laser light, Threshold condition for LASER action, Rate equation for three level laser system, Characteristics of laser radiation. Role of Plane and Confocal cavity resonators, Longitudinal and transverse cavity modes, Mode selection, Q-switching and Mode locking, He-Ne and Nd-YAG Laser.
14)	**Text Books and References:**	
(i)	Atomic & Molecular Spectra : Laser :- Raj Kumar	
(ii)	Introduction to Atomic Spectra:- H.E. White.	

(iii)	Physics of Atoms and Molecules:- Bransden and Joachain.
(iv)	Fundamentals of Molecular Spectroscopy :- C. N. Banwell
(v)	Lasers - Theory and Applications:- K. Thyagrajan and A.K. Ghatak.

Electronics (Lab)

(Credits 2)

1. Energy band gap of semiconductor by reverse saturation current method
2. Energy band gap of semiconductor by four probe method
3. Hybrid parameters of transistor
4. Characteristics of FET, MOSFET, SCR, UJT
5. FET Conventional Amplifier
6. FET as VVR and VCA
7. Study and Verification of AND gate using TTLIC7408
8. Study and Verification of OR gate using TTLIC7432
9. Study and Verification of NAND gate and use as Universal gate using TTLIC7400
10. Study and Verification of NOR gate and use as Universal gate using TTLIC7402
11. Study and Verification of NOT gate using TTLIC7404
12. Study and Verification of Ex-OR gate using TTLIC7486

Text books & References:

1. R.L.Boylestad, L.Nashelsky, "ElectronicDevicesandCircuitTheory", Prentice-Hall of India Pvt.Ltd., 2015, 11e
2. J.Millman, C.C.Halkias, SatyabrataJit,"Electronic Devicesand Circuits", McGrawHill, 2015, 4e
3. B.G.Streetman, S.K.Banerjee, "SolidStateElectronicDevices", PearsonEducationIndia, 2015, 7e
4. J.D.Ryder, "Electronic Fundamentals and Applications", Prentice-Hall of India Private Limited, 1975, 5e
5. S.L.Gupta, V.Kumar, "Hand Book of Electronics", Pragati Prakashan, Meerut, 2016, 43e
6. D. Leach, A.Malvino, Goutam Saha, "Digital Principles and Applications", McGrawHill, 2010, 7e
7. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
8. R.P.Jain, "Modern Digital Electronics", McGrawHill, 2009, 4e

SEMESTER-VIII

1)	**Type of the Course**	Disciplinary Core Course (Major Course -19)
2)	**Name of the Course**	**FIBRE AND INTEGRATED OPTICS**
3)	**Course Code**	PHY01402
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course, which concentrates on classical physics and special relativity, is normally taken by physics majors in their under-graduation. Topics include Einstein's postulates, the Lorentz transformation, relativistic effects and paradoxes, and applications involving electromagnetism and particle physics. This course also provides a brief introduction to some concepts of Newtonian mechanics and special relativity.
8)	**Programme/course Objectives**	• This course on classical dynamics aims to train the student in problem solving ability and develops understanding of physical problems. The emphasis of this course is to enhance the understanding of Classical Mechanics (Lagrangian and Hamiltonian Approach).
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Upon completion of this course, students are expected to- • Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations. • Understand the intricacies of motion of particle in central force field. Critical thinking and problem-solving skills. • Solve the problems of relativity.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 8th semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science

12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Optical Fibers:** Structure of optical fibers, Step and graded index fibers, Single, multimode and W-profile fibers. Meridional and skew rays, Numerical aperture and acceptance angle. Multipath, Material dispersion, their combined effect, RMS pulse widths and frequency response Birefringence, Attenuation in optical fibers – Absorption, Scattering, Radiative losses. Photonic crystal fibers.
(ii)	**Unit-II**	**Wave Propagation in Step-index Fibers:** Modes in a step-index fiber, weakly guiding solutions, Time dispersion, Material Dispersion and Waveguide dispersion in single-mode fibers. **Wave Propagation in Graded-index Fibers:** Modes in graded index fibers, Approximate solution (WKB Approximation), No. of propagating modes, The equivalence of WKB Approximation and the ray model, Inter model and Intra model dispersion in graded-index Fibers, Mode coupling.
(iii)	**Unit-III**	**Optical Sources:** Light -Emitting Diodes and laser diodes Fiber lasers, Power launching and coupling techniques, Source of Power coupling, Fiber to Fiber joints and splitting techniques. **Photo Detector and Sensors:** Photo Detectors, PIN Photodiodes and Avalanche photodiode. Noise performance, Fiber Optics sensor and photonic circuits, Optical fiber fabrication and cabling, fiber assessment (measuring techniques for fiber characteristics), Measurement of attenuation, index profile, numerical aperature. Time domain and frequency domain dispersion measurement, Application of fiber optics.
14)	**Text Books and References:**	
(i)	Optical Communication Systems by John Gowar.	
(ii)	Optical Fiber Communication Systems by Gerd Keiser.	
(iii)	Introduction to Optical fibers: A.K. Ghatak and K. Thayagarajan	

1)	**Type of the Course**	Disciplinary Core Course (Major Course -20)
2)	**Name of the Course**	Nuclear and Particle Physics

3)	**Course Code**	PHY01404
4)	**Total Credit**	L-T-P=4-0-0=4
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Through fundamental studies of atoms, students will better understand the construction of the matter. The physical foundation underlying the formation of molecular bonds will also be studied.
8)	**Programme/course Objectives**	• Objective of this course is to learn atomic, molecular and spin resonance spectroscopy. This course is needed to have clear concept of Atomic, Molecular Physics and Modern Optics amongst students.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving .At the end of this course the student will be able to: • Understand theories of alpha, beta and gamma rays. • Understand the electric and magnetic dipole moments, and Electromagnetic properties of nuclei. • Learn the features of nuclear shell models. • Learn the fundamentals of SU(2), SU(3) and classifications of hadrons.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 8th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Properties of Nucleus** Mass, Charge, Nuclear size and shapes, nuclear spin, parity, nuclear angular momentum, nuclear magnetic moment, Packing fraction, mass defect and binding energy, binding energy of deuteron, variation of packing fraction with mass number, binding energies of nuclei (plot of B/A against A), nature of nuclear forces.

(ii)	**Unit-II**	**Types of Radiation Decays** α-decay, Range of α-particle, Geiger-Nuttal law and α-particle-spectra, Gamow theory of α-decay, β-decay, β-energy spectra and neutrino hypothesis, ϒ-decay, Origin of ϒ-rays, nuclear isomerism and internal conversion
(iii)	**Unit-III**	**Nuclear Reactions:** Types of nuclear reactions and conservation laws, concept of compound and direct reactions, compound nucleus, Q-value of the nuclear reaction, nuclear cross-section, nuclear energy, nuclear fission, nuclear reactors, types of nuclear reactors, Breeder reactors, nuclear fusion, nuclear fusion in stars, nuclear fusion reactors
(iv)	**Unit-IV**	**Particle Physics** Yukawa's Meson theory of nuclear forces and discovery of pion, Liquid drop model, Weizsacher's semi-empirical mass-formula, Shell Model and magic numbers, Predictions of the Shell Model Relativistic kinematics, Types of interactions, Classification of elementary particles, spin and parity determination of pions and strange particles, Gell-Mann Nishijima scheme; C, P and T invariance and applications of symmetry arguments to particle reactions, properties of quarks and their classification, Particle symmetries, elementary ideas of SU(2) and SU(3) symmetry, Hadron particles and classification of hadrons particles, Introduction to the standard model.
14)	**Text Books and References:**	
(i)	Introduction to Nuclear Physics by Enge, H.A. (Addison Wesley)	
(ii)	Nuclear Physics- Theory and experiments by R.R Roy and B. P. Nigam, (New Age International 2005)	
(iii)	Nuclear Physics-An Introduction by S. B. Patel (New Age International 1998)	
(iv)	Introduction to Nuclear and Particle Physics by V.K. Mittal & R. C. Shrama (PHI Learning, 2011)	
(v)	Introduction to Elementary Particle by D. Griffiths (Academic Press, 2nd Ed. 2008)	
(vi)	Atomic and Nuclear Physics by S. N. Ghoshal (S. Chand & Company Ltd.)	

Special Paper-I
Special Paper-II

Pool for 9th Sem Special papers-I,II		
Sl No.	**Field of Specialization**	**Course Title**
1.	Applied Optics	a) Nanophotonics
		b) Optoelectronics and Optical Computing
		c) Fourier Optics and Holography
2.	Atomic and Molecular Physics	a) Spectroscopy and Lasers
		b) Principles and Instrumentation in conventional and Laser Spectroscopy
		c) Group Theory, Molecular Spectra and Modern Optics
3.	Nuclear Physics	d) Nuclear Physics: Interactions and Models
		e) Applied Radiation Physics
		f) Accelerator Physics
4.	Condensed Matter Physics	a) Condensed Matter Physics-I
		b) Condensed Matter Physics-II
		c) Condensed Matter Physics-III
5.	High Energy Physics	a) High Energy Physics I
		b) High Energy Physics II
		c) Quark Gluon Plasma &Quarkonium

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Nanophotonics
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Photonics is a branch of science that emphasizes on the

		application of the EM waves. This course will help students to understand the nano scale optical phenomenon.
8)	**Programme/course Objectives**	• This course aim to develop an understanding of the advance quantum mechanics. The aim of the course is that the students acquire in-depth knowledge about the foundations of quantum mechanics, as well as skills in applying quantum mechanics in advanced problems.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . The Students will be able to learn the following from this course: • Basics of photons and electrons and their features. • Basic ideas about the quantum confinement and structures. • Introduction to photonic crystals, plasmonics and its applications. • Learn the basics of micro-cavities and its applications.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Introduction to photons and electrons, their propagation, confinement, tunneling, Localization under a periodic potential: Band gap. Cooperative effect, Nanoscale optical interactions, Nanoscale confinement of electronic interactions, nanoscale electronic energy transfer, Cooperative emissions. Inorganic semiconductors, quantum wells, wired, dots and rings, Manifestation of quantum confinement, Quantum confined stark effect, Dielectric confinement effect, super-lattices, Core-shell quantum dots and quantum dot quantum wells, Quantum confined structures as Lasing media, Organic Quantum confined structures.
(ii)	**Unit-II**	Basics Concept of Photonic Crystals, Theoretical Modeling, Methods of Fabrication, Optical Circuitry, Nonlinear Photonic Crystals, Photonic Crystals and Optical Communications, Application to high efficiency emitters, miniaturized photonic circuits and dispersion engineering, Photonic Crystal Sensors.

(iii)	**Unit-III**	Photonic crystal fiber, photonic band gap fibers (PBG), band gap guiding, single mode and multi-mode, dispersion engineering, nonlinearity engineering, devices using crystal fibers. Metallic nanoparticles, nanorods and nanoshells, local field enhancement, Collective modes in nanoparticle arrays, particle chains and arrays, surface plasmons, Plasmon waveguides, Applications of Metallic Nanostructures.
(iv)	**Unit-IV**	Resonant cavity quantum well lasers and light emitting diodes, Fundamentals of Cavity QED, strong and weak coupling regime, Purcell factor, Spontaneous emission control, Application of microcavities including low threshold lasers, resonant cavity LED, Microcavity based single photon sources.
14)	**Text Books and References:**	
(i)	Nanophotonics by Paras N Prasad.	
(ii)	Photonic Crystals: Towards Nanoscale Photonic Devices by Jean Michel Lourtioz.	
(iii)	Fundamentals of Photonic Crystal Fibers by Fredric Zolla.	
(iv)	Photonic Crystals: Modelling Flow of Light by John D Joannopoulos, R.D. Meade and J.N. Winn	
(v)	The Handbook of Photonics by Mool Chand Gupta, John Ballato.	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Optoelectronics and Optical Computing
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Optoelectronics and Optical Computing is based on the devices and the phenomenon at which they work. This course is important to understand the link between electronics and photonics.
8)	**Programme/course Objectives**	• This course aim to introduce the students with the various concepts of optoelectronic devices and

		optical computing like LEDs, Photodiode, holography, various number systems.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . The students will be able to learn the following from this course: • Basics of LED principles & characteristics. • Basic ideas about the characteristics &responsivity of photo diodes. • Introduction to Holographic interferometry & Speckle phenomenon. • Learn the basics of Modified signed digit number system, residue number system.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	LED principles & characteristics, Quantum efficiency, Homostructure & Heterostructure LEDs, Rise time, Fall time & Bandwidth, Laser diode characteristics, Quantum well laser diode, Fabry-Perot Laser diode, Heterostructure laser diodes, slope efficiency, power efficiency and quantum efficiency, recombination lifetimes.
(ii)	**Unit-II**	Different types of noise in photo diodes, characteristics &responsivity of photo diodes, p-i-n photodiode, avalanche photodiode, coherent detection and photo transistors.
(iii)	**Unit-III**	Transfer function, Phase & Fourier transform of thin lens, Imaging with thin lens, longitudinal magnification, principles of holography, Image reconstruction, On-axis & Off-axis holography, Holographic interferometry & Speckle phenomenon.
(iv)	**Unit-IV**	Optical addition/subtraction, multiplication/division, averaging, differentiation, integration, Modified signed digit number system, residue number system, Realization in MSD & Residue codes, Threshold logic, Spatial light modulator, Shadow casting system.
14)	**Text Books and References:**	
(i)	Optical Systems and Processes, Joseph Shamir.	
(ii)	Fundamentals of optoelectronics, C Pollock	

(iii)	Optical Computing: An Introduction, Mohd. A Karim&Abdula A S Awaal
(iv)	Laser and holographic Data processing by N.G. Bosov.

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Fourier Optics and Holography
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course is an introduction to Fourier analysis of optical systems, with applications to optical information processing. This course also provides an introduction to optical propagation and diffraction using a scalar wave approach and Fourier theory of imaging. Topics introduced will include pupil function, point spread function and line spread function, optical transfer function, image formation with coherent and incoherent light, holography and diffractive optical elements.
8)	**Programme/course Objectives**	• Objective of this course is to learn basic principles of electro-optic devices. This course is gives the idea of advance applications in optics and holography.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . Upon successful completion of this course it is intended that a student will be able to: • Describe the Nonlinear optical media, second-order nonlinear optics. • Explain the Requirements for holography, Recording geometrices and special configurations. • Learn about Fourier analysis in two dimensions and Fourier transform theorems.

10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Nonlinear optical media, second-order nonlinear optics, third-order nonlinear optics, three-wave mixing, four-wave mixing, optical solitons, Principles of electro-optics, electro-optics of anisotropic media, electro-optics of liquid crystals, photorefraction, electro-optic devices, Interaction of light and sound in matter, acousto-optic devices, acousto-optics of anisotropic media.
(ii)	**Unit-II**	Fourier analysis in two dimensions. Fourier transform theorems. Diffraction of light. Fourier transformation by propagation. Role of a lens in Fourier transformation and imaging.
(iii)	**Unit-III**	Fourier transform processors. Filter type and their realization, Stigmatic Fourier transform processor, Synthetic aperture radar data processor, Image deblurring, spatial filtering, pattern recognition, hybrid processors, Van CittertZernicke theorem. Michelson stellar interferometer. Fourier transform spectroscopy. Frequency response of a lens (imaging system).Optical transfer function.
(iv)	**Unit-IV**	Introduction to holography, Requirements for holography, Recording geometrices and special configurations, Mathematical analysis of volume holograms.Hologram types.Recording media, applications of holography with emphasis to interferometry.
14)	**Text Books and References:**	
(i)	J. W. Goodman, Introduction to Fourier Optics, McGraw-Hill (1968)	
(ii)	J.D. Gaskill, Linear Systems, Fourier Transforms and Optics, John Wiley (1978).	
(iii)	R.S. Sirohi, Wave Optics and Applications, Orient Longman (1993)	
(iv)	W. T. Cathy, Optical information processing and holography, John Wiley (1974).	
(v)	D. Cassasent (Ed.) Optical data processing -Applications, Springer - Verlag (1978).	
(vi)	S.H. Lee (Ed.) Optical data processing -Fundamentals. Springer - Verlag (1981).	
(vii)	L.H. Lin, Optical Holography, Po Hariharan, Optical Holography, Cambridge University Press (1984) R.S. Sirohi and M.P. Kothial, Optical components, systems and measurement techniques, marcel! Oekker (1991).	
1)	**Type of the Course**	Disciplinary Core Course (Major-12)

2)	**Name of the Course**	Spectroscopy and Lasers
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Lasers have their numerous applications and spectroscopy is an important tool in physics to understand structure of atom. The course intends to provide theoretical and practical knowledge of the many powerful methods, as modern atom and molecular spectroscopy offer respect both basic studies and practical applications.
8)	**Programme/course Objectives**	• The course aims to provide students the understanding of electronic spectra, atoms and molecules and Lasers.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . Students will have achieved the ability to: • Describe the atomic spectra of one and two valance ele atoms. • Explain the change in behavior of atoms in external ap electric and magnetic field. • Explain rotational, vibrational, electronic and Raman sp of molecules. • Describe electron spin and nuclear magnetic resonance spectroscopy and their applications
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Spectroscopy of Atoms and Molecules:** Designation of Atomic and Molecular States, Classification of electronic states, Electronic, vibrational and Rotational spectra, interaction of vibration and electronic motion, Renner- Teller effect, coupling of

		rotation with vibration and electronic motion for linear molecules, concept of allowed and forbidden transitions, selection rules, elements of Microwave Spectroscopy, Principle of ESR and NMR with experimental setup, Chemical shift.
(ii)	**Unit-II**	**Electronic Spectra:** Electronic energy and total energy, vibration structure of electronic transitions, progressions and sequences, rotational structure of electronics bands, band head formation and band origin, intensity distribution in vibrational structure, Deslandre table, Frank-Condon principle and its quantum mechanical formulation, Intensity alteration and missing lines in rotational lines. Dissociation energy and its determination.
(iii)	**Unit-III**	**Laser Physics:** Basic elements of a laser, Rate equations for three and four level systems and operation of a laser, critical pumping rate, Resonant modes of optical cavities, Mode size and cavity stability, Q-factor and resonance line width, Q-switching, techniques of Q-switching, Pockel's effect and mode locking.
(iv)	**Unit-IV**	**Laser Systems:** Pulsed crystal lasers, rare earth ion lasers, principle and working of Threshold condition for oscillation in Semiconductor Laser, Semiconductor Laser, Principle and Working of CO2 laser, Nd-YAG laser, Excimer Laser, tunable Dye Lasers.
14)	**Text Books and References:**	
(i)	LASERS Theory and Applications: K. Thyagarajan and A.K. Ghatak	
(ii)	Laser spectroscopy and Instrumentation: W. Demtroder	
(iii)	Molecular Spectra and Molecular Structure: G. Herzberg	
(iv)	High resolution Spectroscopy: J.M. Hollas	
(v)	Atomic Spectra Structure and Modern Spectroscopy: DK Rai and SN Thakur	
(vi)	Fundamentals of Molecular Spectroscopy: C. N. Banwell	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Fourier Optics and Holography
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)

5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course is an introduction to Fourier analysis of optical systems, with applications to optical information processing. This course also provides an introduction to optical propagation and diffraction using a scalar wave approach and Fourier theory of imaging. Topics introduced will include pupil function, point spread function and line spread function, optical transfer function, image formation with coherent and incoherent light, holography and diffractive optical elements.
8)	**Programme/course Objectives**	• Objective of this course is to learn basic principles of electro-optic devices. This course is gives the idea of advance applications in optics and holography.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . Upon successful completion of this course it is intended that a student will be able to: • Describe the Nonlinear optical media, second-order nonlinear optics. • Explain the Requirements for holography, Recording geometrices and special configurations. • Learn about Fourier analysis in two dimensions and Fourier transform theorems.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Nonlinear optical media, second-order nonlinear optics, third-order nonlinear optics, three-wave mixing, four-wave mixing, optical solitons, Principles of electro-optics, electro-optics of anisotropic media, electro-optics of liquid crystals, photorefraction, electro-optic devices, Interaction of light and sound in matter, acousto-optic devices, acousto-

		optics of anisotropic media.
(ii)	**Unit-II**	Fourier analysis in two dimensions. Fourier transform theorems. Diffraction of light. Fourier transformation by propagation. Role of a lens in Fourier transformation and imaging.
(iii)	**Unit-III**	Fourier transform processors. Filter type and their realization, Stigmatic Fourier transform processor, Synthetic aperture radar data processor, Image deblurring, spatial filtering, pattern recognition, hybrid processors, Van CittertZernicke theorem. Michelson stellar interferometer. Fourier transform spectroscopy. Frequency response of a lens (imaging system).Optical transfer function.
(iv)	**Unit-IV**	Introduction to holography, Requirements for holography, Recording geometrices and special configurations, Mathematical analysis of volume holograms.Hologram types.Recording media, applications of holography with emphasis to interferometry.
14)	**Text Books and References:**	
(i)	J. W. Goodman, Introduction to Fourier Optics, McGraw-Hill (1968)	
(ii)	J.D. Gaskill, Linear Systems, Fourier Transforms and Optics, John Wiley (1978).	
(iii)	R.S. Sirohi, Wave Optics and Applications, Orient Longman (1993)	
(iv)	W. T. Cathy, Optical information processing and holography, John Wiley (1974).	
(v)	D. Cassasent (Ed.) Optical data processing -Applications, Springer - Verlag (1978).	
(vi)	S.H. Lee (Ed.) Optical data processing -Fundamentals. Springer - Verlag (1981).	
(vii)	L.H. Lin, Optical Holography, Po Hariharan, Optical Holography, Cambridge University Press (1984) R.S. Sirohi and M.P. Kothial, Optical components, systems and measurement techniques, marcel! Oekker (1991).	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Principles and Instrumentation in conventional and Laser Spectroscopy
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Lasers have their numerous applications and instrumentation is an important tool in physics to understand physical phenomenon. The course intends to provide theoretical and practical knowledge of the many powerful methods, related to both basic studies and practical applications.
8)	**Programme/course Objectives**	~~• The course aims to provide students the understanding of electronic spectra, atoms and molecules and Lasers.~~
9)	**Course features and Learning Outcomes**	~~Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving .~~ ~~Students will have achieved the ability to:~~ ~~• Describe the atomic spectra of one and two valance ele atoms.~~ ~~• Explain the change in behavior of atoms in external ap electric and magnetic field.~~ ~~• Explain rotational, vibrational, electronic and Raman sp of molecules.~~ ~~• Describe electron spin and nuclear magnetic resonance spectroscopy and their applications~~
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Light sources, Detectors and Spectroscopic Techniques**: Synchrotron Radiation source, Thermal detector, Photodiode, Charged

		Coupled detector, Magnetic bottle spectrometer, UV/Vis absorption spectroscopy & luminescence spectroscopy, Basic idea of Circular dichroism, Principle of Fourier transform (FT) spectroscopy, Fast Fourier transform (FFT), FT-IR and FT-Raman spectrometers, Advantages of FT techniques over conventional methods, application of IR and Raman spectroscopy, surface enhanced Raman spectroscopy (SERS) and its applications.
(ii)	**Unit-II**	Photoacoustic Spectroscopy, Time-resolved spectroscopy, Cluster formation and its application to the formation of prebiotic molecules, AES (Auger electron spectroscopy), Techniques of Coincidence detection.
(iii)	**Unit-III**	**Vacuum Techniques and pumps** Vacuum, Production of low and high vacuum, Basic idea of conductance, pumping speed, Rotary oil pump, Diffusion pump, Turbo Molecular Pump, Penning and Pirani gauges.
(iv)	**Unit-IV**	**Non-Conventional Spectroscopic Techniques:** Two-photon spectroscopy, Saturation Spectroscopy, Resonance Raman spectroscopy and CARS, Optogalvanic Spectroscopy, Experimental techniques of MPI spectroscopy, Supersonic beam spectroscopy with emphasis on measurement of molecular parameters.
14)	**Text Books and References:**	
(i)	Laser Spectroscopy: W. Demtroder.	
(ii)	High Resolution Spectroscopy: J. M. Hollas	
(iii)	Spectrophysics: A. Thorpe	
(iv)	Low Energy electron spectroscopy: KD Sevier	
(v)	Radiation Detectors: WH Tait	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Fourier Optics and Holography
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this**	Faculties from Physics

	course	
7)	**Overview**	• This course is an introduction to Fourier analysis of optical systems, with applications to optical information processing. This course also provides an introduction to optical propagation and diffraction using a scalar wave approach and Fourier theory of imaging. Topics introduced will include pupil function, point spread function and line spread function, optical transfer function, image formation with coherent and incoherent light, holography and diffractive optical elements.
8)	**Programme/course Objectives**	• Objective of this course is to learn basic principles of electro-optic devices. This course is gives the idea of advance applications in optics and holography.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . Upon successful completion of this course it is intended that a student will be able to: • Describe the Nonlinear optical media, second-order nonlinear optics. • Explain the Requirements for holography, Recording geometrices and special configurations. • Learn about Fourier analysis in two dimensions and Fourier transform theorems.
10)	**Who can attend /course audience**	This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Nonlinear optical media, second-order nonlinear optics, third-order nonlinear optics, three-wave mixing, four-wave mixing, optical solitons, Principles of electro-optics, electro-optics of anisotropic media, electro-optics of liquid crystals, photorefraction, electro-optic devices, Interaction of light and sound in matter, acousto-optic devices, acousto-optics of anisotropic media.
(ii)	**Unit-II**	Fourier analysis in two dimensions. Fourier transform theorems. Diffraction of light. Fourier transformation by propagation. Role of a lens in Fourier transformation and imaging.

(iii)	**Unit-III**	Fourier transform processors. Filter type and their realization, Stigmatic Fourier transform processor, Synthetic aperture radar data processor, Image deblurring, spatial filtering, pattern recognition, hybrid processors, Van CittertZernicke theorem. Michelson stellar interferometer. Fourier transform spectroscopy. Frequency response of a lens (imaging system).Optical transfer function.
(iv)	**Unit-IV**	Introduction to holography, Requirements for holography, Recording geometrices and special configurations, Mathematical analysis of volume holograms.Hologram types.Recording media, applications of holography with emphasis to interferometry.
14)	**Text Books and References:**	
(i)	J. W. Goodman, Introduction to Fourier Optics, McGraw-Hill (1968)	
(ii)	J.D. Gaskill, Linear Systems, Fourier Transforms and Optics, John Wiley (1978).	
(iii)	R.S. Sirohi, Wave Optics and Applications, Orient Longman (1993)	
(iv)	W. T. Cathy, Optical information processing and holography, John Wiley (1974).	
(v)	D. Cassasent (Ed.) Optical data processing -Applications, Springer - Verlag (1978).	
(vi)	S.H. Lee (Ed.) Optical data processing -Fundamentals. Springer - Verlag (1981).	
(vii)	L.H. Lin, Optical Holography, Po Hariharan, Optical Holography, Cambridge University Press (1984) R.S. Sirohi and M.P. Kothial, Optical components, systems and measurement techniques, marcel! Oekker (1991).	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Group Theory, Molecular Spectra and Modern Optics
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Spectroscopy is an important tool in physics to understand structure of atom. The course intends to provide theoretical and practical knowledge of the group theory, atom and molecular spectroscopy along with optics for both basic studies and practical applications.
8)	**Programme/course Objectives**	~~• The course aims to provide students the understanding of electronic spectra, atoms and molecules and Lasers.~~
9)	**Course features and Learning Outcomes**	~~Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving .~~ ~~Students will have achieved the ability to:~~ ~~• Describe the atomic spectra of one and two valance ele atoms.~~ ~~• Explain the change in behavior of atoms in external ap electric and magnetic field.~~ ~~• Explain rotational, vibrational, electronic and Raman sp of molecules.~~ ~~• Describe electron spin and nuclear magnetic resonance spectroscopy and their applications~~
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Symmetry and Group Theoretical Treatment:** Symmetry elements and symmetry operations, point group and their

		representation, mathematical group, Matrix Representations, Orthogonality theorem (Statement and interpretation only), Reducible and irreducible representations
(ii)	**Unit-II**	Direct product group, Normal modes, symmetry characterization of electronic states and vibrational modes of polyatomic molecules, Character Tables for C2v and C3v point groups and their applications to selection rules of IR and Raman Spectra, Application to CO2 and H2O molecules.
(iii)	**Unit-III**	**Vibration-Rotation Energy Levels and Spectra:** Rotational Energy of Spherical, Prolate and Oblate Symmetric Rotors, Rotational Raman and IR Spectra of linear molecules and Determination of their geometry, Rotation-Vibration band of a diatomic molecules, Parallel and perpendicular type bands in Linear and symmetric rotor molecules.
(iv)	**Unit-IV**	**Nonlinear optics:** Significance of non-linear polarization of lasers and some applications: Second harmonic generation using non-linear optical methods, Elementary idea of laser-based non-linear optical techniques. (Nonlinear susceptibilities, symmetries, phase matching).
14)	**Text Books and References:**	
(i)	Molecular orbital Theory: A. Streitweiser.	
(ii)	Chemical Application of group theory: F.A. Cotton	
(iii)	Elements of Group Theory for physicists: A. W. Joshi.	
(iv)	Fundamentals of Molecular Spectroscopy: C. N. Banwell	
(v)	Modern Spectroscopy: J.M. Hollas	
(vi)	Physics of Nonlinear Optics: Guang S. He and Song H. Liu	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Nuclear Physics: Interactions and Models
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)

5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Nuclear physics is the branch of physics that studies atomic nuclei and their constituents and interactions. The course introduces the fundamental principles that underline nuclear science and its engineering applications, as well as mathematical tools needed to grasp these concepts.
8)	**Programme/course Objectives**	• In this course students will be exposed to the basic principles and functionalities of nuclear interactions and models. This subject aims to train student for the applications of the concepts of nuclear models.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . The Students will be able to learn the following from this course: • To develop a applications based understanding of shell model, deformed liquid drop model. • Learn about qualitative ideas on deep inelastic electron-proton scattering. • To learn about the physical description of heavy ion collisions, collisions near coulomb barrier
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Liquid drop model and nuclear fission, Weizsacker semi-empirical mass formula and its applications, collective vibrations and excited states, permanent deformation and collective rotations, energy levels and electromagnetic properties of even even and odd Deformed nuclei, Shell model, Magic numbers, Evidence of nuclear shell structure, Predictions of shell model, Limitation of Shell model, Fermi gas model, Collective model.
(ii)	**Unit-II**	A brief review of different types of nuclear reactions, Nuclear reaction kinematics, Ground state of Deuteron, S and D state, neutron–proton and proton–proton scattering, central and non-central forces, Spin

		dependence of nuclear forces, exchange forces.
(iii)	**Unit-III**	Compound nucleus theory and its limitations, Continuum theory of nuclear reaction, Resonance scattering, Briet Wigner description formula, Statistical theory of nuclear reactions.
(iv)	**Unit-IV**	Physical description of heavy ion collisions, Collisions near Coulomb barrier, elementary idea of classical and approximate quantum mechanical theories, exotic and super heavy nuclei, complete and incomplete fusion, idea of sub barrier fusion, Quasi-fission, high-spin states.
14)	**Text Books and References:**	
(i)	Introduction to Nuclear Physics by Enge, H.A.	
(ii)	Introductory Nuclear Physics by Samuel S. M. Wong	
(iii)	Nuclear Physics by D.C. Tayal	
(iv)	Nuclear Physics- by Preston, M A and Bhaduri, R.	
(v)	Nuclear Physics- Theory and experiments by R.R Roy and B. P. Nigam	
(vi)	Nuclear Physics-An Introduction by S. B. Patel.	
(vii)	Concept of Nuclear Physics by B.L. Cohen.	
(viii)	Nuclear and Particle Physics: An Introduction by B. Martin	
(ix)	Atomic and Nuclear Physics by S. N. Ghoshal.	
(x)	Introduction to Nuclear and Particle Physics by V.K. Mittal & R. C. Shrama	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Applied Radiation Physics
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Radiations are everywhere. This course provides

		information of radiological concepts and techniques with an overview of radioactivity, sources of radiation, and radioactive decay.
8)	**Programme/course Objectives**	• The aim of this course is to acquire in-depth knowledge about interaction of radiation with matter. This subject helps to build understanding of the various detectors and counters along with the application based features of radiations.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving . On successful completion of the module students should be able to- • Learn about interaction of charged particle and electromagnetic radiation with matter. • Gain knowledge about natural and artificial radioactivity and its applications. • Understand about Gas filled detectors, ionization counter, Geiger-Muller counter etc.. • Gain knowledge about Heavy charged particle sources, Neutron sources, Reactor produced isotopes etc.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Interaction of charged particle and electromagnetic radiation with matter, Photoelectric effect, Compton effect, Pair production, Photon beam exponential attenuation, Rayleigh scattering, Attenuation, energy transfer and mass energy absorption coefficients, Relative importance of various types of interactions.
(ii)	**Unit-II**	Natural and artificial radioactivity and its applications, different type of decay, Laws of radioactive disintegration, Radioactive decay constant, Half-life period, Statistical nature of radioactivity, radioactive growth and decay, Gamma emission, Nuclear isomerism, Elementary ideas of nuclear fission and fusion, Idea about nuclear and fast breeder reactors, Effect of radiation, methods of radiation protection, radiation safety, exposures to radiation, medical uses of radiation.
(iii)	**Unit-III**	Gas filled detectors, ionization counter, Geiger-Muller counter, scintillation counter, solid state or semiconductor detectors, Ge(Li), Si(Li), HPGe detectors, Cloud and Bubble chambers, Spark chambers, Neutron Detectors, , Solid State Nuclear track (SSNTD) detectors,

		Thermolumenescent Dosimeters (TLD), Optically stimulated Luminescence dosimeters (OSLD), Radiophoto luminescent dosimeters
(iv)	**Unit-IV**	Unites and definitions, Natural and artificial radioactive sources, fast electron sources, sources of electromagnetic radiation, Heavy charged particle sources, Neutron sources, Reactor produced isotopes, Particle Accelerators produced isotopes, Fission products, industrial uses.
14)	**Text Books and References:**	
(i)	Radiation Detectors by C. F. G. Delaney and E. C. Finach, Clarendon Press Oxford 1992.	
(ii)	Radiation Detection and Measurement by Glenn F. Knoll, 3rd edition, John Wiley India 2012.	
(iii)	Nuclear Physics-An Introduction by S. B. Patel, New Age International, (P) Limited, Publishers, New Delhi, First edition, 1991.	
(iv)	A Primer in Applied Radiation Physics by F.A. Smith.	
(v)	Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy, New Age International, (P) Publishers, New Delhi, First edition, 1986.	
(vi)	Atom, Radiation and Radiation Protection by J. Turner.	
(vii)	Radiation Biophysics by E.L. Alpen.	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Accelerator Physics
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Accelerators are used to accelerate particles for various purposes. Ion beam facilities in these days are based on accelerator chains consisting of linacs, cyclotrons, and synchrotrons. This course provides information of types of accelerators and their working.
8)	**Programme/course Objectives**	• The aim of this course is to build an understanding of the various types, principles working and application of accelerators used in the past and present.
9)	**Course features and**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for

	Learning Outcomes	query solving. Online faculty for query solving. On successful completion of the module students should be able to- • Learn about basic principle of various particle accelerators, properties of beam. • Gain knowledge about AC and DC accelerators. • Understand about Elements of beam Transport, Electrostatic and magnetic lenses in Transverse beam dynamics. • Learn about Longitudinal phase space dynamics, Momentum compaction in Longitudinal Beam Dynamics.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Brief history and basic principle of various particle accelerators, Properties of beam, Principle of ionization, Ion sources for positive and negative ions, Application of accelerators: Basic research, medicine and industry.
(ii)	**Unit-II**	Particle Accelerators, Need for Charged particle Accelerators, Cock-Craft and Walton Accelerator, Van-de-Graff Accelerator, Tandem Accelerator, Linear Accelerators (LINAC), Cyclotron, Betatron, Microtron, TeV Accelerators, Particle Accelerators in India
(iii)	**Unit-III**	Transverse beam dynamics: Elements of beam Transport, Electrostatic and magnetic lenses, Dipole magnet, Quadrupole magnet, Equations of motion, field index, Betatron oscillations, Weak and strong focusing, Transfer matrix technique, Stability criterion, Phase space ellipse, Liouville's Theorem, Beam emittance.
(iv)	**Unit-IV**	Longitudinal Beam Dynamics: Longitudinal phase space dynamics, Momentum compaction, Phase stability, Equation of motion, Synchrotron oscillation, Longitudinal emittance.
14)	**Text Books and References:**	
(i)	Accelerator Physics, S. Y. Lee.	
(ii)	Helmut Wiedemann, Particle Accelerator Physics.	
(iii)	M. Reiser, Theory and design of charged particle beams.	
(iv)	D. Edwards and M. Syphers, An introduction to the physics of high energy accelerators.	

(v)	S. Humphries, Principle of charge particle acceleration: Free on net	
(vi)	Proceedings of CAS (CERN): Free on net	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Condensed Matter Physics-I
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course provides an introduction to a bunch of basic phenomena that collectively define Condensed Matter Physics or Solid State Physics. Emphasis will be given on developing a coherent path for understanding the set of rather diverse phenomena.
8)	**Programme/course Objectives**	• The aim of this course is to gain knowledge in condensed matter physics. This course can be very useful to get an expertise in area of crystal lattices, plasmons, electrons energy bands and magneto transport.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving. On successful completion of the module students should be able to- • Apply the concept of reciprocal lattice. • Understand the plasma oscillations, Transverse optical m in plasma. • Gain knowledge of quantum theory of lattice heat capacit • Understand the Experimental methods of studying F surface. • Understand the Classical theory of magnetoconductivity and quantum theory of magnetic susceptibility.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science

12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Crystalline solids, unit cells and direct lattice, two and three dimensional Bravais lattices, closed packed structures. Interaction of X-rays with matter, absorption of X-rays. Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods, crystal structure factor and intensity of diffraction maxima.
(ii)	**Unit-II**	Point defects, line defects and planer (stacking) faults. The role of dislocations in plastic deformation and crystal growth. The observation of imperfections in crystals, X-ray and electron microscopic techniques. Electrons in a periodic lattice: Bloch theorem, band theory, classification of solids, effective mass. Tight-binding, pseudo potential methods.
(iii)	**Unit-III**	Fermi surface, de Hass van Alfen effect, cyclotron resonance, magneto resistance, quantum Hall effect, Integer quantum Hall effect, Paramagnetism- Langavin theory, Weiss theory of ferromagnetism, Heisenberg model and molecular field theory. Spin waves and magnons. Curie-Weiss law for susceptibility, Ferri- and antiferro-magnetic order. Domains and Bloch-wall energy.
(iv)	**Unit-IV**	Superconductivity: critical temperature, persistent current, Meissner effect, superconducting phase transitions, manifestations of energy gap. London theory, Cooper pairing due to phonons. BCS theory of superconductivity, Ginzsburg-Landau theory and application to Josephson effect: d-c Josephson effect, a-c Josephson effect, macroscopic quantum interference. Vortices and type II superconductors, high temperature superconductivity (elementary).
14)	**Text Books and References:**	
(i)	Verma and Srivastava: Crystallography for Solid State Physics	
(ii)	Azaroff: Introduction to Solids	
(iii)	Omar: Elementary Solid State Physics	
(iv)	Ashcroft & Mermin: Solid State Physics Kittel: Solid State Physics	
(v)	Chaikin and Lubensky: Principles of Condensed Matter Physics	
(vi)	Madelung: Introduction to Solid State Theory	
(vii)	Callaway: Quantum Theory of Solid State	
(viii)	Huang: Theoretical Solid State Physics	
(ix)	Kittel: Quantum Theory of Solids	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Condensed Matter Physics-II
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course provides an introduction to a bunch of basic phenomena that collectively define Condensed Matter Physics or Solid State Physics. Emphasis will be given on developing a coherent path for understanding the set of rather diverse phenomena.
8)	**Programme/course Objectives**	• The aim of this course is to build an understanding of the various types of important topics of condensed matter physics like magnetism, surfaces and interface and superconductivity. These topics are essential for industrial applications in this field.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving. On successful completion of the module students should be able to- • Gain knowledge about bragg's law, reciprocal lattices, types of bonding. • Understand the concept of Kronig-Penney (K-P) model, Brillouin zones. • Learn about superconductivity and BCS theory.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	

(i)	**Unit-I**	Crystalline and amorphous solids. The crystal lattice. Basis vectors. Unit cell. Symmetry operations. Point groups and space groups. Plane lattices and their symmetries. Three dimensional crystal systems. Miller indices. Directions and planes in crystals. Interplanar spacings. Simple crystal (SC) structures: FCC, BCC, Nacl, CsCl, Diamond and ZnS structure, HCP structure. X-ray diffraction by crystals. Laue theory. Interpretation of Laue equations. Bragg's law. Reciprocal lattice. Ewald construction. Atomic scattering factor. Experimental methods of x-ray diffraction. Neutron and electron diffraction Types of bonding. The van der waals bond. Cohesive energy of inert gas solids. Ionic bond. Cohesive energy and bulk modulus of ionic crystals. Madelung constant. The covalent bond. Metallic bond.
(ii)	**Unit-II**	Vibrations of one-dimensional monatomic and diatomic lattices. Infrared absorption in ionic crystals (one-dimensional model). Normal modes and phonons. Frequency distribution function. Review of Debye's theory of lattice specific heat. Anharmonic effects. Magnetic properties of solids. Diamagnetism, Langevin equation. Quantum theory of paramagnetism. Curie law. Hund's rules. Paramagnetism in rare earth and iron group ions. Elementary idea of crystal field effects. Ferromagnetism. Curie-Weiss law. Heisenberg exchange interaction. Mean field theory. Antiferromagnetism. Neel point. Other kinds of magnetic order. Nuclear magnetic resonance. Quantized free electron theory. Fermi energy, wave vector, velocity and temperature, density of states. Electronic specific heats. Pauli spin paramagnetism. Sommerfeld's model for metallic conduction. AC conductivity and optical properties, plasma oscillations. Hall effects.
(iii)	**Unit-III**	Intrinsic and extrinsic semiconductors. Carrier concentration and Fermi levels of intrinsic and extrinsic semiconductors BandGap. Direct and indirect gap semiconductors. Hydrogenic model of impurity levels. Energy bands in solids. The Bloch theorem. Bloch functions and their eigenvalues. Review of the Kronig-Penney (K-P) model. Brillouin zones. Number of states in the band. Band gap in the near free electron model. The tight binding approximation. The fermi surface. Electron dynamics in an electric field. The effective mass. Concept of hole.
(iv)	**Unit-IV**	Superconductivity, Survey of important experimental results. Critical temperature. Meissner effect. Type-I and Type-II superconductors.

		Thermodynamics of superconducting transition. London equation. London penetration depth. Energy gap. Basic ideas of BCS theory. High-T_c superconductors.
14)	**Text Books and References:**	
(i)	F.C.Phillips: An introduction to crystallography (wiley) (3rd edition)	
(ii)	Charles A Wert and Robb M Thomson: Physics of Solids	
(iii)	J. P. Srivastava: Elements of solid state physics (Prentice Hall India; 2nd edition).	
(iv)	Christmaan-solid state physics (academic press)	
(v)	John Singleton: Band theory and Electronic properties of Solids (Oxford University Press; Oxford Master Series in Condensed Matter Physics).	
(vi)	Ibach & Luth: Solid State Physics	
(vii)	M. Ali Omar: Elementary solid state physics (Addison-wesley)	
(viii)	C. Kittel: Solid-state physics (Wiley eastern)(5th edition).	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Condensed Matter Physics-III
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course provides an introduction to a bunch of basic phenomena that collectively define Condensed Matter Physics or Solid State Physics. Emphasis will be given on developing a coherent path for understanding the set of rather diverse phenomena.
8)	**Programme/course Objectives**	• This course highlights some of the basic as well as advance concepts of condensed matter physics. The selection of the topics aims at giving the student a very clear picture of this subject to impart expertise in the subject.

9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving. The Students will be able to learn the following from this course: • Basics of Lattice dynamics and Optical properties of solids. • Basic ideas about the The Lyddane-Sachs-Teller (LST) relation, Polaritons. Localized lattice vibrations. • Introduction to , Jellium Model, Hartree and Hartree-Fock equation. • Learn the basics of Spintronics, Multiferroics, Giant magnetoresistance (GMR), Colossal magnetoresistance.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Lattice dynamics: Equation of motion of a vibrating lattice, Harmonic approximation. Atomic force constants. Dynamical matrix. Central and non-central forces. Dispersion relation. Vibrational properties of square and cubic lattices, Acoustic and optical modes. Quantisation of lattice vibration. Optical modes in ionic crystals. The Lyddane-Sachs-Teller (LST) relation. Polaritons. Localized lattice vibrations. Frequency distribution function, Van Hovesingularities. Thermodynamic functions of a vibrating solid in the harmonic approximation. An harmonic interaction. Gruneisen constant, Mie-Gruneisen equation of state. Slow neutron scattering in solids, Elastic/inelastic and Coherent/incoherent scattering. Optical properties of solids: Kramers-Kronig relations sum rule for oscillator strengths. Direct and indirect interband transitions. Optical absorption in Semiconductors and MottWannier excitations.
(ii)	**Unit-II**	Many body techniques: The basic Hamiltonian, Jellium Model, Hartree and Hartree-Fock equation, interacting electron gas, Hartree-Fock approximations for the electron gas, Exchange hole, exchange energy, Density Functional Theory, Static screening, Thomas Fermi approximation, Plasma Oscillations, Bohm Pines theory-Random Phase

		Approximation, plasma oscillations, dielectric function of an electron gas, Linhard dielectric function.
(iii)	**Unit-III**	Superconductivity: Phenomenology: signatures of superconductivity in resistivity, susceptibility, heat capacity, IR reflectivity etc., fluxoid quantization, Cooper pairing: instability of the Fermi sea, BCS Hamiltonian and its diagonalization by Bogoliubov-Valatin transformation, ground state energy, gap equation, critical temperature, isotope effect, magnetic mechanisms of pairing, Ginzburg-Landau theory He_2, Abrikosov vortex lattice, Josephson junction and Josephson effect, exotic symmetries of the order parameter. Coexistence of superconductivity and magnetism, applications of high Tc superconductors.
(iv)	**Unit-IV**	Ferrimagnetism and Antiferromagnetism: Ferrites, two sublattice models, Curie temperature and susceptibility, super exchange, magnetic bubbles. Exchange Hamiltonian, Dispersion relation, Zero-point sublattice magnetization, Thermal behavior of sublattice magnetization. Dielectric and Ferroelectrics: Ionic crystals, Polarization catastrophe, nature of phase transitions, Ferroelectricity, Piezoelectricity, Pyroelectricity. Advanced materials / Phenomenon: Spintronics, Multiferroics, Giant magnetoresistance (GMR), Colossal magnetoresistance (CMR), La-based Perovskite, C_{60} Fullerene.
14)	**Text Books and References:**	
(i)	Theory of Superconductivity, J. Robert Schrieffer	
(ii)	Introduction to Superconductivity, 2nd Edition, by Michael Tinkham	
(iii)	O. Madelung – Introduction of Solid State Theory (Springer).	
(iv)	Solid State Physics: Ashcroft and Mermin	
(v)	Introduction to Magnetic Materials: B. D. Cullity	
(vi)	Ferrites: J. Smith & P. J. Wijn	
(vii)	M. Ali Omar: Elementary solid state physics (Addison-wesley)	
(viii)	C. Kittel: Solid-state physics (Wiley eastern)(5th edition).	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	**High Energy Physics I**
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• The aim of high energy physics is to determine the most fundamental building blocks of matter and to understand the interactions between these particles. This course tries to give a deep understanding of the basic and advance concepts of high energy physics.
8)	**Programme/course Objectives**	• This subject aims to introduce some of the basic properties of quarks and terminology related to them. It is designed to impart knowledge about the quark models, quark-quark interactions and quantum chromodynamics.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving. • On successful completion of the module students should be able to- • Learn about the Nucleon resonances and baryon spectroscopy and Quark model of hadrons. • Learn about the phenomenology of strange particles and their semileptonic and nonleptonic decays. • Apply knowledge in understanding the Physics of heavy flavor particles and Cabibbo theory. • Explain some of the basics of Quantum Chromodynamics and Quark-Quark interactions.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6^{th} Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	

(i)	**Unit-I**	Static Quark Model of Hadrons: The Baryon Moments Decuplet, Quark spin and color, Baryon Octect, Quark-Antiquark combinations :- The pseudoscalar mesons, the vector mesons, leptonic decay of vector mesons, Baryon Magnetic moments, Heavy-meson spectroscopy and the quark model. J/Ψ and upsilon states; Quark confinement and search for free quarks.
(ii)	**Unit-II**	Nucleon Structure and Quark Model :Nucleon as a composite particle. Nucleon resonances and baryon spectroscopy. Quark model of hadrons, spin and flavour SU(6) wave functions of mesons and baryons. Mass formula for baryons and mesons. Calculation of magnetic moments.
(iii)	**Unit-III**	Physics of heavy flavor particles: Phenomenology of strange particles and their semileptonic and nonleptonic decays. Cabibbo theory.Flavor oscillation, Discovery of quarks, Charm, bottom and top quarks.Quarkonium and their spectra. Predicted c-cbar and b-bar states with principal quantum numbers n= 1 & 2 with their properties. The quark-antiquark potential, Lepton-Quark symmetry, Quark mixing.Quark confinement and search for free quarks.
(iv)	**Unit-IV**	Quantum Chromodynamics and Quark-Quark interactions, QCD potential at short distances, QCD potential at large distances (String model) Multijet events in e+e-annihilation, effects of quark interactions in Deep-Inelastic lepton-nucleon scattering, Running coupling constant : Quantitative predictions of QCD, q2evolution of structure functions, Comparison of Quark and Gluon distribution.
14)	**Text Books and References:**	
(i)	Quarks and Leptons by .Halzen, F and Martin, A.D(John-Wiley)	
(ii)	Quarks and Partons by Close, F.E. (Academic Press)	
(iii)	Particle Physics Martin, B R and Shaw, G (John-Wiley)	
(iv)	Introductions to High Energy Physics by DonanldH.Perkins.	
(v)	Nuclear &Paticle Physics by E. Burcham	
(vi)	Elementary Particles by I.S. Hughes	
(vii)	Quarks, Leptons and Gauge fields by Kerson Huang	
(viii)	Introduction to Particle Physics by M.P. Khanna	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	High Energy Physics II
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• The aim of high energy physics is to determine the most fundamental building blocks of matter and to understand the interactions between these particles. This course try to give a deep understanding of the basic and advance concepts of high energy physics.
8)	**Programme/course Objectives**	• The aim of this course is to acquire in-depth knowledge about Relativistic Kinematics, Ultra-relativistic Nucleus-Nucleus Collisions and Review of some Major High Energy Physics Experiments. This subject helps to build understanding of the various advanced concepts of high energy physics.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving. On successful completion of the module students shoul able to- • Learn about High Energy Hadron-Nucleon and Hadron-Nucleus interactions. • Gain knowledge about Fermi Golden Rule, differential and total scattering cross sections. • Understand the hydrodynamics of Quark-Gluon Plasma and phase diagram. • Gain knowledge about Neutrino Flavour oscillation experiments and Physics Scenarios at RHIC and LHC energies.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	

(i)	**Unit-I**	Relativistic Kinematics: Review of Lorentz transformations for energy and momentum, four-vectors and invariants, Laboratory and Centre-of-momentum systems, calculation of energy, momentum and angle of particles produced in nuclear reactions in Lab. and centre-of-momentum frames and their transformations and calculation of threshold energies for particle production. Mandelstam variables, Fermi Golden Rule, differential and total scattering cross sections, Lorentz invariant phase space.
(ii)	**Unit-II**	High Energy Hadron-Nucleon and Hadron-Nucleus Interactions: High energy hadron-nucleon collisions: Features of relativistic hadron-nucleon collisions upto very high energy, behaviour of elastic, inelastic and total cross-sections as a function of incident energy, multiplicity distribution. Rapidity and pseudorapidity variables.Lab. and CM rapidity. Maximum and minimum rapidities.Pseudorapidity distribution in projectile, target and central fragmentation regions.
(iii)	**Unit-III**	Ultra-relativistic Nucleus-Nucleus Collisions, QGP formation and its Signatures:Ultra-relativistic nucleus-nucleus collisions: Glauber model of nucleus-nucleus collision, participant-spectator model, Bjorken estimate of the initial energy density, hydrodynamics of Quark-Gluon Plasma and phase diagram, global observables at RHIC and LHC energies, possible signatures of Quark-Gluon Plasma formation, dileponproduction,Drell-Yan Process in nucleus-nucleus collision, direct photon production, De-bye screening in the QGP, J/Ψsuppression in the QGP, strangeness enhancement, an isotropic flow and jet quenching.
(iv)	**Unit-IV**	Review of some Major High Energy Physics Experiments: Neutrino Flavour oscillation experiments and Physics Scenarios at RHIC and LHC energies.
14)	**Text Books and References:**	
(i)	Pilkuhn, H.: The Interactions of Hadrons	
(ii)	Martin, L.P.: High Energy Hadron Physics (John Willey)	
(iii)	Collins, P.D.B. & Martin, A.D.: Hadron Interactions (Adam Hingler)	
(iv)	Hagedorn, R.: Relativistics Kinematics (Benjamin)	
(v)	Perkins, D.H.: Introduction to High Energy Physics(Addison wesley)	
(vi)	Halzen, F. and Martin, A.: Quarks and Leptons (John-Wiley)	
(vii)	Wong, C.Y.: Introduction to High Energy Heavy Ion Collisions (World Scientific)	
(viii)	Ferbel, T.: Experimental Techniques in High Energy Physics (Addison Wesley)	
(ix)	Leo, W.R.: Techniques for Nuclear and Particle Physics Experiments (Narosa)	

1)	**Type of the Course**	Disciplinary Core Course (Major-12)
2)	**Name of the Course**	Quark gluon plasma and Quarkonium
3)	**Course Code**	
4)	**Total Credit**	L-T-P=3-0-0=3 (three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• Quark–gluon plasma is studied to recreate and understand the high energy density conditions prevailing in the Universe when matter formed from elementary degrees of freedom (quarks, gluons) at about 20μs after the Big Bang.
8)	**Programme/course Objectives**	• Objective of this course is to learn about quark gluon plasma and quarkonium. This course is gives the idea of advance topics of high energy physics.
9)	**Course features and Learning Outcomes**	Classroom teaching, conducting lab practical (hands on training). Audio video lecture using ICT. Online faculty for query solving. Online faculty for query solving. Upon successful completion of this course it is intended that a student will be able to: • Describe the Quark Gluon Plasma and Glauber model of Nucleus Nucleus Collisions. • Explain the Quarkonium suppression by a quark gluon plasma, Quarkonium suppression by hadrons. • Learn about the Phase transition in nuclear physics, Energy momentum tensor, Hydrodynamic equations.
10)	**Who can attend /course audience**	~~This course is suitable for students from Physics. CUJ Students of 6th Semester can attend the course.~~
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Quarks and gluons, Bag Model of hadron, Quark Gluon Plasma, Quark Gluon Plasma at high temperatures, Quark Gluon Plasma with a High Baryon Density, Glauber model of Nucleus Nucleus Collisions, Bjorken estimate of initial energy density in high energy Nucleus Nucleus

		Collisions.
(ii)	**Unit-II**	Introduction to Quarkonium in heavy ion collisions, Quarkonium level at T=0, Quarkonium production, Quarkonium suppression by a quark gluon plasma, Quarkonium suppression by hadrons, Nucleus Nucleus collisions.
(iii)	**Unit-III**	Review of thermodynamics, Phase transition, Phase transition in nuclear physics, Energy momentum tensor, Hydrodynamic equations, and Solution of Hydrodynamic equations: longitudinal expansion, Solution of Hydrodynamic equations: Transverse (radial) expansion
14)	**Text Books and References:**	
(i)	Introduction to high energy heavy ion collisions- C. Y. Wong	
(ii)	Ultra relativistic heavy ion collisions- R. Vogt	
(iii)	Introduction to relativistic heavy ion collisions- L. P. Csernai	

Minor Papers (Offered by Physics to other department students)

1)	**Type of Course**	Disciplinary/Interdisciplinary (Minor Course-1)
2)	**Name of the Course**	Applied Physics: Physics-I
3)	**Course Code:**	
4)	**Total Credit:**	L+ T + P= 3+ 0 + 0 = 3
5)	**Floated by/Proposed by**	Departments of Physics
6)	**Who can teach this course**	Faculty from Department of Physics

7)	**Overview**	The objective of this course is to familiarize the students with basic of Vectors, Static Electric and Magnetics fields, Rigid body dynamics, Mechanical properties of matter, and Oscillations and Waves. lt aims to equip the students to deal with basic problems that they would be seeing in the real world.
8)	**Programme/course objective**	The students will learn: • The basics of vector calculus like differentiation and Integration. • The concepts of static electric and magnetic fields. • The applications of the rigid body dynamics and mechanical properties of matter. • The basic terminology used in understanding waves and oscillations.
9)	**Course features and learning outcome**	At the end of the course, students will demonstrate the ability • To use vectors in various co-ordinate systems. • To explain the properties of static electric and magnetic fields • To use and apply the Moment of inertia, Rigid body kinematics, Rigid body kinetics. • To understand mechanical concepts of matter like Modulus of rigidity, Viscosity and use Poiseulle's equation. • To explain the different types of harmonic oscillations, along with the reflection and transmission of waves.
10)	**Who can attend the course**	This course is suitable for students from science background.
11)	**Course Eligibility/Pre-requisite**	10+2 with science
12)	**Course Duration:**	One Semester

13)	**Course Structure**	
(i)	**Unit I**	**Review of Vector calculus**
		Vector algebra addition, Subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, partial differentiation, Integration, vector operator del, gradient, divergence and curl, Integral theorems of vectors. Conversion of vector from one coordinate system to another.
(ii)	**Unit-II**	**Static electric Field**
		Coulomb's law, Electric field intensity, Electrical field due to charges. Line, surface, Volume charge distributions. Gauss law and its applications. Absolute electric potential, Potential difference, calculation of potential differences for different configurations. Electric dipole, electrostatic energy and energy density.
(iii)	**Unit-III**	**Static Magnetic field**
		Biot-Savort's Law, Ampere Law, Magnetic Flux and Magnetic flux density, Scalar and Vector magnetic potentials, steady magnetic fields produced by current carrying conductors.
(ii)	**Unit-IV**	**Rigid Body Motion**
		Rigid body, Moment of inertia, Rigid body kinematics, Rigid body kinetics, Motion of gyroscope.
(iii)	**Unit-V**	**Mechanical Properties of Matter**
		Modulus of rigidity, Poisson's ratio, relation connecting different elastic-constants, Viscosity, Poiseulle's equation of liquid flow through a narrow tube.
(iv)	**Unit-VI**	**Oscillations and Waves**
		Simple harmonic oscillation damped harmonic oscillation and forced oscillation, Q factor and resonance. Differential equation of one dimensional wave and its solution, reflection and transmission of waves.
14)	**Text Book and References:**	

(i)	Physics Part-I: Resanick and Halliday Vol I, Edition 5 (2007).
(ii)	Mechanics: D.S. Mathur S. Chand Publishing Edition Ist(2000).
(iii)	Concepts in Physics Vol .I : H.C.Verma, Dhanpat Rai and Co. Edition Ist.
(iv)	Mechanics: R.K. Shukla and Anchal Srivastava New Age International Publishers(2006).
(v)	An Introduction to Mechanics: D. Kleppner and R. Kolenkow, Ist Edition, McGraw Hill (2017).
(vi)	Mechanics (Berkeley Physics Course) Vol. I: C. Kettel, W. D. Knight, M.A. Ruderman and A.C. Helmholz edition 2nd, McGraw Hill Education, (2017).

Semester-II

1)	**Type of the Course**	Disciplinary/Interdisciplinary (Minor Course -2)
2)	**Name of the Course**	Applied Physics: Physics-II
3)	**Course Code**	
4)	**Total Credit**	L+ T + P= 3+ 0 + 0 = 3
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course is concentrated on electrostatics, electrodynamics and relativity. Topics include Gauss law, polarization, ohms law, electromagnetic waves and, Poynting's theorem. This course also provides a brief introduction to relativity and its consequences
8)	**Programme/course Objectives**	• This subject explains about the concepts of electrostatics, electrodynamics and relativity that are useful to get the solution of physical problems. The subject covers the important topics that make the interpretation of physics easy.
9)	**Course features and Learning Outcomes**	Class room teaching, Conducting Lab practical (hands on training), Audio video lecture using ICT, Online faculty for query solving. On successful completion of the module students should be able to- • Recognize basic terms in electrostatics, electrodynamics. • Apply the different laws to solve physical problem. • Basic understanding on electromagnetic wave. • Understand the relativity and its consequences.

		• Understand physical problem from relativity point of view.
10)	**Who can attend /course audience**	This Course suitable for students from science background.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Electrostatics** Coulomb's Law, Gauss's law (integral and differential form) and its applications, Energy of a charge distribution, Laplace's and Poisson's equations, Conductors, Method of images, Field and Potential due to dipole. Polarization in a dielectric, vectors D, P and E, linear dielectrics, force on dielectrics,
(ii)	**Unit-II**	**Electric Currents** Line, surface and volume currents and current densities, electrical conductivity and Ohm's law, equation of continuity, energy dissipation, Motion of charged particles in electric and magnetic fields.
(iii)	**Unit-III**	**Electrodynamics** Electromagnetic induction, motional emf and Faraday's law, inductance and energy in magnetic field, the displacement current, Maxwell's equations, Electromagnetic Wave: E. M wave in vacuum, dielectrics and conductors, Poynting's- theorem, Fresnel's equation
(iv)	**Unit-IV**	**Relativity** Galilean transformation, axioms of relativity, Lorentz transformation and its consequences: length contraction, time dilation, simultaneity, addition of velocity, variation of mass with velocity (derivation not required), mass energy relation.
14)	**Text Books and References:**	
(i)	D.J.Griffiths, Introduction to electrodynamics 3rd Ed., 1998	
(ii)	E.M. Purcell, Electricity and Magnetism (Berkeley Physics course) 2nd Ed.	
(iii)	H.S. Mani & G.K. Mehta, Introduction to Modern Physics	
(iv)	R.P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture of Physics Vol	
(v)	Introduction to Special Relativity: Robert Resnick	

1)	**Type of the Course**	Disciplinary/Interdisciplinary (Minor Course -3)
2)	**Name of the Course**	Modern Physics

3)	**Course Code**	
4)	**Total Credit**	L+ T + P= 4+ 0 + 0 = 4 (Four)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This subject is a comprehensive study of modern physics that emphasizes concepts and problem solving. Modern physics generally means the breakthroughs in special relativity and quantum mechanics during the early 1900’s. This course includes that part of classical physics that failed to explain certain well-known experiments. In the late 1800’s classical physics consisted of Newton’s Laws, Maxwell’s equations, and thermodynamics. As these failures became more worrisome to prominent scientist, new ideas began to emerge and special relativity and quantum physics were born. This course is about the emergence of special relativity, quantum physics and the Schrodinger equation and application of the latter to new phenomena.
8)	**Programme/course Objectives**	• In this course students would be able to understand the topics that make the basis of modern physics such as origin of quantum mechanics, atomic models, lasers, nuclear structure and fundamentals of radioactivity.
9)	**Course features and Learning Outcomes**	Class room teaching, Conducting Lab practical (hands on training), Audio video lecture using ICT, Online faculty for query solving. On successful completion of the module students should be able to- • Understand the atomic models like Thomson's Atom Model, Rutherford's Nuclear Atom Model, Bohr's Theory of Atomic Structure. • Explain and use the Photoelectric effect, Compton effect, etc. • Understand the Basic idea of The Franck-Hertz Experiment, Space Stern and Gerlach Experiment. • Apply knowledge in understanding the of radioactive decay, Basic idea of α, β and γ-decay • Explain some of the basic properties and reactions of nucleons.
10)	**Who can attend /course**	This course suitable for students from Science and Engineering

	audience	Background.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Origin of Quantum Theory** Inadequacy of Classical Mechanics, The Franck-Hertz Experiment, Space Quantization: Stem and Gerlach Experiment, Limitations of old Quantum Theory, Wave Nature of Particles: Matter Waves, Experimental Confirmation of Particle Waves, G. P. Thomson's Experiment, Applications of Electron Diffraction, Bohr's Correspondence Principle. **Atomic Structure of Matter** Thomson's Atom Model, Rutherford's Nuclear Atom Model, Hydrogen Spectrum, Bohr's Theory of Atomic Structure, Bohr's Theory of Hydrogen Atom, Sommerfeld correction, Spectrum of Ionised Helium, Finite Mass Correction, Discovery of Heavy Hydrogen (Deutron), Hydrogen Like Spectra, Alkali Atomic --Spectra, Excitation and Ionisation Potentials, Experimental Evidence for Quantisation, Types of Spectra, Emission and Absorption Line (atomic) Spectra, Fluorescenceand Phosphorescence.
(ii)	**Unit-II**	**Photoelectric effect and Emission spectrum** Introduction, Einstein's photoelectric equation, Compton effect, Theory of Compton effect, Applications of photoelectric effect. **X-rays** Production of X-rays: Coolidge Tube, Properties of X-rays, Measurement of the Intensity of X-rays, Variation of X-ray Intensity with Wavelength, Origin of Continuous Spectrum, Origin of Characteristic X-ray Spectrum, Absorption of X-rays, Moseley'sLaw, X-ray diffraction, Bragg's law, Determination of crystal structure.
(iii)	**Unit-III**	**Radioactivity** Natural and artificial radioactivity, Properties of a, β and y rays, fundamental laws of radioactivity, radioactive disintegration, half and average life periods, activities of radioactive substances, radiation damage, radiation detectors: G M Counter, Scintillation counter, semiconductor detectors, bubble chamber, spark chamber detector, production of artificial radioactivity, radio-isotopes, application of artificial radioactivity, radioactive dating (radiometric, carbon and geological).
(iv)	**Unit-IV**	**The Nucleus and Nuclear Energy** Nuclear Mass, Nuclear Size, Angular Momentum of the Nucleus, Constituents of the Nucleus, Neutron as Building Block, Binding Energy, Stable Nuclei, Decay of Unstable Nuclei, Nuclear Fission, Spontaneous

		Fission and Potential Barrier, Emission of Neutrons in Fission, Self-Sustaining Chain Reaction: Nuclear Reactor, Neutron Balance in Reactor, Uncontrolled Chain Reaction-Bomb, Nuclear Fusion, Controlled Fusion, Fusion in Stars.
14)	**Text Books and References:**	
(i)	J.B.Rajam, Modern Physics	
(ii)	S.L. Kakani& S. Kakani, Modern Physics	
(iii)	.S. Mani & G.K. Mehta, Introduction to Modern Physics	
(iv)	A.S.Vasudeva,Modern Physics	

Semester-IV

1)	**Type of the Course**	Disciplinary Core Course (Minor-4)
2)	**Name of the Course**	Optics
3)	**Course Code**	
4)	**Total Credit**	L+ T + P= 4+ 0 + 0 = 4 (Four)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• The aim of this course is to acquire in-depth knowledge of waves, superposition of harmonic waves, standing waves, acoustics, nature of light, interference of light by division of wave front, Interference of light by division of amplitude, Fraunhofer diffraction, Fresnel Diffraction and Polarization.
8)	**Programme/course Objectives**	• In this course students would be able to understand the topics that make the basis of optics such as interference, Diffraction, Polarization etc.
9)	**Course features and Learning Outcomes**	Class room teaching, Conducting Lab practical (hands on training), Audio video lecture using ICT, Online faculty for query solving. On successful completion of the module students should be able to- • Learn about different properties of waves, characteristics of wave motion, particle and wave velocities and superposition of harmonic waves.

		• Understand the standing waves, absorption coefficient, Sabine's Reverberation Formula. • Gain knowledge about the factors affecting acoustics in buildings.
10)	**Who can attend /course audience**	This course suitable for students from Science and Engineering Background.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Waves** Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation, Wave Equation – Differential form (derivation). Particle and Wave Velocities: Relation between them, Energy Transport – Expression for intensity of progressive wave, Newton's Formula for Velocity of Sound. Laplace's Correction (Derivation). Brief account of Ripple and Gravity Waves.
(ii)	**Unit-II**	**Superposition of Harmonic Waves** Linearity and Superposition Principle. Superposition of two collinear oscillations having (a) equal frequencies and (b) different frequencies (Beats) – Analytical treatment.
(iii)	**Unit-III**	**Standing Waves** Velocity of transverse waves along a stretched string (derivation), Standing (Stationary) Waves in a String - Fixed and Free Ends (qualitative). Theory of Normal modes of vibration in a stretched string, Energy density and energy transport of a transverse wave along a stretched string. Vibrations in rods – longitudinal and transverse modes (qualitative). Velocity of Longitudinal Waves in gases (derivation).
(iv)	**Unit-IV**	**Acoustics** Absorption coefficient, Reverberation and Reverberation time, Sabine's Reverberation formula (derivation), Factors affecting acoustics in buildings, Requisites for good acoustics. Acoustic measurements – intensity and pressure levels.

		Nature of light The corpuscular model of light-The wave model-Maxwell's electromagnetic waves, Wave Particle Duality
14)	**Text Books and References:**	
(i)	The Physics of Waves and Oscillations, N K Bajaj Tata McGraw-Hill Publishing Company Ltd., Second Edition, 1984	
(ii)	Waves and Oscillations N Subramanyam and Brij Lal Vikas Publishing House Pvt. Ltd., Second Revised Edition 2010	
(iii)	A Text Book of Sound, D R Khanna and R S Bedi, Atma Ram & Sons, Third Edition, 1952	
(iv)	Oscillations and Waves, Satya Prakash, Pragathi Prakashan, Meerut, Second Edition 2003	
(v)	Optics, Ajoy Ghatak, McGraw Hill Education, (India) Pvt Ltd, 2017	
(vi)	A text Book of Optics, Brij Lal, M N Avadhanulu & N Subrahmanyam, S. Chand Publishing 2012	

Laboratory Syllabus (2 Credits)

Semester-V

1)	**Type of the Course**	Disciplinary/Interdisciplinary (Minor Course-5)
2)	**Name of the Course**	Solid State Devices
3)	**Course Code**	
4)	**Total Credit**	L+ T + P= 4+ 0 + 0 = 4 (Four)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This subject has a motive of giving student an idea of the electrical instrument used. The working of these instruments and their applications in daily life can be useful in making the subject more interesting. The topics selected are good for developing basics of electrical systems.
8)	**Programme/course Objectives**	• In this course students would be able to understand the topics that make the basis of solid state devices such as Kirchoff's laws, Semiconductors based devices, Applications of CRO etc.
9)	**Course features and Learning Outcomes**	Class room teaching, Conducting Lab practical (hands on training), Audio video lecture using ICT, Online faculty for query solving. On successful completion of the module students should be

		able to- • Learn the usage of Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits. • Understand the General principle and performance equations of D'Arsonval Galvanometers. • Gain knowledge about the Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer. • Learn about the use of CRO in measurement of frequency, phase, Amplitude and rise time.
10)	**Who can attend /course audience**	This course suitable for students from Science and Engineering Background.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Ammeters,voltmeters: (DC/AC), Representation of sinusoidal waveforms, peak and rms values, power factor. Analysisofsingle-phaseseriesandparallelR-L-Caccircuits.Three-phasebalanced circuits, voltage and current relations in star and delta connections. Watt-meters: Induction type, single phase and three phase wattmeter, Energy meters: AC. Induction type single phase and three phase energy-meter, Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications.
(ii)	**Unit-II**	Galvanometers: General principle and performance equations of D'Arsonval Galvanometers, Vibration Galvanometer and Ballistic Galvanometer. Potentiometers: DC Potentiometer, Crompton potentiometer, construction, standardization, application. AC Potentiometer, DC/AC Bridges: General equations for bridge balance, measurement of self inductancebyMaxwell'sbridge(withvariableinductance&variablecapacitance), Hay's bridge, Owen's bridge, measurement of capacitance by Schearing bridge, errors, Wagner's earthing device, Kelvin's double bridge.
(iii)	**Unit-III**	Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer CRO: Block

		diagram, Sweep generation, vertical amplifiers, use of CRO in measurement of frequency, phase, Amplitude and rise time of a pulse. Digital Multi-meter: Block diagram, principle of operation, Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing.
14)	**Text Books and References:**	
(i)	D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications,**2019**	
(ii)	David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005	
(iii)	Vincent Del Toro, Electrical Engineering Fundamentals Prentice Hall India**2009**	
(iv)	A.D. Helfrick& W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, **PHI,2016**	

1)	**Type of the Course**	Disciplinary/Interdisciplinary (Minor Course -6)
2)	**Name of the Course**	Numerical Methods and Programming
3)	**Course Code**	
4)	**Total Credit**	L+ T + P= 4+ 0 + 0 = 4 (Four)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This subject has a motive of giving student an idea of the electrical instrument used. The working of these instruments and their applications in daily life can be useful in making the subject more interesting. The topics selected are good for developing basics of electrical systems.
8)	**Programme/course Objectives**	• In this course students would be able to understand the topics that make the basis of solid state devices such as Kirchoff's laws, Semiconductors based devices, Applications of CRO etc.
9)	**Course features and Learning Outcomes**	Class room teaching, Conducting Lab practical (hands on training), Audio video lecture using ICT, Online faculty for query solving. On successful completion of the module students should be able to- • Learn the usage of Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits.

		• Understand the General principle and performance equations of D'Arsonval Galvanometers. • Gain knowledge about the Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer. • Learn about the use of CRO in measurement of frequency, phase, Amplitude and rise time.
10)	**Who can attend /course audience**	This course suitable for students from Science and Engineering Background.
11)	**Course eligibility/Pre-requisite**	10+2 with science
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	**Numerical Methods of Analysis:** Solution of algebraic and transcendental equations: Iterative, bisection and Newton Raphson methods, Solution of simultaneous linear equations : Matrix inversion method, Interpolation: Newton and Lagrange formulas, Numerical differentiation, Numerical Integration, Trapezoidal, Simpson and Gaussian quadrature methods, Least-square curve fitting, Straight line and polynomial fits, Numerical solution of ordinary differential equations : Euler and Runge-Kutta method.
(ii)	**Unit-II**	**Fortran:** Flow charts, Algorithms, Integer and floating point arithmetic, Precision, Variable types, Arithmetic statements, Input and output statements, Control statements, Executable and non-executable statements, Arrays, Repetitive and logical structures, Subroutines and functions, Operation with files, Operating systems, Creation of executable programs.
14)	**Text Books and References:**	
(i)	Computer Oriented Numerical Methods : V. Rajaraman	
(ii)	Computational Methods in Physics and Engineering: Wong.	
(iii)	Applied Numerical Analysis: Gerald.	
(iv)	Computer Programming in FORTRAN 90 and 95: V. Rajaraman	

Semester-I (for Ist Semester)

Multi Disciplinary courses: Apparatus and Instrumentation in Physics

1)	**Type of the Course**	Multi/Inter disciplinary Course (MDC -1)
2)	**Name of the Course**	Apparatus and Instrumentation: OPTICS-I
3)	**Course Code**	
4)	**Total Credit**	3 (Three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course allows for the students to understand basics principles, theory and construction of apparatus/setups in different areas of applied physics and provide basic training of their handling.
8)	**Programme/course Objectives**	• To make students understand basics principles, theory and construction of apparatus/setups in different areas of applied physics so that their experimental skilled are enhanced. Further, they can go to higher studies and develop expertise in an area of their choice.
9)	**Course features and Learning Outcomes**	Class room teaching, Conducting Lab practical (hands on training), Audio video lecture using ICT, Online faculty for query solving. On successful completion of the module students should be able to do experiments in a better way. Further, they can go to higher studies and develop expertise in an area of their choice
10)	**Who can attend /course audience**	This Course suitable for students from other than Science and Engineering Background.
11)	**Course eligibility/Pre-requisite**	Students from other than science and Engineering Background.
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Reflection and refraction, lenses, optical systems and cardinal points, thick lenses
(ii)	**Unit-II**	Matrix method, dispersion, lens aberration
(iii)	**Unit-III**	Optical instruments
14)	**Text Books and References:**	
(i)	A textbook of optics by N. Subramanian, Brij Lal and M. N. Avadhanulu	
(ii)	Optics by Benjamin Crowell	

Semester-II (for 2nd Semester)

1)	**Type of the Course**	Multi/Inter disciplinary Course (MDC -2)
2)	**Name of the Course**	Apparatus and Instrumentation (OPTICS-II)
3)	**Course Code**	
4)	**Total Credit**	3 (Three)
5)	**Floated by/Proposed by**	Department of Physics
6)	**Who can teach this course**	Faculties from Physics
7)	**Overview**	• This course allows for the students to understand basics principles, theory and construction of apparatus/setups in different areas of applied physics and provide basic training of their handling.
8)	**Programme/course Objectives**	• To make students understand basics principles, theory and construction of apparatus/setups in different areas of applied physics so that their experimental skilled are enhanced. Further, they can go to higher studies and develop expertise in an area of their choice.
9)	**Course features and Learning Outcomes**	Class room teaching, Conducting Lab practical (hands on training), Audio video lecture using ICT, Online faculty for query solving. On successful completion of the module students should be able to do experiments in a better way. Further, they can go to higher studies and develop expertise in an area of their choice
10)	**Who can attend /course audience**	This Course suitable for students from other than Science and Engineering Background.
11)	**Course eligibility/Pre-requisite**	Students from other than science and Engineering Background.
12)	**Course duration**	One Semester
13)	**Course Structure**	
(i)	**Unit-I**	Basic wave optics (Interference, Diffraction, Polarization) Features of a laser beam
(ii)	**Unit-II**	Basics of Fiber Optics
(iii)	**Unit-III**	Optical instruments, Optical setups and optics experiments
14)	**Text Books and References:**	
(i)	A textbook of optics by N. Subrahmanyam, Brij Lal and M. N. Avadhanulu	
(ii)	Optics by Ajoy Ghatak	

EXPERIMENTAL PHYSICS (4-0-0)

Unit-I: Particle Accelerators

Ion Sources, Cock-Craft-Walton and Voltage Generator, Van-de-graffAccelerator,Tandem Accelerator, Pelletron Accelerators, Folded Tandem Accelerators, Linear Accelerators (LINAC) or Drift tube Linear accelerators, Cyclotron, Betatron, TeV Accelerators, Particle Accelerators in India

Unit-II Detection and Measurement of Nuclear Radiation

Basic Idea about detection of nuclear radiation, Ionisation Chamber, Proportional Counter, Geiger-Muller counter (G.M. Counter), Scintillation Counters, Scintillation Detector for Gamma ray Spectroscopy, Semiconductor Detectors, Surface Barrier Detectors, Germanium-Lithium (Ge-Li) and HPGe Detectors, Modern Cloud Chamber, Multiwire Proportional Chambers (MWPC)

Unit-III:Optical Properties of Materials

Experiments to study optical properties of materials: Basics of rotational, vibrational, infrared and Raman spectroscopy. Working principle and experimental design of UV-Vis spectrometer, Photo luminescence spectrometer, FTIR spectrometer and RamanSpectrometer and data analysis.Experiments to study thermal properties of materials: Basics of thermo gravimetric,differential thermal analysis and differential scanning calorimetry techniques. Workingprinciple,experimental design and data analysis

Recommended books

1) W.R. Leo by Techniques for Nuclear and Particle Physics Experiments (Narosa)
2) S. S. Kapoor and V. S. Ramamurthy by Nuclear Radiation Detectors (New Age)
3) R. M. Singru by Introduction to Experimental Nuclear Physics (Wiley Eastern Pvt.)
4) Rohit P. Prasankumar, Optical Techniquesfor Solid-State Materials Characterization.
5)Fiorilloand Isaak D. Mayergoyz, Characterization and Measurement of Magnetic Materials.

COMMUNICATION ELECTRONICS (4-0-0)

Communication Networks: Introductions Types of network, Network topologies, Networks protocols, Networks Architecture.

Review of Analog and Digital communications, Introduction to Amplitude, Frequency and phase Modulation and their frequency spectra.

Pulse communication: Information theory, Coding, Noise in an information carrying channel, Pulse modulation - Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation, Pulse Code Modulation.: concept of Time Division Multiplexing.

Optical Fibre communication: Principle and techniques of electro-optic modulation. Constituents of optical communication system, propagation of light in optical fibre.

Satellite communication: Introduction to microwave electronics, principle of velocity modulation, General structure of Satellite communication, Merits and drawbacks, Active and Passive satellites, Concept of digital modulation (Amplitude shift keying, Frequency shift keying, Phase shift keying), Digital satellite communication.

Recommendedbooks

1. Fraser,Telecommunications.
2. GuptaandKumar,HandbookofElectronics.
3. SimonHaykin, Principles ofCommunication Systems, JohnWiley.
4. GeorgeKennedyandBernardDavis,ElectronicsandCommunication System, TMH.
5. RoddyandCoolen,Electronicscommunication.
6. D.C.AgrawalandA.K.Maini,SatelliteCommunication.
7. T.PrattandC.W.Bostiem,SatelliteCommunication
8. G.E.Optical Fiber Communications, McGraw-Hili

OPTO ELECTRONICSAND FIBRE OPTIC COMMUNICATION (4-0-0)

Fermat's Principle and its applications, Revision of basics of reflection, refraction, transmission and absorption of light radiation, Ray tracking through mirrors, lenses, prisms, etc. Refractive index and total internal reflection.

Introduction of optical fiber (step index, graded index, single-mode and multimode light propagation in optical fibre, dispersion and losses in optical fibers, fiber manufacturing

Basic constituents of optical communication system, Optical transmitters: LEDs and Laser diode - working principle and applications, Optical receivers: Photo-detectors, Optical amplifiers: WDM systems.

Introduction to electro-optics, Principle and technique of electro-optic modulation. "Introduction to liquid crystals, LED and Liquid Crystal Display.

Recommended Books;

1. R.P.Khare,FibreOptiCSandOptoelectronics, OxfordPress.
2. J.WilsonandJ.Hawkes,Optoelectronics–AnIntroduction, PrenticeHall.
3. A.K.GhatakandK.Thyagarajan,Introduction ToFibreOptics,CambridgeUniv.Press.

4. G.E.Keiser,OpticalFiberCommunications, McGraw-Hili.
5. P.K.Chea,FiberOptiCS,DevicesandSystems.

RADIATION PHYSICS (4-0-0)

Unit-I: Idea of Nuclear Processes in Radioactive Sources

Characteristic of nuclear radiations, alpha decay, beta decay, electron capture, gamma emission, annihilation radiation, alpha Sources, gamma Sources, neutron sources, source activity, law of radioactive decay, statistical error of nuclear physics, radioactive growth and decay, decay chains

Unit-II: Nuclear Radiation Passes Through Matter

cross-section, interaction probability in a distance and mean free path, stopping power of charged particles, straggling, Qualitative discussion of Bethe-Bloch formula, Radiation length, Half thickness, range of electrons, interaction of photons, neutrons and charged particles with matter

Unit-III: Characteristics of Detectors:

Sensitivity, Detector response, Energy resolution, Response time, Detector efficiency, Dead time, Recovery time, Ionization mechanism and introductory idea of some charged particle, gamma rays and neutron detectors.

Unit-IV: Protection of Radiation

Dosimeter, Dosimetric Units, Roentgen, Absorbed dose, Relative Biological effectiveness (RBE),Equivalent dose, Effective Dose, Typical doses from sources (Natural, Enviro nmental & Medical exposures), Radiation shielding and its safety (Gamma-rays, electrons, positrons, charged particles, Neutrons), Ethics of radiations.

Unit-IV: Radiation Effects on Biological Systems:

High doses received in a short time, Low-level doses limits, direct ionization of DNA, radiation damage to DNA, Biological effects (Genetic, Somatic, Cancer and sterlity).

Recommended Books:

1) Introduction to Experimental Nuclear Physics by R.M. Singru.
2) A Primer in Applied Radiation Physics by F.A. Smith.
3) Radiation Biophysics by E.L. Alpen.
4) Atom, Radiation and Radiation Protection by J. Turner.

SEC - COMPUTATIONAL PHYSICS

Interpolation: Finite differences; Newton's forward and backward interpolation formula; Lagrange's formula; Central differences; Method of least squares.
Solution of algebraic and transcendental equations: Iterative methods, Newton-Raphson method.
Matrices: Eigen value and eigen vectors, matrix decomposition, inverse of matrix, norm of matrix.
Solution of System of Linear equations: Direct methods: Gauss elimination method, LU – Decomposition, Cholesky method, iteration methods: Jacobi method, Gauss-Seidel method.
Numerical solution of ordinary differential equations: Euler method, Modified Euler method and Runge-Kutta method.
Finite difference method: Solution of boundary value problems of ordinary and partial differential equations.

Books Suggested:

1. S. S. Sastry. Numerical Analysis, Prentice Hall of India Pvt. Ltd., New delhi.

2. M. K. Jain et. al. Numerical Methods for Scientists and Engineers, New Age International Publishers, New Delhi.