MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI – 12

M.Sc. DEGREE COURSE IN PHYSICS

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005

FROM THE ACADEMIC YEAR 2024 – 2025

PREAMBLE

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M. Sc., Physics**
Programme Code	
Duration	The course of study shall be on Semester System. The two year post graduate programme in M.Sc., Physics consists of four semesters under Choice Based Credit System (CBCS).

PROGRAM OBJECTIVES AND OUTCOMES

PO1	The primary objective of the M.Sc (Physics) program is to offer an enriched curriculum that incorporates the latest scientific developments in physics and its interdisciplinary areas, addressing the needs of contemporary academia, research, and industry.
PO2	To provide comprehensive knowledge in theoretical, experimental, and computational physics, ensuring a thorough understanding of the subject.
PO3	To educate students on the core subjects of physics, enabling them to acquire knowledge and gain a deep understanding of the laws, concepts, and principles of physics, as well as to solve analytical problems.
PO4	To enhance knowledge through problem-solving exercises, projects, seminars, participation in scientific events, and study visits.
PO5	To prepare students for careers in teaching, research laboratories, and public/private sector units, while also fostering entrepreneurial skills.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Upon successful completion of the M.Sc. Physics program, students will:

PSO1	Possess a deep understanding of the fundamental concepts of physics and comprehend how various natural phenomena adhere to the laws of physics.
PSO2	Be capable of identifying, formulating, and analyzing scientific problems using basic principles.
PSO3	Develop strong problem-solving skills and be able to apply mathematical tools to understand and describe physical problems.
PSO4	Be proficient in handling laboratory equipment, gaining knowledge of advanced experimental techniques, and successfully interpreting results for research and industrial applications.
PSO5	Acquire effective computational skills for application to scientific and technological problems.
PSO6	Become familiar with contemporary research across various fields of physics

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The curriculum for the P.G. Physics for universities and colleges is revised as per Learning Outcomes- based Curriculum Framework (LOCF). The learner centric courses are designed to enable the students to progressively develop a good understanding of the concepts of various domains in physics. Significant modification is the inclusion of the courses to equip students to face challenges in industries and make them employable. Skill development in different spheres and confidence building are given a special focus.

TANSCHE Template for P.G., Programmes

Semester–I	**Credit**	**Hours**	**Semester-II**	**Credit**	**Hours**	**Semester-III**	**Credit**	**Hours**	**Semester–IV**	**Credit**	**Hours**
Core-I	5	7	Core-IV	5	6	Core-VII	5	6	Core-XI	5	6
Core-II	5	7	Core-V	5	6	Core-VIII	5	6	Core-XII	5	6
Core – III	4	6	Core – VI	4	6	Core – IX	5	6	Project with viva voce	7	10
Elective -I Discipline Centric	3	5	Elective – III Discipline Centric	3	4	Core – X	4	6	Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
Elective-II Generic:	3	5	Elective -IV Generic:	3	4	Elective - V Discipline Centric	3	3	Skill Enhancement course / Professional Competency Skill	2	4
			Skill Enhancement I	2	4	3.6 Skill Enhancement II	2	3	Extension Activity	1	
						3.7 Internship/ Industrial Activity	2	-			
	20	**30**		**22**	**30**		**26**	**30**		**23**	**30**

Total Credit Points -91

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System for all Post – Graduate Courses including Lab Hours

First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	5	7
	Core – II	5	6
	Core Practical - I	4	6
	Elective – I (Discipline Centric)	3	6
	Elective – II (Generic)	3	5
		20	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – III	5	6
	Core – IV	5	6
	Core Practical -II	4	6
	Elective – III **(Discipline Centric)**	3	4
	Elective – IV (Industry Entrepreneurship)	3	4
	Skill Enhancement Course - I	2	4
		22	**30**

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
	Core –V	5	6
	Core –VI	5	6
	Core - VII	5	6
	Core Practical – III (Industry Module)	4	6
	Elective – V **(Discipline Centric)**	3	3
	Skill Enhancement Course - II	2	3
	Internship / Industrial Activity	2	-
		26	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – VIII	5	6
	Core Practical - IV	4	6
	Project with VIVA VOCE	8	8
	Elective – VI (Generic)	3	6
	Skill Enhancement Course – III / Professional Competency Skill	2	4
	Extension Activity	1	-
		23	**30**
Total 91 Credits for PG Courses			

METHODS OF EVALUATION - Theory		
Internal Evaluation	Continuous Internal Assessment Test Assignments / Snap Test / Quiz Seminars Attendance and Class Participation	**25 Marks**
External Evaluation	End Semester Examination	**75 Marks**
Total		**100 Marks**

METHODS OF ASSESSMENT	
Remembering (K1)	• The lowest level of questions require students to recall information from the course content • Knowledge questions usually require students to identify information in the textbook.
Understanding (K2)	• Understanding of facts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in their own words. The questions go beyond simple recall and require students to combined at a together
Application (K3)	• Students have to solve problems by using/applying a concept learned in the classroom. • Students must use their knowledge to determine a exact response.
Analyze (K4)	• Analyzing the question is one that asks the students to break down given problem into its component parts. • Analyzing requires students to identify reasons causes or motives and reach conclusions or generalizations.
Evaluate (K5)	• Evaluation requires an individual to make judgment on the given problem / question. • Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. • Students are engaged in decision-making and problem–solving. • Evaluation questions do not have single right answers.
Create (K6)	• The questions of this category challenge students to get engaged in creative and original thinking. • Developing original ideas and problem solving skills

M.Sc PHYSICS - COURSE STRUCTURE

FIRST SEMESTER

COURSE COMPONENTS	NAME OF THE COURSE	Instruction Hours	Credits	Exam Hours	MAX MARKS	
					CIA	EXT
Core-I	Mathematical Physics	**7**	5	3	25	75
Core-II	Classical Mechanics and Relativity	6	5	3	25	75
Core Practical- I	Practical-I: General Physics and Electronics Experiments – I	6	4	6	50	50
Elective- I (Discipline Centric)	**Choose any one from** a) Energy Physics b) Astro Physics c) Plasma Physics	5	3	3	25	75
Elective-II (Generic)	**Choose any one from** a) Linear and Digital ICs and Applications b) Digital Communication c) Communication Electronics	6	3	3	25	75
		30	**20**			

SECOND SEMESTER

COURSE COMPONENTS	NAME OF THE COURSE	Instruction Hours	Credits	Exam Hours	MAX MARKS	
					CIA	EXT
Core-III	Statistical Mechanics	6	5	3	25	75
Core-IV	Quantum Mechanics –I	6	5	3	25	75
Core Practical-II	Practical – II: General Physics and Electronics Experiments – II	6	4	6	50	50
Elective- III (Discipline Centric)	**Choose any one from** a) Advanced Optics b) Non Linear Dynamics c) Physics of Nano Science and Technology	4	3	3	25	75
Elective – IV (Industry Entrepreneurship)	**Choose any one from** a) Microprocessor 8085&Microcontroller 8051 b) Material Science c) Characterization of Materials	4	3	3	25	75
***SEC – I (PCS)**	Physics for Competitive Examinations	4	2	3	25	75
		30	**22**			

***SEC: Skill Enhancement Course – Professional Competency Skill**

THIRD SEMESTER

COURSE COMPONENTS	NAME OF THE COURSE	Instruction Hours	Credits	Exam Hrs	MAX MARKS	
					CIA	EXT
Core- V	Quantum Mechanics-II	5	5	3	25	75
Core- VI	Condensed Matter Physics	5	5	3	25	75
Core –VII	Numerical Methods and Programming in C++	5	5	3	25	75
Core Practical- III (Industry Module)	Advanced Physics Experiments-I and Microprocessor 8085 & Microcontroller 8051 Programming	6	4	6	50	50
Elective- V (Discipline Centric)	**Choose any one from** a) Spectroscopy b) Crystal Growth and Thin Films c) General Relativity and Cosmology	5	3	3	25	75
***SEC- II (Industry Oriented)**	Sewage and Waste Water Treatment and Reuse	4	2	3	25	75
	Internship / Field Visit / Industrial Visit/ Research Knowledge Updating Activity	-	2		50	50
		30	**26**			

***SEC: Skill Enhancement Course**

FOURTH SEMESTER

COURSE COMPONENTS	NAME OF THE COURSE	Instruction Hours	Credits	Exam Hrs	MAX MARKS	
					CIA	EXT
Core- VIII	Nuclear and Particle Physics	6	5	3	25	75
Core Practical- IV	Advanced Physics Experiments - II and Numerical Methods in C++	6	4	3	50	50
Elective- VI (Generic)	**Choose any one from** a) Electro Magnetic Theory b) Quantum Field Theory c) Advanced Mathematical Physics	6	3	6	25	75
***SEC- III (Industry Oriented)**	Solar Energy Utilization	4	2	3	25	75
Core Project	Project with viva voce	8	8		50	50
	Extension Activity: Choose any one from List - I	-	1		50	50
		30	**23**			

***SEC: Skill Enhancement Course**

SUMMARY STRUCTURE OF THE PROGRAMME

Course Type	No. of Courses	Credit Distribution	Total No. of Credits
Core Paper	8	5	40
Core Practical	4	4	16
Elective	6	3	18
Project	1	8	8
Skill Enhancement Course	3	2	6
Internship/Field Visit /Research Knowledge Updating Activity	1	2	2
Extension Activity	1	1	1
TOTAL	**24**		**91**

LIST - I - ACADEMIC EXTENSION ACTIVITY

1. **Entrepreneurship and Innovation Workshop Series**
   Empowering students to develop entrepreneurial skills and explore opportunities for commercializing physics-related technologies or starting their ventures.

2. **Computational Physics Hackathon**
   Organizing hackathons or coding competitions focused on solving physics problems using computational techniques, fostering collaboration and innovation among students

3. **Science Education Outreach Program**
   Involving students in educational outreach activities, such as designing and delivering physics workshops for schools or mentoring undergraduate students in projects.

4. **Physics in Your Pocket**
   An interactive workshop series exploring the physics concepts and experiments that can be conducted using sensors available in mobile phones, covering topics such as motion, sound, light & magnetism and monitoring air quality, temperature, humidity, and pollution levels in various locations (student residence)

5. **Conduct Virtual Experiments and Prepare Reports**
   a) Conduct the diffraction at a slit experiment virtually using the following link
   https://www.walter-fendt.de/html5/phen/singleslit_en.htm
   i) Measure the angular spread (ϴ) for different slit widths (Δx) for given wavelength of the incident photon. ii). Determine the momentum of the incident photon using, p=h/λ
   iii) . Create a line of best fit through the points in the plot 1 Δpx against $\Delta x$and find its slope. How this exercise is related to Heisenberg Uncertainty principle Make a report of the observations
   b) Virtual lab - Photoelectric effect using Value@Amritha: link
   https://vlab.amrita.edu/?sub=1&brch=195&sim=840&cnt=1
   i) Determine the minimum frequency required to have Photoelectric effect for an EM radiation, when incident on a zinc metal surface. ii) . Determine the target material if the threshold frequency of EM radiation is$5.5x10^{15}$ Hz in a particular photoelectric experimental set up.
   iii) Determine the maximum kinetic energy of photo-electrons emitted from a Zinc metal surface,
   if the incident frequency is $3x10^{15}$Hz. Make a report of the calculations
   c) Visualization of wave packets using Physlet@Quantum Physics:
   https://www.compadre.org/PQP/quantum-need/prob5_11.cfm
   Six different classical wave packets are shown in the animations. Which of the wave packets have a phase velocity that is: greater than / less than / equal to the group velocity? Make a report of the observations.

6. **Construction of physics Models**
7. **Science Club Activities**
   (Report for the Extension activity shall be submitted by the students individually)

Field Visit/WORK

Fieldwork, as a derived concept, is the practical work carried out by students outside the classroom or laboratory in order to acquire hands-on experience, handle data, make observations, and interact with areas that are actual, involving the subject of their studies or professional practices. Practical field work includes having an interaction with nature, field sites, fancy tools, instruments, and local communities for discussion of the specific topics and studies to collect, investigate and analyze or for the utilization in disciplines of natural sciences, social sciences, humanities, engineering and other professional fields.

Following are some of the fieldwork activities a student or group of students may undertake.

(Not only restricted to the following activities)

Atmospheric Physics Measurements: Perform atmospheric physics measurements, such as temperature, humidity, and pressure, using weather stations or handheld instruments. Study atmospheric phenomena, weather patterns, and climate change indicators.

Water Quality Analysis: Collect water samples from lakes, rivers, or oceans to analyze water quality parameters, such as pH, salinity, and dissolved oxygen. Investigate water pollution sources, ecological impacts, and aquatic ecosystems.

Wind Energy Measurements: Conduct wind speed and direction measurements using anemometers and wind vanes at potential wind farm sites.

Study wind energy potential, turbine design, and wind farm optimization.

Thermal Power Plant Tour and Operation Overview: Organize a guided tour of a thermal power station to study the overall operation, energy generation processes, and power plant components, such as boilers, turbines, and generators. Learn about thermal power generation principles, steam cycles, and energy conversion efficiency.

Nuclear Power Plant Tour: Organize a guided tour of a nuclear power plant to study nuclear reactor design, operation, and safety measures.

Learn about nuclear fuel cycles, reactor control systems, and radiation monitoring.

Observational Astronomy: Organize a field trip to an observatory or a dark sky site for astronomical observations using telescopes. Study celestial objects, such as planets and stars.

Solar Observations: Conduct solar observations using solar telescopes or solar filters or collect data from solar observatories to study sunspots, solar flares, and solar prominences. Analyze solar activity and its impact on space weather.

Space Observatory Field Trip: Visit space observatories, astronomical research facilities, or satellite ground stations to study space exploration missions, astronomical observations, and satellite communications. Explore telescope technologies, observational techniques, and data acquisition systems.

Rocket Launch and Space Mission Observation: Attend rocket launch events, space mission launches, or spacecraft test flights to observe space launch operations, rocket propulsion systems, and aerospace technologies. Explore launch vehicle designs, mission profiles, and space exploration advancements.

Geomagnetic Field Measurements: Conduct geomagnetic field measurements using magnetometers at different locations to study Earth's magnetic field variations. Investigate geomagnetic storms, magnetic anomalies, and their effects on Earth's environment.

Data Science and Machine Learning Workshop: Attend workshops or training sessions on data science, machine learning, and artificial intelligence applications in physics research. Explore data analytics, pattern recognition, and predictive modeling techniques.

(Report for the Internship/ Field visit/ Industrial Visit/ Research Knowledge Updating Activity shall be submitted by the students individually)

PROJECT WORK

Rules and Regulations for PG Physics Project

<table>
<tr><td>Individual Project</td><td>Each candidate must undertake an individual project. Group projects are not permitted</td></tr>
<tr><td>Project Types</td><td>Projects must be based on one or more of the following areas:
Theoretical Physics
Experimental Physics
Computational Physics
Scientific Data Analysis</td></tr>
<tr><td>Prohibited Projects</td><td>Readymade projects are not recommended
Electronic construction projects, IOT projects are not allowed unless they are the original idea of the student and approved by the project supervisor.</td></tr>
<tr><td>Project Report</td><td>Students must adhere to the template provided for the preparation of their project reports.
The report should include an abstract, introduction, literature review, methodology, results, discussion, conclusion, and references.</td></tr>
<tr><td>Originality and Plagiarism</td><td>Projects must be original work by the student.
Plagiarism in any form is strictly prohibited and will result in disqualification.</td></tr>
<tr><td>Supervision</td><td>Each project must be supervised by a faculty member.
Regular updates and consultations with the supervisor are mandatory</td></tr>
<tr><td>Safety and Ethics</td><td>Students conducting experimental projects must follow all laboratory safety protocols.
Ethical guidelines in research must be strictly followed</td></tr>
<tr><td>Evaluation</td><td>Projects will be evaluated by the external examiners based on originality, methodology, analysis, and adherence to the provided template.
Both a written report and an oral presentation may be required as part of the evaluation process.</td></tr>
<tr><td colspan="2">Students are encouraged to consult their supervisors and the department for any clarifications regarding these rules and regulations</td></tr>
<tr><td colspan="2">Internal : 50 Marks and External : 50 Marks</td></tr>
</table>

FORMAT FOR PREPARATION OF PROJECT REPORT

Students are required to submit a Project report at the end of Semester - IV and also required to make presentation of the project work during Viva- voce Examination. Each student should submit **TWO** copies of the project report with a minimum of 50 pages not exceeding 75 pages to the Department on or before the date notified for the same.

The sequence in which the project report should be arranged and bound should be as follows

1	Cover Page and Title Page
2	Certificate
3	Declaration
4	Acknowledgement (not exceeding one page)
5	Abstract
6	Contents
7	List of Figures / Exhibits / Charts/ Circuit Diagrams
8	List of tables
9	Symbols and notations
10	Chapters
11	Result and Discussion
12	Conclusion
13	References
14	Xerox Copies of Publications/Certificates of Seminar, Conference Participation if any

Running matter - Times New Roman , Font size 12 , with 1.5 line spacing

CORE I: MATHEMATICAL PHYSICS	I YEAR - FIRST SEMESTER

Subject Code	Subject Name		L	T	P	Credit	Instruction hours	Marks
	MATHEMATICAL PHYSICS	**Core**				5	7	75

Pre-Requisites
Matrices, Vectors, Basics of Differentiation, Integration and Differential equations
Learning Objectives
➢ To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program ➢ To extend their manipulative skills to apply mathematical techniques in their fields ➢ To help students apply Mathematics in solving problems of Physics

UNITS	Course Details
UNIT I: LINEAR VECTOR SPACE	Basic concepts – Definitions- examples of vector space – Linear independence Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure – linear operators – Dual space- Ket and Bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator – orthogonal transformations and rotation for R^2 Vector space with standard basis.
UNIT II: COMPLEX ANALYSIS and GROUP THEORY	Review of Complex Numbers -de Moivre's Theorem-Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series Laurent's Expansion- Zeros and poles – Residue theorem. Concept of groups-Abelian group-cyclic group- subgroups- classes- conjugate subgroups- Isomorphism and homomorphism – reducible and irreducible representations- character tables- construction of character tables for C_2V and C_3V point groups.
UNIT III: MATRICES	Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem – Diagonalization

UNIT IV: FOURIER TRANSFORMS & LAPLACE TRANSFORMS	Definitions -Fourier series and transform and its inverse – Properties of FT - Fourier transform of derivatives - Cosine and sine transforms – Properties of FT – Simple Applications. Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms – Properties of LT- Simple applications.
UNIT V: DIFFERENTIAL EQUATIONS	Second order differential equation- Sturm-Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function Orthogonality properties - Recurrence relations – Legendre polynomials Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function - One dimensional Green's function and Reciprocity theorem.

TEXT BOOKS	1. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press. 2. P.K. Chattopadhyay, 2013, *Mathematical Physics* (2^{nd} edition), New Age, New Delhi 3. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt. Ltd., India 4. B. D. Gupta, 2009, *Mathematical Physics* (4^{th} edition), Vikas Publishing House, New Delhi. 5. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.
REFERENCE BOOKS	1. E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi, 2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi. 3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York 3. E. Butkov, 1968, Mathematical Physics Addison Wesley, Reading, Massachusetts. 4. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated East West, New Delhi. 5. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York
WEB SOURCES	1. www.khanacademy.org 2. https://youtu.be/LZnRlOA1_2I 3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath 4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ 5. https://archive.nptel.ac.in/courses/115/106/115106086/

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	**K1, K2**
CO2	Able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	**K2, K3**
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	**K4**
CO4	Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	**K4, K5**
CO5	To find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	**K2, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes**(CO)** for each course with program outcomes**(PO)** and program specific outcomes **(PSO)** inthe3-pointscale of STRONG(3), MEDIUM(2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

CORE II: CLASSICAL MECHANICS AND RELATIVITY	I YEAR – FIRST SEMESTER

Subject Code	Subject Name		L	T	P	Credit	Instruction hours	Marks
	CLASSICAL MECHANICS AND RELATIVITY	**Core**				5	6	75

Pre-Requisites
Fundamentals of mechanics, Foundation in mathematical methods.
Learning Objectives
➢ To understand fundamentals of classical mechanics. ➢ To understand Lagrangian formulation of mechanics and apply it to solve equation of motion. ➢ To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion. ➢ To discuss the theory of small oscillations of a system. ➢ To learn the relativistic formulation of mechanics of a system

UNITS	Course Details
UNIT I: PRINCIPLES OF CLASSICAL MECHANICS	Mechanics of a single particle – conservation laws for a particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.
UNIT II: LAGRANGIAN FORMULATION	D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine – Lagrange's equations in presence of non-conservative forces – Lagrangian for a charged particle moving in an electromagnetic field.
UNIT III: HAMILTONIAN FORMULATION	Phase space – generalized momentum and cyclic coordinates – Hamiltonian function and conservation of energy – Hamilton's canonical equations of motion – applications: (i) one dimensional simple harmonic oscillator (ii) motion of particle in a central force field.
UNIT IV: SMALL OSCILLATIONS	Stable and unstable equilibrium –Formulation of the problem: Lagrange's equations of motion for small oscillations – Properties of T, V and w –Normal co-ordinates and normal frequencies of vibration – free vibrations of a linear triatomic molecule.

UNIT V: RELATIVITY	Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in four vector notation and their transformations.

TEXT BOOKS	1. H. Goldstein, *Classical Mechanics*, 3rd Edition, Pearson Edu. 2002. 2. J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publshing Co. New Delhi. 3. S.L. Gupta,V.Kumar, H.V. Sharma, Classical Mechanics, PrakatiPrakashan, Meerut. 4. R. Resnick, *Introduction to Special Theory of Relativity*, Wiley Eastern, New Delhi, 1968. 5. N. C. Rana and P.S. Joag, Classical Mechanics - Tata McGraw Hill, 2001
REFERENCE BOOKS	1. R. G. Takwala and P.S. Puranik, Introduction to Classical Mechanics –Tata – McGraw Hill, New Delhi, 1980. 2. K. R. Symon, 1971, *Mechanics*, Addison Wesley, London. 3. S. N. Biswas, 1999, *Classical Mechanics*, Books & Allied, Kolkata. 4. T.W.B. Kibble, *Classical Mechanics*, ELBS. 5. Greenwood, *Classical Dynamics*, PHI, New Delhi.
WEB SOURCES	1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf 2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014editionpdf-pdf-free.html 3. https://nptel.ac.in/courses/122/106/122106027/ 4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanicsiii-fall-2014/lecture-notes/ 5. https://www.britannica.com/science/relativistic-mechanics

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the fundamentals of classical mechanics.	**K2**
CO2	Apply the principles of Lagrangianmechanics to solve the equations of motion of physical systems.	**K3**
CO3	Apply the principles of Hamiltonian mechanics to solve the equations of motion of physical systems.	**K3, K5**
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	**K4, K5**
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

CORE PRACTICAL I: GENERAL PHYSICS AND ELECTRONICS EXPERIMENTS – I	I YEAR - FIRST SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credit	Instruction hours	Marks
	Practical-I: General Physics and Electronics Experiments – I	**Core**				4	6	50

Pre-Requisites
Knowledge and hands on experience of basic general and electronics experiments of Physics
Learning Objectives
➢ To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations. ➢ Application of Diffraction and Interference ➢ Determination of some physical constants ➢ To calculate the thermodynamic quantities and physical properties of materials. ➢ To analyze the optical and electrical properties of materials.

Course Details

(Choose any SIX experiments from Part A and SIX from Part B)

PART A- General Physics Experiments

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of Thickness of the enamel coating on a wire by diffraction
3. Measurement of Band gap energy of the Thermistor material
4. Determination of Planck Constant – LED Method
5. Determination of Compressibility of a liquid using Ultrasonic Interferometer
6. Determination of Wavelength, Separation of wavelengths using Michelson Interferometer
7. Accurate measurement of wavelength of Diode Laser using Diffraction grating.
8. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
9. Measurement of Susceptibility of liquid - Quincke's method
10. Determination of Self Inductance of the given coil using Maxwell's method.
11. Determination of Crystallographic Parameters for the given XRD spectrum
    a) Unit cell determination b) W-H plot and interpretation
12. Measurement of RC Time constant (through discharging) and its theoretical verification.

PART B – Electronics Experiments

1. Construction of series voltage regulator and its characteristics
2. FET CS amplifier- Frequency response, input impedance, output impedance
3. Important electrical characteristics of IC 741 (i/p and o/p impedance, Voltage Gain, CMRR).
4. Construction of a Constant current source using Transistor/FET and 741 and I-R characteristics (Floating and Grounded Load)
5. V- I and optical Characteristics of LEDs of different wavelengths.
6. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
7. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
8. To design and construct a Schmitt trigger using IC741
9. Construction of square wave and Triangular wave generator using IC 741
10. Construction of pulse generator using the IC 741 – application as frequency divider
11. Construction of Op-Amp- 4-bit Digital to Analog converter (Binary Weighted and R/2R ladder type
12. BCD addition using IC7483

TEXT BOOKS	1. Practical Physics, Gupta and Kumar, PragatiPrakasan. 2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences. 3. Electronic Laboratory Primer a design approach , S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi. 4. Electronic lab manual Vol I, K ANavas, Rajath Publishing. 5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
REFERENCE BOOKS	1. Advanced Practical Physics, S.P Singh, PragatiPrakasan. 2. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd 3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition. 4. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd. 5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the strength of material using Young's modulus.	**K2**
CO2	Acquire knowledge of thermal behavior of the materials.	**K1**
CO3	Understand theoretical principles of magnetism through the experiments.	**K2**
CO4	Acquire knowledge about arc spectrum and applications of laser	**K1, K3**
CO5	Improve the analytical and observation ability in Physics Experiments	**K3, K5**
CO6	Conduct experiments on characteristics of FET Amplifier	**K4**
CO7	Analyze various parameters related to operational amplifiers.	**K4**
CO8	Understand the concepts involved in arithmetic and logical circuits using IC's	**K2**
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	**K1**
CO10	Analyze the applications of counters and registers	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total
50	**50**	**100**

CORE- III : STATISTICAL MECHANICS	I YEAR - II SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	STATISTICAL MECHANICS	Core				5	6	75

Pre-Requisites
Laws of thermodynamics, phase transition, entropy, ensembles, partition function, classical and Quantum statistics, thermal equilibrium, Brownian motion
Learning Objectives
➢ To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics ➢ To identify the relationship between statistics and thermodynamic quantities ➢ To comprehend the concept of partition function, canonical and grand canonical ensembles ➢ To grasp the fundamental knowledge about the three types of statistics ➢ To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time

UNITS	Course Details
UNIT I: THERMODY NAMICS AND PHASE TRANSITIONS	Thermodynamic potentials and the reciprocity relations - Thermodynamic Equilibrium - Gibb's phase rule - Third law of Thermodynamics - Phase transitions of first and second kind – Critical exponent - Phase Transitions of the second kind: The Ising model – Bragg-Williams approximation - One dimensional Ising model.
UNIT II: STATISTICAL MECHANICS	Introduction to statistical mechanics - Phase space – Ensembles and their types – Liouville's theorem – Postulate of equal priori probability – Microstates and macrostates – Stirling's formula – The most probable distribution – Law of equipartition of energy - Entropy and probability – Probability distribution and entropy of a two level system - Negative temperature.
UNIT III: MICRO CANONICAL AND GRAND CANONICAL ENSEMBLES	Microcanonical ensemble (Isolated system) – Perfect gas in Microcanonical ensemble – Gibbs paradox – Partition function and its correlation with thermodynamic quantities - Grand canonical ensemble (system with an infinite number of particles) – Partition function and thermodynamic functions for Grand canonical ensemble – Perfect gas in Grand canonical ensemble – Applications: Mean kinetic energy of a molecule in a gas, Brownian motion and Harmonic oscillator.

UNIT IV: CLASSICAL AND QUANTUM STATISTICS	Density matrix - Density matrix in micro canonical, canonical and grand canonical ensembles - Bose-Einstein statistics - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Black-body radiation and the –Plank radiation law - Bose-Einstein gas - Bose-Einstein condensation – Fermi-Dirac gas.
UNIT V: LOW TEMPERATURE, ISINGMODELAND FLUCTUATIONS	Production of Low Temperature – Measurement of Low temperature – Approach to absolute zero by adiabatic demagnetization : Principle, Method, Theory and T-S diagram – Conversion of magnetic temperature to Kelvin temperature - Fluctuations and transport phenomena – Brownian movement –Motion due to fluctuating force: The Fokker - Planck equation – Fluctuation in energy and pressure

TEXT BOOKS	1. Dr. S. L. Gupta and Dr. V. Kumar, 2008, *ElementaryStatistical Mechanics,* 22nd Edition, PragatiPrakashan, Meerut. 2. S. K. Sinha, 1990, *Statistical Mechanics*, Tata McGraw Hill, New Delhi. 3. B. K. Agarwal and M. Eisner, 1998, *Statistical Mechanics*, Second Edition New Age International, New Delhi. 4. J. K. Bhattacharjee, 1996, *Statistical Mechanics*: An Introductory Text, Allied Publication, New Delhi. 5. F. Reif, 1965, *Fundamentals of Statistical and Thermal Physics,* McGraw -Hill, New York. 6. M. K. Zemansky, 1968, *Heat and Thermodynamics,* 5th edition, McGrawHill New York.
REFERENC E BOOKS	1. R. K. Pathria, 1996, *Statistical Mechanics*, 2nd edition, Butter WorthHeinemann, New Delhi. 2. L. D. Landau and E. M. Lifshitz, 1969, *Statistical Physics,* Pergamon Press, Oxford. 3. K. Huang, 2002, *Statistical Mechanics*, Taylor and Francis, London 4. W. Greiner, L. NeiseandH.Stoecker, *Thermodynamics and Statistical Mechanics,* Springer Verlang, New York. 5. A. B. Gupta, H. Roy, 2002, *Thermal Physics*, Books and Allied, Kolkata.
WEB SOURCES	1. https://byjus.com/chemistry/third-law-of-thermodynamics/ 2. https://web.stanford.edu/~peastman/statmech/thermodynamics.h tml 3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_therm odynami cs 4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble 5. https://en.wikipedia.org/wiki/Ising_model

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	**K5**
CO2	To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. Describe the peculiar behavior of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	**K4**
CO3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	**K1**
CO4	To recall and apply the different statistical concepts to analyze the behavior of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	**K4, K5**
CO5	To discuss and examine the thermodynamical behavior of gases under fluctuation and also using Ising model	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

CORE IV - QUANTUM MECHANICS – I	I YEAR - SECOND SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	QUANTUM MECHANICS –I	Core				5	6	75

Pre-Requisites
Newton's laws of motion, Schrodinger's equation, integration, differentiation
Learning Objectives
.   ➢ To develop the physical principles and the mathematical background important to quantum mechanical descriptions.   ➢ To describe the propagation of a particle in a simple, one-dimensional potential.   To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential   ➢ To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature   ➢ To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

UNITS	Course Details
UNIT I: BASIC FORMALISM	Wave Mechanical Concepts: Wave packet - Time dependent Schrodinger equation –Interpretation of the wave function –Ehrenfest's theorem- Time independent Schrodinger equation - Stationary states –– Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation.
UNIT II: GENERAL FORMALISM	Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation –Momentum representation – Symmetries and conservation laws: Conservation of linear momentum, Energy and Angular momentum – Parity conservation and time reversal.

UNIT III: ONE DIMENSIONAL AND THREEDIMENSIONAL ENERGY EIGEN VALUE PROBLEMS	Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-Penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Rigid rotator– Hydrogen atom.
UNIT IV: APPROXIMATION METHODS	Time independent perturbation theory:Non-degenerate energy levels – Ground state of Helium atom – First order Stark effect in Hydrogen atom – Degenerate energy levels - Excited state of Hydrogen atom - WKB approximation – Connection formulae (no derivation) –Application of WKB method: Barrier penetration – Alpha emission.
UNIT V: ANGULAR MOMENTUM	The Eigenvalue spectrum– Ladder operators– Matrix representation of J – Spin angular momentum – Addition of angular momenta – CG Coefficients – Angular momentum commutation relations – Eigen values of J^2 and J_z - Spin angular momentum - Pauli's exclusion principle.

TEXT BOOKS	1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2ndedition (37th Reprint), Tata McGraw-Hill, New Delhi, 2010. 2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009. 3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011. 4. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982. 5. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4thEdition, Macmillan, India, 1984.
REFERENCE BOOKS	1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970. 2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985. 3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976. 4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata,1999. 5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011.

WEB SOURCES	1. http://research.chem.psu.edu/lxjgroup/download_files/chem565c7.pdf 2. http://www.feynmanlectures.caltech.edu/III_20.html 3. http://web.mit.edu/8.05/handouts/jaffe1.pdf 4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_ 1.pdf 5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	**K1, K5**
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	**K3, K4**
CO3	Can discuss the various representations, space time symmetries and formulations of time evolution	**K1**
CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems	**K4, K5**
CO5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	**K3, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

CORE Practical -II: GENERAL PHYSICS AND ELECTRONICS EXPERIMENTS – II	I YEAR - SECOND SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	PRACTICAL II: **General Physics and Electronics Experiments – II**	Core				4	6	50

Pre-Requisites
Knowledge and handling of basic general and electronics experiments of Physics
Learning Objectives
➢ To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations. ➢ To analyze the magnetic properties of materials. ➢ To analyze the optical and electrical properties of materials. ➢ To observe the applications of FET and UJT. ➢ To study the different applications of operational amplifier circuits. ➢ To learn about Combinational Logic Circuits and Sequential Logic Circuits

Course Details

PRACTICAL II

(Choose any SIX experiments from Part A and SIX from Part B)

PART A : General Physics Experiments -II

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
2. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
3. B-H curve - Formation and tracing magnetic hysteresis loop and determination of energy loss for the given specimen.
4. Measurement of Magnetic Susceptibility by Guoy's method
5. Formation of acoustic grating in a given liquid and determination of velocity of ultrasonic wave in the liquid and compressibility of liquid. (Ultrasonic diffraction)
6. Determination of Thickness of thin film using Michelson Interferometer
7. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser
8. Determination of Numerical Apertures and Acceptance angle, attenuation of optical fibers
9. Equipotential lines and electric field mapping for electrodes of different shapes.
10. Determination of Mutual Inductance and coefficient of coupling for the given pair of coils using Heaviside Bridge method
11. Hall Effect – determination of Hall coefficient, carrier concentration and mobility
12. Temperature coefficient of a thermistor using Carry Foster Bridge.

PART B : Electronics Experiments -II

1. Determination of V-I Characteristics and efficiency of solar cell.
2. Construction of a relaxation oscillator using UJT, measuring the frequency of oscillation for different RC values and comparing it with the theoretical value.
3. Modulus counter using IC 7490 and seven segment display using IC 7447 / IC 7448
4. Solving simultaneous equations using IC 741 / IC LM324
5. Study of Op-Amp –Active filters: Low pass, High pass and Band pass filters
6. Construction of Current to Voltage and Voltage to Current Convertor using IC 741
7. Construction of square wave generator using IC 555 and VCO using 555
8. Code Conversion: BCD to Excess- 3 and Excess 3 to BCD
   Binary to Gray and Gray to Binary
9. Study of Binary Ripple Counter using IC 74393 and LEDs
10. Study of RS, Clocked RS and D Flip-Flops.
11. Construction of Shift register and Ring counter using IC 7476 /IC 7474
12. Construction of Schmitt trigger circuit using IC555 for a given hysteresis – Application as squarer

TEXT BOOKS	1. Practical Physics, Gupta and Kumar, PragatiPrakasan 2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences 3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition. 4. Electronic lab manual Vol I, K ANavas, Rajath Publishing 5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
REFERENCE BOOKS	1. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd 2. Advanced Practical Physics, S.P Singh, PragatiPrakasan 3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt.ltd 4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing 5. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total
50	50	**100**

COURSE OUTCOMES

At the end of the course the student will be able to:

CO1	Understand the strength of material using Young's modulus	**K2**
CO2	Acquire knowledge of thermal behavior of the materials	**K1**
CO3	Understand theoretical principles of magnetism through the experiments.	**K2**
CO4	Acquire knowledge about arc spectrum and applications of laser	**K1**
CO5	Improve the analytical and observation ability in Physics Experiments	**K4**
CO6	Conduct experiments on applications of UJT	**K5**
CO7	Analyze various parameters related to operational amplifiers	**K4**
CO8	Understand the concepts involved in arithmetic and logical circuits using IC's	**K2**
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	**K3**
CO10	Analyze the applications of counters and registers	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	S	S	2	2	2	3	3
CO2	2	2	S	S	S	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	S	S	2	2	2	3	3
CO7	2	2	S	S	S	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

Skill Enhancement Course I: PHYSICS FOR COMPETITIVE EXAMINATIONS	I YEAR - SECOND SEMESTER

Subject Code	Subject Name		L	T	P	Credits	Inst. Hours	Marks
	PHYSICS FOR COMPETITIVE EXAMINATIONS	SEC				2	4	75

Pre-Requisites
Basic fundaments of Physics ,Newton's equations of motion, Black body radiation, Snell's law, Gauss' law, special theory of relativity etc.
Learning Objectives
➢ To develop the basics of physical principles and the mathematical background important to general mechanics and properties of matter. ➢ To recollect the ideas of heat and thermodynamics ➢ Formulation of the concepts of reflection, refraction in optics and longitudinal, transverse waves in sound. ➢ To explain the formalism of electricity and magnetism ➢ To discuss the concepts in modern physics

UNITS	Course Details
UNIT I: GENERAL MECHANICS AND PROPERTIES OF MATTER	Physical quantities - SI system of units - dimensions - scalars and vectors (Concepts) - Newton's equations of motion - impulse - principle of conservation of linear momentum - projectile motion - Kepler's laws - Newton's law of gravitation - acceleration due to gravity - escape velocity - angular momentum - banking of roads - simple harmonic motion - viscosity - surface Tension.
UNIT II: HEAT AND THERMO DYNAMICS	Different scales of temperatures - thermal expansions - calorimetry - specific heat - latent heat - triple point - transmission of heat - heat conductivity - Black body radiation - Stefan Boltzmann law - Wien's displacement law - Gas equation - Boyle's law - Charle's law - Law of equipartition of energy.
UNIT III: LIGHT AND SOUND	Reflection and refraction - Snell's law - total internal reflection - polarization - Brewster's Law - Huygen's principle – Young's double slit interference and single slit diffraction - longitudinal and transverse waves - velocity of sound - Newton's formula, Laplace correction, effects of pressure - beats - laws of vibrating strings - open and closed organ pipes - resonance.

UNIT IV: ELECTRICITY AND MAGNETISM	Coulomb's Law - Electric field due to charged particles: a point charge, a dipole, a line of charge - electric flux - Gauss' law and applications – Biot-Savart law, magnetic field due to a current in: a long straight wire, a circular arc of wire - Ampere's Law - magnetic field outside and inside a long straight wire - solenoids and toroids - Faraday's laws and Lenz's law
UNIT V: MODERN PHYSICS	Postulates of Einstein's theory of relativity - Galilean and Lorentz transformation - time dilation - length contraction - Planck's radiation - photoelectric effect - Compton shift, matter waves - Bohr's atomic theory. Nuclear properties - binding energy and mass defect -radioactive decay - alpha decay, beta decay and gamma decay - Radioactive dating.

TEXT BOOKS	1. J. Walker, D. Halliday, R. Resnick, Fundamentals of Physics, 10th Edition, Wiley, United states of America, 2007. 2. H.C Verma, Concept of Physics, (Volume I), 1st Edition, Bharati Bhawan Publishers & Distributors, New Delhi, 2008. 3. H.C Verma, Concept of Physics, (Volume II), 1st Edition, Bharati Bhawan Publishers & Distributors, New Delhi, 2008.
REFERENCE BOOKS	1. Michael Nelkon, Philip Parker, Advanced Level Physics, 7th Edition, CBS Publishers, India, 1995 2. D. Young Hugh, A. Freedman Roger, University Physics with Modern Physics, 14th Edition, Pearson Education, India, 2017.
WEB SOURCE	1. https://hcverma.in/

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	acquire the knowledge of the fundamental concept of physics	**K1**
CO2	understand the concepts of fundamental physics	**K2**
CO3	apply the concept of physics to solve various problems	**K3**
CO4	strengthen an appropriate problem-solving approach and assess a step to describe the quantitative analysis.	**K4**
CO5	evaluate the results of new analytical problems and develop a correct solutions or conclusions	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	2	2	2	2	3	2	2	3
CO2	3	3	2	2	3	2	3	2	2	3
CO3	3	3	2	2	3	2	3	2	2	3
CO4	3	3	2	2	3	2	3	3	2	3
CO5	3	3	2	2	3	2	3	3	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	2	1	1	2	3	2	2	3
CO2	3	2	2	2	3	2	3	2	2	3
CO3	2	3	3	2	1	2	3	2	2	3
CO4	1	3	3	2	1	2	3	3	2	3
CO5	1	3	3	2	1	2	3	3	2	3

CORE V: QUANTUM MECHANICS – II		II YEAR - THIRD SEMESTER						
Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
	QUANTUM MECHANICS – II	Core				5	5	75

Pre-Requisites
Knowledge of postulates of Quantum mechanics, properties of Hermitian operators, ladder operators, degeneracy, angular momentum techniques and commutation rules
Learning Objectives
➢ Formal development of the theory and the properties of angular momenta, both orbital and spin ➢ To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Barn approximation. ➢ Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field ➢ To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts ➢ To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions

UNIT I: SCATTERING THEORY
Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for S wave – Optical theorem – Transformation from centre of mass to laboratory frame.
UNIT II: PERTURBATION THEORY
Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability - Einstein‘s A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation .
UNIT III: RELATIVISTIC QUANTUM MECHANICS
Klein – Gordon Equation – Charge and Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation of Negative Energy States – Antiparticles – Spin of Electron - Magnetic Moment of an Electron Due to Spin.

UNIT IV: DIRAC EQUATION
Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman ‘s theory of positron (Elementary ideas only without propagation formalism)
UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION
Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether‘s theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics,2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. Nouredine Zettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017.

REFERENCE BOOKS

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition, Oxford University Press, London, 1973.
2. B. K. Agarwal&HariPrakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics, 1stedition,I.K.International Publishing house Pvt. Ltd., 2006
4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi.
5. E. Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970.

WEB SOURCES
1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture notes/MIT8_05F13_Chap_09.pdf 2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf 3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf 4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notes-gk.pdf 5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation	**K1**
CO2	Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts	**K2**
CO3	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment	**K1, K4**
CO4	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions	**K1, K3**
CO5	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

CORE VI - CONDENSED MATTER PHYSICS	II YEAR - THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	CONDENSED MATTER PHYSICS	Core				5	5	75

Pre-Requisites
Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.
Learning Objectives
➢ To describe various crystal structures, symmetry and to differentiate different types of bonding. ➢ To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat. ➢ To critically assess various theories of electrons in solids and their impact in distinguishing solids. ➢ Outline different types of magnetic materials and explain the underlying phenomena. ➢ Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

UNIT I: CRYSTAL PHYSICS
Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (SC,BCC, FCC). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).
UNIT II: LATTICE DYNAMICS
Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye‘s theory of lattice heat capacity - Thermal Conductivity - Umklapp processes.
UNIT III: THEORY OF METALS AND SEMICONDUCTORS
Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz Law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - De Hass-van Alphen effect.
UNIT IV: MAGNETISM
Diamagnetism - Quantum theory of Para-magnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Ferromagnetic domains - Bloch wall - Spin waves -

Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferromagnetic material - Neel temperature.

UNIT V: SUPERCONDUCTIVITY

Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Type I and II Superconductors. Theoretical Explanation: Thermodynamics of super conducting transition - London equations - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory - Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High Temperature Superconductors – SQUIDS.

TEXT BOOKS

1. C. Kittel, 1996, Introduction to Solid State Physics, 7th Edition, Wiley, New York.
2. Rita John, Solid State Physics, Tata Mc-Graw Hill Publication.
3. A. J. Dekker, Solid State Physics, Macmillan India, New Delhi.
4. M. Ali Omar, 1974, Elementary Solid State Physics – Principle and Applications, Addison - Wesley
5. H. P. Myers, 1998, Introductory Solid State Physics, 2nd Edition Viva Book, New Delhi.

REFERENCE BOOKS

6. J. S. Blakemore, 1974 , *Solid state Physics*, 2nd Edition, W.B. Saunder, Philadelphia
7. H. M. Rosenburg, 1993, *The Solid State*, 3rd Edition, Oxford University Press, Oxford.
8. J. M. Ziman, 1971, Principles *of the Theory of Solids*, Cambridge University Press, London.
9. C. Ross-Innes and E. H. Rhoderick, 1976, *Introduction to Superconductivity,* Pergamon, Oxford.
10. J. P. Srivastava, 2001, *Elements of Solid State Physics*, Prentice-Hall of India, New Delhi.

WEB SOURCES

1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html
2. http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html
3. https://www.britannica.com/science/crystal
4. https://www.nationalgeographic.org/encyclopedia/magnetism/
5. https://www.brainkart.com/article/Super-Conductors_6824/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	**K1**
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	**K1, K2**
CO3	Student will be able to comprehend the heat conduction in solids	**K3**
CO4	Student will be able to generalize the electronic nature of solids from band theories.	**K3, K4**
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

CORE Paper VII - NUMERICAL METHODS AND PROGRAMMING IN C++	II YEAR – THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Instruction Hours	Marks
	NUMERICAL METHODS AND PROGRAMMING IN C++	Core				5	5	75

Pre-Requisites
Prior knowledge on computer and basic mathematics
Learning Objectives
➢ To make students to understand different numerical approaches to solve a problem. ➢ To understand the basics of programming and its application to solve physical problems

UNIT I -ROOTS OF EQUATION
Roots of equation: Bisection method – False position method – Newton Raphson method – Secant method – Order of convergence. Simultaneous Equations: Existence of solutions- Basic Gauss elimination method – Gauss Jacobi iteration method – Gauss Seidal iteration method – Inverse of a matrix using Gauss elimination method .
UNIT II - CURVE FITTING – INTERPOLATION
Curve fitting: Method of least squares – straight line, fitting a parabola, fitting $y = ax^n$, $y = ae^{bx}$ type curves – **Interpolation:** Polynomial Interpolation – Lagrange polynomial – Newton polynomial - Forward and Backward differences – Gregory Newton forward and backward interpolation formula for equal intervals – Divided difference – properties of divided differences – Newton's divided differences formula – Lagrange's interpolation formula for unequal interval
UNIT III – EIGEN VALUES, DIFFERENTIATION AND INTEGRATION
Eigenvalues: Power method to find dominant Eigenvalue - Jacobi method **Numerical differentiation**: Numerical differentiation – Formulae for derivatives – Taylors Series Method - Forward backward differences and central difference formula **Numerical Integration** : Newton – cotes formula – Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, – Error estimates in trapezoidal and Simpson's rule – Monte Carlo Method.

UNIT IV - DIFFERENTIAL EQUATIONS
Ordinary differential equation: Solution by Taylor's series — Basic Euler method –Improved and Modified Euler method – Runge Kutta fourth order method – solution of simultaneous first order differential equations and second order differential equations by RK fourth order Method **Partial differential equation**: Introduction- Classification of partial differential equation of the 2nd order – Finite Difference approximations - Solution of Laplace's equation – Solution of Poisson's Equation –standard five point formula and diagonal five point formula (Jacobi and Gauss Seidal Methods).

UNIT V : PROGRAMMING IN C++
Program structure and header files - Basic data types- operators - Control Structures: decision making and looping statements. Arrays, Strings, Structures, Pointers and File handling. Application programs – Solution to Algebraic and transcendental equations by Newton Raphson Method - Charging and discharging of a condenser by Euler's Method – Radioactive Decay by Runge Kutta fourth order method - Currents in Wheatstone's bridge by Gauss elimination method - Cauchy's constant by least square method - Evaluation of integral by Simpson's and Monte-Carlo methods - Newton's Law of cooling by Numerical differentiation.

TEXT BOOKS

1. Introductory methods of numerical analysis, S. S. Sastry, Prentice Hall of India, 2010
2. Numerical methods for mathematics, science and engineering, John H. Matthews, Prentice Hall of India, 2nd Edition, 2000
3. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering computation, 3 rd edition, New age international (P) Ltd, Chennai , 1998.
4. Object Oriented Programming with C++ by E. Balagurusamy, Tata McGraw-Hill , India, 4th Edition

REFERENCE BOOKS

1. Computer Applications in Physics, S. Chandra, M.K. Sharma, Narosa, 3rd Edition,2014
2. M. K. Venketraman, Numerical Methods in Science and Engineering 2nd Ed., National Publishing Co., Chennai (2010).
3. E. Balagurusamy, Computer Oriented Statistical and Numerical Methods, Macmillan India Ltd, New Delhi (2000).

Related online resources:

1. https://youtu.be/LbKKzMag5Rc
2. https://youtu.be/Xb9Ypn77LBo
3. https://youtu.be/FfqAIlOxkoY

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Recall the transcendental equations and analyze the different root finding methods. Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	**K1, K2**
CO2	Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.	**K5**
CO3	Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation	**K2, K3**
CO4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simpson's method of numerical integration.	**K3, K4**
CO5	Understand the basics of C++-programming and conditional statements.	**K2**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

Core Practical III : ADVANCED PHYSICS EXPERIMENTS – I AND MICROPROCESSOR 8085 & MICROCONTROLLER 8051 PROGRAMMING	II YEAR – THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Instruction Hours	Marks
	ADVANCED PHYSICS EXPERIMENTS – I AND MICROPROCESSOR 8085 & MICROCONTROLLER 8051 PROGRAMMING	Core				4	6	50

Pre-Requisites
Prior knowledge of basic physics and programming skills.
Learning Objectives
➢ To make students to understand different concepts of physics ➢ To understand the basics of microprocessor and microcontroller programming

Advanced Physics Experiments – I and Microprocessor 8085 & Microcontroller 8051 Programming

Section A (Any 6 Experiments)

1. Determination of Cauchy's Constant of the given prism – material. Obtain data by doing the Cauchy's Experiment and fitting a straight line using any software.
2. Determination of Rydberg constant using Hydrogen Vapor lamp source.
3. Determination of Magneto resistance of the given material.
4. Determination of Dielectric constant of the given liquid medium using Colpitt's oscillator or LCR circuit.
5. Study of Characteristics of a Photo Transistor.
6. Study the performance characteristics of the temperature Sensor LM35
7. Analysis of rotation and vibration spectrum /Interpretation of vibrational spectra of a given material
8. Determination of e/k using Transistors
9. Approximate determination of Fermi Energy of Copper (Heating & Cooling method)
10. To study V-I Characteristics, Load Response, and Spectral Response of Photovoltaic Solar Cell
11. Labview / Pspice Simulation: Designing and simulating an Astable Multivibrator using a 555 Timer for the given frequency.
12. Labview / Pspice Simulation: Simulation of a Zener diode characteristics and voltage regulator.

Section B : Microprocessor 8085 and Microcontroller 8051 Programming

(Any 6 Experiments)
All Programs should contain Algorithms and Flowcharts

8085 Microprocessor Programs

1. Arithmetic Operations
a) Addition and Subtraction of two 8 bit numbers
b) Multiplication of two 8 bit numbers –16-bit result.
c) Division of 16 bit number by 8 bit number.

2. Data Manipulation
a) Arrange the given data items in Ascending or Descending order
b) Finding the Minimum or Maximum value in the given data set.
c) Search of a given character/number in the given data set.

3. **System Call and Rolling a character**
a) Calculation of time delay for a given interval.
b) Roll a given character from Left to Right / Right to Left on the 7 segment displays with the specified time interval.

4. **ADC Interfacing and Conversion**
a) Interfacing ADC with 8085 – ADC chip Block diagram – 8085 - ADC interfacing diagram
b) Conversion of analog input to digital – Resolution – Graph between input and output.

5. **DAC interfacing and Wave form generation**.
Interfacing DAC with 8085 – DAC Chip Block diagram – 8085 - DAC - 8085 interfacing diagram. Wave Form Generation using DAC.
a) Square wave with the specified period T
b) Rectangular Wave with Specified T_H and T_L
d) Ramp Wave

8051 Programs using Trainer Kit or Using Simulator - MCU8051 IDE (Freeware)

6. Data Transfer Programming
a) Write an assembly language program to transfer N bytes of data from location A: XX H to location B: YY H
b) Write an assembly language program to exchange N bytes of data at location A: XX H and at location B:YY H.

7. **Data Manipulation**
a) Write an assembly language program to find the largest element in a given array of N bytes at location 0400h. Store the largest element at location 0500h.
b) Write an assembly language program to count number of ones and zeros in an eight bit Number.

8. **Arithmetic Programming**

a) Write an assembly language program to perform the addition of two 16-bit numbers.
b) Write an assembly language program to perform the subtraction of two 16-bit numbers.
c) Write an assembly language program to perform the multiplication of two 8-bit numbers.
d) Write an assembly language program to find the square of a given number N.

9. **Code Conversion**

a) Write an assembly language program to convert a BCD number into ASCII.
b) Write an assembly language program to convert a ASCII number into Decimal.
c) Write an assembly language program to convert a decimal number into ASCII.
d) Write an assembly language program to convert a binary (hex) number into decimal.
e) BCD to 7 Segment Code

10. Counter

Write an assembly language program to implement a decimal counter and show the count on the 7segment display virtual hardware available in the simulator. Write and use a proper delay routine.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Determination of some physical constants using specialized instruments	**K1, K2**
CO2	Spectral data analysis techniques and interpretation	**K5**
CO3	Simulation of some physical experiments using specialized software	**K2, K3**
CO4	Hands on experience with microprocessor Programming	**K3 ,**
CO5	Hands on experience with Microcontroller Programming	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2

SEC –II : SEWAGE AND WASTE WATER TREATMENT AND REUSE	II YEAR - THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Instruction Hours	Marks
	SEWAGE AND WASTE WATER TREATMENT AND REUSE	SEC				2	4	75

Pre-Requisites
Basic knowledge of classification of sewage and waste water and its harmful effects and its recycling.

Learning Objectives
➢ To gain basic knowledge in sewage and waste water Treatment procedures ➢ To gain industry exposure and be equipped to take up job. ➢ To harness entrepreneurial skills. ➢ To analyze the status of sewage and waste water management in the nearby areas. ➢ To sensitize the importance of healthy practices in waste water management.

UNITS	Course Details
UNIT I: RECOVERY & REUSE OF WATER	Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication
UNIT II: DISINFECTION	Disinfection: Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile Bacteriostatic and Bactericidal - factors affecting disinfection.
UNIT III: CHEMICAL DISINFECTION	Chemical Disinfection: Introduction - Theory of Chemical Disinfection Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment Disinfection By-Products(DBPs)
UNIT IV: PHYSICAL DISINFECTION	Physical Disinfection: Introduction - Ultraviolet Radiation - Solar Disinfection - Heat Treatment - Filtration Methods - Distillation Electrochemical Oxidation Water Disinfection by Microwave Heating.
UNIT V: INDUSTRIAL VISIT	Industrial visit – data collection and analysis - presentation

TEXT BOOKS	1. Drinking water and disinfection technique, Anirudhha Balachandra. CRC press (2013) 2. Design of Water and Wastewater Treatment Systems (CV-424/434), Shashi Bushan,) 3. Integrated Water Resources Management, Sarbhukan M M, CBS PUBLICATION (2013) 4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007 5. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.
REFERENCE BOOKS	1. Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, 2020 2. Wastewater Treatment Technologies, MritunjayChaubey, Wiley, 2021. 3. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002. 4. W. Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2nd Edn., McGraw Hill Inc., 1989 5. Lancaster, Green Chemistry: An Introductory Text, 2nd edition, RSC publishing, 2010.
WEB SOURCES	1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en 2.https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648? 3.https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsACgM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 4. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB 5. https://www.amazon.in/Design-Wastewater-Treatment-Systems-CV-424/dp/B00IG2PI6K/ref=asc_df_B00IG2PI6K/?tag=googleshopmob-21&linkCode=df0&hvadid=397013004690&hvpos=&hvnetw=g&hvrand=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gained knowledge in solid waste management	**K1**
CO2	Equipped to take up related job by gaining industry exposure	**K5**
CO3	Develop entrepreneurial skills	**K3**
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	**K4**
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	3	3	2	3	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	2	2	2	2	3	3	3	3	2
CO4	3	2	3	3	2	3	3	3	3	2
CO5	2	2	2	2	3	3	2	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	3	3	2	3	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	2	2	2	2	3	3	3	3	2
CO4	3	2	3	3	2	3	3	3	3	2
CO5	2	2	2	2	3	3	2	2	2	2

Core VIII - NUCLEAR AND PARTICLE PHYSICS	II YEAR - FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	NUCLEAR AND PARTICLE PHYSICS	Core				5	6	75

Pre-Requisites
Knowledge of basic structure of atom and nucleus.
Learning Objectives
➢ Introduces students to the different models of the nucleus in a chronological order ➢ Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles ➢ Provides students with details of nuclear decay with relevant theories ➢ Exposes students to the Standard Model of Elementary Particles and Higgs boson

UNIT I: NUCLEAR MODELS
Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrupole moment - Bohr and Mottelson collective model – rotational and vibrational bands.
UNIT II: NUCLEAR FORCES
Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism.
UNIT III: NUCLEAR REACTIONS
Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.

UNIT IV: NUCLEAR DECAY
Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –
Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.
UNIT V: ELEMENTARY PARTICLES
Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks –SU (2) and SU (3) groups-Gell Mann matrices– Gell Mann Okuba Mass formula- Quark Model. Standard model of particle physics – Higgs boson.

TEXT BOOKS

1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011).
2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008).
3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996).
4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011).
5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.- 3rd Revised edition (1968).

REFERENCE BOOKS

1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973).
2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).
3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002).
4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001).
5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.

WEB SOURCES

1. http://bubl.ac.uk/link/n/nuclearphysics.html
2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdf
3. http://www.scholarpedia .org/article/Nuclear_Forces
4. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/
5. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html
6. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	**K1, K5**
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	**K2, K3**
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	**K3**
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	**K3, K4**
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

CORE Practical – IV : ADVANCED PHYSICS EXPERIMENTS – II AND NUMERICAL METHODS IN C++	II YEAR – FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	Advanced Physics Experiments – II and Numerical Methods in C++	Core				4	6	50

Pre-Requisites
Basic knowledge in principles of Physics, Circuit theory, Digital electronics, Scilab software Basic knowledge of Numerical Methods and Programming skills
Learning Objectives
➢ To apply theoretical knowledge through hands-on experiments in order to analyze and understand the characteristics and behaviors of various physical and electronic systems, while developing practical skills in measurement, data analysis, and circuit design. ➢ To familiarize the students with numerical methods used in problem-solving by writing programs using the high level language C++

Advanced Physics Experiments – II and Numerical Methods in C++

Section A: Advanced Physics Experiments – II

(Any 6 Experiments)

1. Investigate the equilibrium points of the logistic map equation $X_{n+1} = aX_n (1-X_n)$ for various parameter values and initial conditions:
   a) Determine the equilibrium points for 'a' ranging from 0.5 to 2.5 with a step size of 0.1 considering x_0=0.1.
   b) Explore the behavior of the logistic map for 'a' values between 3.5 and 4.0 with a step size of 0.05 for x_0=0.2.
   c) Analyze the dynamics near the period-doubling bifurcation point at a≈3.828, considering x_0=0.3.
   d) Plot x_n versus n for each scenario and generate bifurcation diagrams to visualize the system's behavior.

2. Determination of resistivity of a semiconductor by Four Probe Method.
3. Examine the input-output characteristics of an ADC or DAC IC (0800 series). The characteristics may include parameters such as linearity, accuracy, resolution and dynamic range.
4. Photo Conductivity Experiment:
    a) To plot the current-voltage characteristics of a CdS Photo Resistor (LDR) at constant irradiance.
    b) To measure the Photo current as a function of irradiance at constant voltage
5. Determination of the distance between two tracks of a CD and a DVD using a Solid state laser
6. Verification of Thevenin's and Max power theorems
7. Study the Characteristics of a Load cell
8. Design of a Serial Shift Registers using necessary Flip-Flop ICs
9. Design of Encoder and Decoder Circuits using necessary ICs
10. Study of a quartz crystal (1 MHz) and construction of a Pierce crystal Oscillator using digital inverters
11. UV spectral data analysis for the given spectrum
12. Simulation of satellite orbit around the earth using the universal law of gravitation in Scilab

Section – B : Numerical Methods in C++
(Any SIX programs with Algorithm and Flow chart)

1 Algebraic and Transcendental equation.
a) Solution of the given equations using Newton Raphson Method – manual calculation.
b) C++ program to find the solution using N-R method and verification.

2. Algebraic and Transcendental equations.
a) Solution of the given equations using Bisection Method – manual calculation.
b) C++ program to find the solution using Bisection method and verification.

3. Curve Fitting – Linear Fit
a) Principle of least square and fitting a straight line.
b) C++ program to fit a straight line using the given data related with any physics experiment.

4. Curve Fitting – Non Linear Fit
a) Principle of fitting a second degree polynomial using method of least square
b) C++ program to fit a polynomial using the given data related with any physics experiment.

5. Interpolation
a) Derive Lagrangian interpolation formula.
b) C++ program to interpolate using the given data related with any physics experiment by Lagrangian Method.

6. Solution of simultaneous equations -Gauss Elimination method.
   a) Procedure to solve Simultaneous equations using Gauss Elimination (GE) Method
   b) C++ program for solving unknown branch currents in Wheatstone's bridge using GE method.

7. Numerical solution of ordinary Differential Equations.
   a) Derivation of Exponential law of Radioactive decay.
   b) RK 4th order method of solving a given 1st order differential equation.
   c) C++ program using RK method to solve radioactive problem – Compare output with the analytical result.

8. Area under the Curve - Numerical integration
   a) Derivation of Trapezoidal and Simpson's rule
   b) C++ programs for Trapezoidal and Simpson 1/3 rule
   c) Comparison of the program output with direct integration.

9. Random Number Generation and Montecarlo Method
   a) Generate and scale the random numbers for the desired range using the C++ library functions.
   b) Evaluate the given integral using Montecarlo method.

10. Matrix Multiplication
   a) Multiplication of two given matrices
   b) Rotation matrix definition.
   c) C++ program to rotate the given 2D- object about the origin using rotation matrix through the given angle.

11. Inverse of a Matrix
   a) Procedure to determine the Inverse of a Matrix using Gauss elimination Method.
   b) C++ Program to find the Inverse of a Matrix using Gauss Elimination Method.

12. Numerical Differentiation
   a) Numerical differentiation – related to any physical problem
   b) Derivation of Newton's law of cooling –equation
   c) C++ program to verify the Newton's law of cooling from the given experimental data.

Course Outcomes: Section –A

CO1	Students will be able to evaluate the efficiency and performance of solar cells by analyzing their spectral response to different wavelengths of light.
CO2	Students will understand the functional characteristics of ADCs, including linearity, accuracy, resolution, and dynamic range, through practical examination of the ADC 0804.
CO3	Students will be able to characterize the current-voltage relationship of a CdS photoresistor under constant irradiance conditions.
CO4	Students will be able to determine and analyze the temperature coefficient of resistance for a thermistor using the Carey Foster Bridge method.
CO5	Students will be able to measure and interpret the spacing between tracks on optical discs using diffraction patterns generated by a solid-state laser.

CO6	Students will gain practical experience in verifying and applying Norton's, Thevenin's, and Maximum Power Transfer theorems in electrical circuits.
CO7	Students will understand and evaluate the performance characteristics of load cells, including their response to varying loads.
CO8	Students will acquire the ability to design, implement, and test serial shift registers using flip-flops and integrated circuits.
CO9	Students will learn to design and construct encoder and decoder circuits, understanding their principles and applications in digital systems.
CO10	Students will be able to analyze the properties of a quartz crystal and construct a Pierce crystal oscillator, understanding its operation and applications.
CO11	Students will develop skills in using simulation software to model and analyze satellite orbits based on the universal law of gravitation.

Course Outcomes: Section -B

CO1	Students will be able to apply the Newton Raphson method manually to solve given equations and implement it in C++ for verification.
CO2	Students will demonstrate proficiency in applying the Bisection method manually and implementing it in C++ to find solutions, ensuring accuracy through verification.
CO3	Learners will understand the principle of least squares and successfully fit a straight line to given data using C++, applying it to physics experiments.
CO4	Students will grasp the principle of least squares for nonlinear fits and implement it in C++ to fit a polynomial to experimental data, specifically exploring physics-related datasets.
CO5	Students will derive the Lagrangian interpolation formula and apply it in C++ to interpolate data from physics experiments, gaining practical experience in numerical methods.
CO6	Students will comprehend the Gauss Elimination method for solving simultaneous equations and implement it in C++ to find unknown branch currents in a Wheatstone bridge, linking numerical methods to circuit analysis.
CO7	Learners will derive the exponential law of radioactive decay and employ the RK 4th order method in C++ to solve differential equations, comparing results to analytical solutions in a radioactive decay scenario.
CO8	Students will understand and derive the Trapezoidal and Simpson's rules for numerical integration and implement corresponding C++ programs, validating their accuracy through comparison with direct integration methods.
CO9	Students will be proficient in generating and scaling random numbers in C++ using library functions and applying the Monte Carlo method to evaluate integrals, integrating randomness into numerical methods.
CO10	Students will demonstrate competence in matrix multiplication, comprehend rotation matrix concepts, and implement a C++ program to rotate 2D objects about the origin, emphasizing practical applications in computer graphics or physics simulations.
CO11	Students will apply numerical differentiation to solve physical problems, derive Newton's law of cooling equation, and validate it through a C++ program analyzing experimental data, connecting mathematical modeling to real-world phenomena.

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) and program specific outcomes (PSO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1
CO11	2	2	2	3	3	1	1	1	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1
CO11	2	2	2	3	3	1	1	1	3	3

SEC – III. SOLAR ENERGY UTILIZATION	II YEAR – FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	SOLAR ENERGY UTILIZATION	SEC				2	5	75

Pre-Requisites
Basic knowledge of heat energy, way of transfer of heat, solar energy, materials types
Learning Objectives
➢ To impart fundamental aspects of solar energy utilization. ➢ To give adequate exposure to solar energy related industries ➢ To harness entrepreneurship skills ➢ To understand the different types of solar cells and channelizing them to the different sectors of society ➢ To develop an industrialist mindset by utilizing renewable source of energy ➢

UNITS	Course Details
UNIT I: HEAT TRANSFER & RADIATION ANALYSIS	Introduction to sun and solar energy – Conduction, Convection and Radiation – Solar Radiation at the earth's surface – Earth radiation budget- Determination of solar time – Solar energy measuring methods and instruments- Analysis of Solar insolation .
UNIT II: SOLAR COLLECTORS	Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.
UNIT III: SOLAR HEATERS	Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems – Design and cost estimation of a solar thermal system (Load analysis, system design, component list, price break down)
UNIT IV: SOLAR ENERGY CONVERSION	Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells- different approaches on the process- texturization, diffusion, Antireflective coatings, metallization-Emerging solar cell technologies.

UNIT V: NANOMATERIALS IN FUEL CELL APPLICATIONS	Use of nanostructures and nanomaterial in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage. **Industrial visit – data collection and analysis - presentation**

TEXT BOOKS	1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 1987. 2. Carbon Nano forms and Applications", Maheshwar Sharon, Madhuri Sharon, Mc Graw-Hill, 2010. 3. Solar Energy Engineering: Processes and Systems‟, Soteris A. Kalogirou Academic Press, London, 2009 4. Solar Energy – Fundamentals Design, Modelling and applications, Tiwari Narosa Publishing House, New Delhi, 2002 5. Solar Energy, Sukhatme S.P. Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
REFERENCE BOOKS	1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976) 2. Solar energy thermal processes – John A.Drife and William. (1974) 3. John W. Twidell& Anthony D.Weir, 'Renewable Energy Resources,2005 4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, john Wiley and Sons, 2013 5. Duffie, J.A., Beckman, W.A. , "Solar Energy Thermal Process", John Wiley and Sons,2007. 6. Solar Domestic Water Heating "The Earthscan Expert Handbook for Planning, Design and Installation" published by Earthscan Ltd. ISBN: 978-1-84407-736-6 7. Solar Water and Pool Heating Manual: Design and Installation & Repair and Maintenance, FSEC-IN-24. Free download at: [PDF] Solar Water and Pool Heating Manual File Format: PDF/Adobe Acrobat - Quick View Pool Heating Manual. Design and Installation. &. Repair and Maintenance. Florida Solar Energy Center. Cocoa, Florida
WEB SOURCES	1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb 2. https://books.google.vg/books?id=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read 3. www.nptel.ac.in/courses/112105051 4. www.freevideolectures.com 5. http://www.e-booksdirectory.com

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gained knowledge in fundamental aspects of solar energy utilization	**K1**
CO2	Equipped to take up related job by gaining industry exposure	**K3**
CO3	Develop entrepreneurial skills	**K5**
CO4	Skilled to approach the needy society with different types of solar cells	**K4**
CO5	Gained industrialist mindset by utilizing renewable source of energy	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3

ELECTIVE SUBJECTS

LIST OF ELECTIVE SUBJECTS
(Choose any one subject from each Elective)

Semester	Type	Course Title
I	Elective - I (Discipline Centric)	a) Energy Physics
		b) Astro Physics
		c) Plasma Physics
	Elective - II (Generic)	a) Linear and Digital ICs and Applications
		b) Digital Communication
		c) Communication Electronics
II	Elective - III (Discipline Centric)	a) Advanced Optics
		b) Non Linear Dynamics
		c) Physics of Nano Science and Technology
	Elective - IV (Generic)	a) Microprocessor 8085 and Microcontroller 8051
		b) Material Science
		c) Characterization of Materials
III	Elective - V (Discipline Centric)	a) Spectroscopy
		b) Crystal Growth and Thin Films
		c) General Relativity and Cosmology
IV	Elective - VI (Generic)	a) Electro Magnetic Theory
		b) Quantum Field Theory
		c) Advanced Mathematical Physics

Elective 1-A. ENERGY PHYSICS	I YEAR - I SEMESTER

Subject Code	Subject Name		L	T	P	Credits	Inst. Hours	Marks
	ENERGY PHYSICS	**Elective**				3	5	75

Pre-Requisites
Knowledge of conventional energy resources
Learning Objectives
➢ To learn about various renewable energy sources. ➢ To know the ways of effectively utilizing the oceanic energy. ➢ To study the method of harnessing wind energy and its advantages. ➢ To learn the techniques useful for the conversion of biomass into useful energy. ➢ To know about utilization of solar energy

UNITS	Course Details
UNIT I: INTRODUCTION TO ENERGY SOURCES	A brief survey of conventional and non-conventional energy sources and their availability–present and future needs-. prospects of Renewable energy sources– Energy from other sources– chemical energy–Nuclear energy–Energy storage and distribution.
UNIT II: ENERGY FROM THE OCEANS	Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidal energy – Principle of ocean thermal energy conversion systems.
UNIT III: WIND ENERGY SOURCES	Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy.
UNIT IV: ENERGY FROM BIOMASS	Biomass conversion Technologies– wet and dry process– Photosynthesis Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion–factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas-utilization of biogas.

UNIT V: SOLAR ENERGY SOURCES	Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation–solar cooking–solar greenhouse – Solar pond and its applications.

TEXT BOOKS	1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi. 2. S. Rao and Dr. ParuLekar, Energy technology. 3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983). 4. Solar energy, principles of thermal collection and storage by S.P.Sukhatme, 2ndedition, Tata McGraw-Hill Publishing Co. Lt., New Delhi (1997). 5. Energy Technology by S.Rao and Dr.Parulekar.
REFERENCE BOOKS	1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York. 2. Applied solar energy, A.B.MeinelandA.P.Meinal 3. John Twidell and Tony Weir, Renewable energy resources, Taylor and Francis group, London and New York. 4. Renewal Energy Technologies: A Practical Guide for Beginners C.S. Solanki-PHI Learning 5. Introduction to Non-Conventional Energy Resources -Raja et. al., Sci. Tech Publications
WEB SOURCES	1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1 2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/ 3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy 4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/ 5. https://www.acciona.com/renewable-energy/solar-energy/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	To identify various forms of renewable and non-renewable energy sources	**K1**
CO2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	**K2**
CO3	Discuss the working of a windmill and analyze the advantages of wind energy.	**K3**
CO4	Distinguish aerobic digestion process from anaerobic digestion.	**K3,K4**
CO5	Understand the components of solar radiation, their measurement and apply them to utilize solar energy.	**K2,K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	3	3
CO2	2	3	3	3	2	2	2	3	3	3
CO3	2	3	3	3	2	2	2	3	3	3
CO4	2	3	3	3	2	2	2	3	3	3
CO5	2	3	3	3	2	2	2	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	3	2	2	2	3	3	3
CO2	2	3	3	3	2	2	2	3	3	3
CO3	2	3	3	3	2	2	2	3	3	3
CO4	2	3	3	3	2	2	2	3	3	3
CO5	2	3	3	3	2	2	2	3	3	3

Elective 1-B. ASTRO PHYSICS	**I YEAR – I SEMESTER**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
	ASTRO PHYSICS	**Elective**				3	5	75

Pre-Requisites
undamental knowledge of electromagnetic spectrum in observational astronomy, About the universe and galaxies.
Learning Objectives
➢ To impart knowledge on the physical universe and its evolution ➢ To make the sudent to understand fundamental principles and techniques of astronomy and astrophysics ➢ To make the student to study electromagnetic radiation from stars, atomic spectra and ➢ classficiation of stars ➢ To provide information about the properties and the evolution of stars ➢ To render information about astronomical instrumentation

UNITS	Course Details
UNIT I: OBSERVATIONAL ASTRONOMY	The electromagnetic spectrum; geometrical optics (ray diagrams, focal length, magnification etc); diffraction (resolving power, Airy disc, diffraction limit etc); telescopes (reflecting, refracting, multiwavelength)
UNIT II: PROPERTIES OF STARS	Brightness (luminosities, fluxes and magnitudes); colours (black body radiation, the Planck, Stefan-Boltzmann and Wien's laws, effective temperature, interstellar reddening); spectral types; spectral lines (Bohr model, Lyman & Balmer series etc, Doppler effect); Hertzprung Russell diagram; the main sequence (stellar masses ,binary systems, Kepler's laws, mass-luminosity relations); distances to stars (parallax, standard candles, P-L relationships, ms-fitting etc); positions of stars (celestial sphere, coordinate systems, proper motions, sidereal and universal time).

UNIT III: THE LIFE AND DEATH OF STARS	Energy source (nuclear fusion, p-pchain, triple-alpha, CNO cycle, lifetime of the Sun); solar neutrinos; basic stellar structure hydro static equilibrium, equation of state);evolution beyond the main sequence; formation of the heavy elements; supernovae; stellar remnants(white dwarfs, neutron stars, black holes, degeneracy pressure, Swarszchild radius, escape velocities).
UNIT IV: GALAXIES	Constituents of galaxies; stellar populations; the interstellar medium; HII regions; 21cm line; spirals and ellipticals; galactic dynamics; galaxy rotation curves and dark matter ; active galaxies and quasars.
UNIT V: COSMOLOGY	Galaxies and the expanding Universe; Hubble's Law; the age of the Universe; the Big Bang; cosmic microwave background (black body radiation);big bang nucleosynthesis (cosmic abundances, binding energies, matter & radiation); introductory cosmology (the cosmological principle, homogeneity and isotropy, Olber's paradox); cosmological models (critical density, geometry of space, the fate of the Universe); dark energy and the accelerating Universe.

TEXT BOOKS	1.Zeilik& Gregory, Introductory Astronomy & Astrophysics,4thedition (Saunders College Publishing) 2.Morison,I.,IntroductiontoAstronomyand Cosmology, (Wiley) 3.Kutner,M.L., Astronomy: A Physical Perspective (Cambridge University Press) 4. Green,S.F.& Jones,M.H.,An Introduction to the Sunand Stars (Cambridge University Press)
REFERENCE BOOKS	5.Jones,M.H.&Lambourne,R.J.A.,An Introduction to Galaxies & Cosmology (Cambridge UniversityPress) 6.Carroll,B.W.&Ostlie,D.A.,An Introduction to ModernAstrophysics (Pearson) 7.Shu,F.H.,The Physical Universe, An Introduction to Astronomy, (University Science Books) 8.Motz,L.&Duveen,A.,The Essentials of Astronomy, (ColombiaUniversityPress)
WEB SOURCES	1. https://www.coursera.org/courses?query=astrophysics 2. https://www.space.com 3. https://www.britanica.com 4. https://science.nasa.gov 5. https://merriam-webster.com

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Recall and understand the electromagnetic ration from celestial objects. Analyze the wave nature of light in the form of ray diagram. Apply the knowledge of phenomenon of diffraction and asses, how diffraction limits the resolution of any system having a lens or mirror. Distinguish between reflecting and refracting telescopes and their usage.	**K1** **K2** **K3** **K4** **K5**
CO2	Correlate luminosity, flux and magnitude, related to the brightness of a star. Analyze the evolution of stars using HR diagram. Apply and examine the various laws related to temperature of a star. Assess the distance of stars, measured using trigonometric parallax method. Understand the position of star in the celestial sphere. Distinguish between sideral and universal time.	**K1** **K2** **K3** **K4** **K5**
CO3	Define nuclear fusion, which is the fundamental energy source of stars. Analyze, how neutrinos are born during the process of nuclear fusion in the sun. Recall and explain the CNO cycle – the main source of energy of hotter stars. Comprehend stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories	**K1** **K2** **K3** **K4**
CO4	Remember and illustrate the structure of our Milky way galaxy. Classify the types of galaxies. Understand thepresence of dark matter in the universe. Explain, howquasars and active galaxies are powered by supermassiveblack holes which produce copious luminosity.	**K1** **K2** **K3** **K4**
CO5	Explain cosmology, a branch of astronomy that involvesthe origin and evolution of the universe, from the Big Bangto today and on into the future. Define Hubble's law ofcosmic expansion. Analyze and assess the big bangnucleosynthesis universe that explains the relative	**K1** **K2** **K3** **K4** **K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	2	1	3	2	1	2
CO2	3	2	3	1	2	1	3	2	1	2
CO3	3	2	3	1	2	1	3	2	1	2
CO4	3	2	3	1	2	1	3	2	1	2
CO5	3	2	3	1	2	1	3	2	1	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	1	2	1	3	2	1	2
CO2	3	2	3	1	2	1	3	2	1	2
CO3	3	2	3	1	2	1	3	2	1	2
CO4	3	2	3	1	2	1	3	2	1	2
CO5	3	2	3	1	2	1	3	2	1	2

Elective – 1-C. PLASMA PHYSICS	I YEAR – I SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	PLASMA PHYSICS	ELECTIVE				3	5	75

Pre-Requisites
Fundamentals of Electricity and Magnetism, Electromagnetic theory, Maxwell's equation, Basic knowledge of electrical and electronics instrumentation.
Learning Objectives
➢ To explore the plasma universe by means of in-site and ground-based observations. ➢ To understand the model plasma phenomena in the universe. ➢ To explore the physical processes which occur in the space environment.

UNITS	Course Details
UNIT I: FUNDAMENTAL CONCEPTS OF PLASMA	Kinetic pressure in a partially ionized - mean free path and collision cross section - Mobility of charged particles - Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity- Effect of magnetic field- Quasi- neutrality of plasma Debye shielding distance - Optical properties of plasma.
UNIT II: MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELD	Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and magnetic fields- Motion of charged particle inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement - motion of an electron in a time varying electric field- Magneto- hydrodynamics - Magneto-hydrodynamic equations – Condition for magneto hydrodynamic behaviour.
UNIT III: PLASMA OSCILLATIONS AND WAVES	Introduction, theory of simple oscillations - electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation - Ion oscillation and waves in a magnetic field - thermal effects on plasma oscillations - Landau damping - Hydro magnetic waves - Oscillations in an electron beam.
UNIT IV: PLASMA DIAGNOSTICS TECHNIQUES	Single probe method - Double probe method - Use of probe technique for measurement of plasma parameters in magnetic field - microwave method - spectroscopic method - -laser as a tool for plasma diagnostics-X-ray diagnostics of plasma - acoustic method - conclusion.

UNIT V: APPLICATIONS OF PLASMA PHYSICS	Magneto hydrodynamic Generator - Basic theory - Principle of Working Fuel in MHD Generator - Generation of Microwaves Utilizing High Density Plasma - Plasma Diode.

TEXT BOOKS	1. Plasma Physics- Plasma State of Matter - S. N.Sen, PragatiPrakashan, Meerut. 2. Introduction to Plasma Physics-M. Uman 3. Krall, N. A., and A. W. Trivelpiece. Principles of Plasma Physics. Berkeley, CA: San Francisco Press, 1986. ISBN: 9780911302585.Tanenbaum, B. S. Plasma Physics. New York, NY: McGraw-Hill, 1967. ISBN: 9780070628120. 4. Goldston, R. J., and P. H. Rutherford. Introduction to Plasma Physics. Philadelphia, PA: IOP Publishing, 1995. ISBN: 9780750301831. 5. Hutchinson, I. H. Principles of Plasma Diagnostics. Cambridge, UK: Cambridge University Press, 2005. ISBN: 9780521675741.
REFERENCE BOOKS	1. Chen, F. F. Introduction to Plasma Physics. 2nd ed. New York, NY: Springer, 1984. ISBN: 9780306413322. 2. Introduction to Plasma Theory-D.R. Nicholson 3. Shohet, J. L. The Plasma State. San Diego, CA: Academic Press Inc., 1971. ISBN: 9780126405507. 4. Hazeltine, R. D., and F. L. Waelbroeck. The Framework of Plasma Physics. Boulder, CO: Westview Press, 2004. ISBN: 9780813342139. 5. Huddlestone, R. H., and S. L. Leonard. Plasma Diagnostic Techniques. San Diego, CA: Academic Press, 1965
WEB SOURCES	1. https://fusedweb.llnl.gov/Glossary/glossary.html 2. http://farside.ph.utexas.edu/teaching/plasma/lectures1/index.html 3. http://www.plasmas.org/ 4. http://www.phy6.org/Education/whplasma.html 5. http://www.plasmas.org/resources.htm

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Understand the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state.	**K1, K2**
CO2	Understand the plasma and learn the magneto-hydrodynamics concepts applied to plasma.	**K2**
CO3	Explore the oscillations and waves of charged particles and thereby apply the Maxwell's equation to quantitative analysis of plasma.	**K1, K3**
CO4	Analyze the different principle and techniques to diagnostics of plasma.	**K2, K5**
CO5	Learn the possible applications of plasma by incorporating various electrical and electronic instruments.	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	2	1	2	3	3
CO3	3	3	2	2	1	2	1	3	3	3
CO4	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	2	1	2	3	3
CO3	3	3	2	2	1	2	1	3	3	3
CO4	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3

Elective 2-A: LINEAR AND DIGITAL ICs (Discipline Centric) & APPLICATIONS	I YEAR – I SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	LINEAR AND DIGITAL ICs AND APPLICATIONS	Elective				3	6	75

Pre-Requisites
Knowledge of semiconductor devices, basic concepts of digital and analog electronics
Learning Objectives
➢ To introduce the basic building blocks of linear integrated circuits. ➢ To teach the linear and non-linear applications of operational amplifiers. ➢ To introduce the theory and applications of PLL. ➢ To introduce the concepts of waveform generation and introduce one special function ICs. ➢ Exposure to digital IC's

UNITS	Course Details
UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER	**Introduction**, Classification of IC's, Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit diagram, Op-Amp Characteristics – Inverting and Non-Inverting Modes of operation- DC and AC performance Characteristics.
UNIT II: APPLICATIONS OF OP-AMP	**Linear applications of Op-Amp:** Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters. **Non-linear applications of Op-Amp:** Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.
UNIT III: ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS	**Active filters:** Introduction, Butterworth filters – 1st order, 2nd order low and high pass filters, band pass, band reject and All pass filters- Applications. **Timer and Phase Locked Loops:** Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, voltage controlled oscillator (IC 566), PLL - introduction, basic principle, phase detector/comparator, monolithic PLL (IC 565) and applications.

UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS	**Voltage Regulators:** Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator. **DAC and ADC:** Introduction, basic DAC techniques weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.
UNIT V: CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs	**CMOS Logic**: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR AND-INVERT gates, implementation of any function using CMOS logic. **Combinational circuits using TTL 74xx ICs**: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154)BCD to 7-segment decoder (IC7446/7447), Encoder (IC74147), Multiplexer (IC74151), De multiplexer (IC 74154). **Sequential circuits using TTL 74xx ICs:** Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).

TEXT BOOKS	1. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt.Ltd., NewDelhi,India. 2. Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, NewDelhi. 3. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co. 4. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition. 5. V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog), S.Viswanathan Printers & Publishers Private Ltd, Reprint. V.
REFERENCE BOOKS	1. Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi. 2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi. 3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi 4. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi. 5. Integrated Electronics, Millman&Halkias, Tata McGraw Hill, 17th Reprint (2000)

WEB SOURCES	1. https://nptel.ac.in/course.html/digital circuits/ 2. https://nptel.ac.in/course.html/electronics/operational amplifier/ 3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt7/field-effect-controlled-thyristors/ 4. https://www.electrical4u.com/applications-of-op-amp/ 5. https://www.geeksforgeeks.org/digital-electronics-logic-designtutorials/

COURSE OUTCOMES:
At the end of the course the student will be able to:

CO1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	**K1, K5**
CO2	Develop skills to design linear and non-linear applications circuits using OpAmp and design the active filters circuits.	**K3**
CO3	Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	**K1, K3**
CO4	Learn about various techniques to develop A/D and D/A converters.	**K2**
CO5	Acquire the knowledge about the CMOS logic, combinational and sequential circuits	**K1, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

Elective 2-B. DIGITAL COMMUNICATION	I YEAR – FIRST SEMSTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	DIGITAL COMMUNICATION	Elective				3	6	75

Pre-Requisites
Exposure to Fourier transform, pulse modulation, multiplexing, noises in communication signals
Learning Objectives
➢ To understand the use of Fourier, transform in analyzing the signals ➢ To learn about the quanta of transmission of information ➢ To make students familiar with different types of pulse modulation ➢ To have an in depth knowledge about the various methods of error controlling codes ➢ To acquire knowledge about spread spectrum techniques in getting secured communication

UNITS	Course Details
UNIT I: SIGNAL ANALYSIS	Fourier transforms of gate functions, delta functions at the origin – Two delta function and periodic delta function – Properties of Fourier transform – Frequency shifting –Time shifting - Convolution –Graphical representation – Convolution theorem – Time Convolution theorem – Frequency Convolution theorem –Sampling theorem.
UNIT II: INFORMATION THEORY	Communication system – Measurement of information – Entropy- Source Encoding - Coding – Baudot Code CCITT Code –Hartley Law – Noise in an information Carrying Channel- Effects of noise- Capacity of noise in a channel – Channel capacity of continuous channel- Shannon Hartley theorem –Redundancy- Practical communication system in lights of Shannon theorem
UNIT III: PULSE MODULATION	Pulse amplitude modulation - natural sampling – Instantaneous sampling - Transmission of PAM Signals -Pulse width modulation – Time division multiplexing – Band width requirements for PAM Signals. Pulse Code Modulation –Principles of PCM –Quantizing noise – Generation and demodulation of PCM -Effects of noise –Companding – Advantages and application .

UNIT IV: ERROR CONTROL CODING	Error Correcting Codes Introduction, Linear Block Code, Hamming Codes, Cyclic Code, Burst error detecting and correcting codes, Interlace codes for burst and random error correction, Convolution Code, Grain Viterbi decoding Comparison of coded and un coded system.
UNIT V: SPREAD SPECTRUM SYSTEMS	Introduction to spread spectrum, spread spectrum techniques,Pseudo noise sequences - generation and Correlation properties- Direct sequence system, frequency hopping system, pulse FM (chirp) system, hybrid systems. processing gain, anti-jam and multipath performance.

TEXT BOOKS	1. B.P. Lathi, *Communication system*, Wiley Eastern. 2. George Kennedy, *Electronic Communication Systems,* 3rd Edition, Mc Graw Hill. 3. Simon Haykin, *Communication System*, 3rd Edition, John Wiley & Sons. 4. George Kennedy and Davis, 1988, *Electronic Communication System,* Tata McGraw Hill 4th Edition. 5. Taube and Schilling, 1991, *"Principles of Communication System"*, Second edition Tata McGraw Hill 6. Modern Digital and Analog Communication Systems, B. P. Lathi, (3rd Edition), Oxford Publication 7. Principles of Communication Systems, Taub & Schilling, (2nd Edition), Tata McGraw Hill Publication 8. S.Haykin, Communication systems, John Wiley 2001 4. Bhattacharya Amitabh, "Digital Communication", Tata McGraw-Hill, 1st Ed., 2006. 9. R. C. Dixen, "Spread Spectrum Systems with commercial application", John Wiley, 3rd Ed.
REFERENCE BOOKS	1. John Proakis, 1995, *Digital Communication,* 3rd Edition, McGraw Hill, Malaysia. 2. M. K. Simen, 1999, *Digital Communication Techniques, Signal Design and Detection*, Prentice Hall of India. 3. Dennis Roddy and Coolen, 1995, *Electronics communications,*Prentice Hall of India IV Edition. 4. Wave Tomasi, 1998, *"Advanced Electronics communication System"* 4th Edition Prentice Hall, Inc. 5. M.Kulkarni, 1988, *"Microwave and Radar Engineering",* Umesh Publications.

WEB SOURCES	1. http://nptel.iitm.ac.in/ 2. http://web.ewu.edu/ 3. http://www.ece.umd.edu/class/enee630.F2012.html 4. http://www.aticourses.com/Advanced%20Topics%20in%20Digital%20Signals 5. http://nptel.iitm.ac.in/courses/117101051.html

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Apply the techniques of Fourier transform, convolution and sampling theorems in signal processing	**K1, K3**
CO2	Apply different information theories in the process of study of coding of information, storage and communication	**K3**
CO3	Explain and compare the various methods of pulse modulation techniques	**K4**
CO4	Apply the error control coding techniques in detecting and correcting errors- able to discuss, analyze and compare the different error control coding	**K3, K4**
CO5	Apply, discuss and compare the spread spectrum techniques for secure communications	**K3, k5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	2	2	3	2	2	3
CO2	3	3	3	1	2	2	3	2	2	3
CO3	3	3	3	1	2	2	3	2	2	3
CO4	3	3	3	1	2	2	3	2	2	3
CO5	3	3	3	1	2	2	3	2	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	2	2	3
CO2	3	3	3	1	2	2	3	2	2	3
CO3	3	3	3	1	2	2	3	2	2	3
CO4	3	3	3	1	2	2	3	2	2	3
CO5	3	3	3	1	2	2	3	2	2	3

Elective 2-C. COMMUNICATION ELECTRONICS	I YEAR – FIRST SEMSTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	COMMUNICATION ELECTRONICS	**Elective**				3	6	75

Pre-Requisites
Knowledge of Regions of electromagnetic spectrum and its characteristics
Learning Objectives
➢ To comprehend the transmission of electromagnetic waves thorough different types of antenna and also to acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth ➢ To gain knowledge in the generation and propagation of microwaves ➢ To acquire knowledge about radar systems and its applications and also the working principle of colour television ➢ To learn the working principle of fiber optics and its use in telecommunication ➢ To understand the general theory and operation of satellite communication systems

UNITS	Course Details
UNIT I ANTENNAS AND WAVE PROPAGATION	Radiation field and radiation resistance of short dipole antenna grounded antenna-ungrounded antenna-antenna arrays-broadside and end side arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere- Eccles and Larmor theory- Magneto ionic theory- ground wave propagation
UNIT II MICROWAVES	Microwave generation—multi cavity Klystron-reflex klystron magnetron travelling wave tubes (TWT) and other microwave tubes MASER-Gunndiode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio(SWR)
UNIT III **RADAR AND TELEVISION**	Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers radar receivers and indicators-pulsed systems-other radar systems colour TV transmission and reception-colour mixing principle-colour picture tubes-Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV

UNIT IV SATELLITE COMMUNICATION	Orbital satellites-geostationary satellites-orbital patterns-satellite system link models-satellite system parameters-satellite system link equation link budget-INSAT communication satellites- .
UNIT V EARTH STATION TECHNOLOGY:	Transmitters, Receivers, Antennas, Tracking systems, Terrestrial Interface, Power Test methods, Lower Orbit Considerations. Satellite Navigation & Global Positioning Systems: Radio and Satellite Navigation, GPS Position Location principles, GPS Receivers, GPS C/A code accuracy, Differential GPS.

TEXT BOOKS	1. Handbook of Electronics by Gupta and Kumar, 2008 edition. 2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988. 3. Taub and Schilling, principles of communication systems, second edition, Tata Mc Graw Hill (1991). 4. M. Kulkarani, Microwave and radar engineering, UmeshPublications, 1998. 5. Mono Chrome and colour television, R. R. Ghulathi 6. Satellite Communication Engineering- Wilbur L. Pritchand, Robert A Nelson and Henri G.Suyderhoud, 2nd Edition, Pearson Publications. 7. Digital Satellite Communications-Tri. T.Ha, 2nd Edition, 1990, Mc. Graw Hill.
REFERENCE BOOKS	1. Electronic communications – Dennis Roody and Coolen, Prentice Hall of India, IV edition, 1995. 2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998 3. Dennis Roddy and Coolen,1995,*Electronics communications*,Prentice Hall of India IV Edition. 4. Wayne Tomasi,1998 *"Advanced Electronics communication System"* 4thedition, Prentice Hall of India, 1998 5. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.
WEB SOURCES	1. https://www.geeksforgeeks.org/digital-electronics-logic-designtutorials/ 2. https://www.polytechnichub.com/difference-analog-instrumentsdigital-instruments/ 3. http://nptel.iitm.ac.in/ 4. http://web.ewu.edu/ 5. http://nptel.iitm.ac.in/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Discuss and compare the propagation of electromagnetic waves through sky and on earth's surface Evaluate the energy and power radiated by the different types of antenna	**K1, K5**
CO2	Compare and differentiate the methods of generation of microwaves analyze the propagation of microwaves through wave guides- discuss and compare the different methods of generation of microwaves	**K4**
CO3	Classify and compare the working of different radar systems- apply the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances – discuss the importance of radar in military- elaborate and compare the working of different picture tube	**K3**
CO4	Classify, discuss and compare the different types of optical fiber and also to justify the need of it-discover the use of optical fiber as wave guide	**K1, K3**
CO5	Explain the importance of satellite communication in our daily life-distinguish between orbital and geostationary satellites elaborate the linking of satellites with ground station on the earth	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	2	2	3	2	1	3
CO2	3	3	3	1	2	2	3	2	1	3
CO3	3	3	3	1	2	2	3	2	1	3
CO4	3	3	3	1	2	2	3	2	1	3
CO5	3	3	3	1	2	2	3	2	1	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	2	1	3
CO2	3	3	3	1	2	2	3	2	1	3
CO3	3	3	3	1	2	2	3	2	1	3
CO4	3	3	3	1	2	2	3	2	1	3
CO5	3	3	3	1	2	2	3	2	1	3

Elective – 3-A. ADVANCED OPTICS	I YEAR – II SEMESTER

Subject Code	Subject Name		L	T	P	Credits	Inst. Hours	Marks
	ADVANCED OPTICS					3	4	75

Pre-Requisites
Knowledge of ray properties and wave nature of light
Learning Objectives
➢ To know the concepts behind polarization and could pursue research work on application aspects of laser ➢ To impart an extensive understanding of fiber and non-linear optics ➢ To study the working of different types of LASERS ➢ To differentiate first and second harmonic generation ➢ Learn the principles of magneto-optic and electro-optic effects and its applications

UNITS	Course Details
UNIT 1: POLARIZATION AND DOUBLE REFRACTION	Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity
UNIT II: LASERS	Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO_2 laser – Chemical lasers – HCl laser – Semiconductor laser
UNIT III: FIBER OPTICS	Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolicindex fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor

UNIT IV: NON-LINEAR OPTICS	Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light
UNIT V: MAGNETO-OPTICS AND ELECTRO-OPTICS	Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro optic effect

TEXT BOOKS	1. B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd. 2. AjoyGhatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd. 3. William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York 4. J. Peatros, Physics of Light and Optics, a good (and free!) electronic book 5. B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley-Interscience,
REFERENCE BOOKS	1. F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition. 2. Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH. 3. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011. 4. Y. B. Band, Light and Matter, Wiley and Sons (2006) 5. R. Guenther, Modern Optics, Wiley and Sons (1990)

WEB SOURCES	1. https://www.youtube.com/watch?v=WgzynezPiyc 2. https://www.youtube.com/watch?v=ShQWwobpW60 3. https://www.ukessays.com/essays/physics/fiber–optics–and–itapplications.php 4. https://www.youtube.com/watch?v=0kEvr4DKGRI 5. http://optics.byu.edu/textbook.aspx

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Discuss the transverse character of light waves and different polarization phenomenon	**K1**
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	**K2**
CO3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	**K3, K4**
CO4	Identify the properties of nonlinear interactions of light and matter	**K4**
CO5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	3
C02	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Elective 3-B. NON LINEAR DYNAMICS	I YEAR - II SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	NONLINEAR DYNAMICS	Elective				3	4	75

Pre-Requisites
Basics of Numerical methods and Differential equations, Fundamentals of linear and nonlinear waves, and Basics of communication systemS
Learning Objectives
➢ To school the students about the analytical and numerical techniques of nonlinear dynamics. ➢ To make the students understand the concepts of various coherent structures. ➢ To train the students on bifurcations and onset of chaos. ➢ To educate the students about the theory of chaos and its characterization. ➢ To make the students aware of the applications of solitons, chaos and fractals.

UNITS	Course Details
UNIT I: GENERAL	Linear waves-ordinary differential equations(ODEs)-Partial differential equations(PDEs)- Methods to solve ODEs and PDEs.- Numerical methods – Linear and Nonlinear oscillators-Nonlinear waves-Qualitative features
UNIT II: COHERENT STRUCTURES	Linear and Nonlinear dispersive waves - Solitons – KdB equation – Basic theory of KdB equation –Ubiquitous soliton equations – AKNS Method, Backlund transformation, Hirotabilinearization method, Painleve analysis - Perturbation methods- Solitons in Optical fibres - Applications.
UNIT III: BIFURCATIONS AND ONSET OF CHAOS	One dimensional flows – Two dimensional flows – Phase plane – Limit cycles – Simple bifurcations – Discrete Dinamical system – Strange attractors – Routes to chaos.
UNIT IV: FRACTALS	Self-similarity - Properties and examples of fractals - Fractal dimension - Construction and properties of some fractals - Middle one third cantor set - Koch curve - Sierpinski triangle – Julia set – Mandelbrot set - Applications of fractals.

UNIT V APPLICATIONS	Soliton based communication systems – Solition based computation – Synchronization of chaos – Chaos based communication – Cryptography – Image processing – Stochastic – Resonance – Chaos based computation – Time Series analysis.

TEXT BOOKS	1. M.Lakshmanan and S.Rajasekar, Nonlinear Dynamics: Integrability, Chaos and Patterns.Springer, 2003. 2. A.Hasegawa and Y.Kodama, Solitons in Optical Communications. Oxford Press, 1995. 3. Drazin, P. G. Nonlinear Systems. Cambridge University Press, 2012. ISBN: 9781139172455. 4. Wiggins, S. Introduction to Applied Nonlinear Dynamical Systems and Chaos. Springer, 2003. ISBN: 9780387001777. 5. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014. ISBN: 9780813349107.
REFERENCE BOOKS	1. G.Drazin and R.S.Johnson. Solitons: An Introduction. Cambridge University Press, 1989. 2. M.Lakshmanan and K.Murali. Chaos in Nonlinear Oscillators. World Scientific, 1989. 3. S.Strogatz**.** Nonlinear Dynamics and Chaos. Addison Wesley, 1995. 4. Hao Bai-Lin, Chaos (World Scientidic, Singapore, 1984). 5. Kahn, P. B., Mathematical Methods for Scientists & Engineers (Wiley, NY, 1990)
WEB SOURCES	1. https://www.digimat.in/nptel/courses/video/108106135/L06.html 2. http://digimat.in/nptel/courses/video/115105124/L01.html 3. https://www.digimat.in/nptel/courses/video/108106135/L01.html 4. http://complex.gmu.edu/neural/index.html 5. https://cnls.lanl.gov/External/Kac.php

COURSE OUTCOMES:
At the end of the course, the student will be able to:

CO1	Gain knowledge about the available analytical and numerical methods to solve various nonlinear systems.	**K1, K4**
CO2	Understand the concepts of different types of coherent structures and their importance in science and technology.	**K2**
CO3	Learn about simple and complex bifurcations and the routes to chaos	**K1, K2**
CO4	Acquire knowledge about various oscillators, characterization of chaos and fractals.	**K1**
CO5	To analyze and evaluate the applications of solutions in telecommunication, applications of chaos in cryptography, computations and that of fractals.	**K3, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	2	1	2	2	2	2
CO2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	2	1	2	2	2	2
CO2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	2	2	2

ELECTIVE 3-C. PHYSICS OF NANO SCIENCE AND TECHNOLOGY	I YEAR - II SEMSTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	PHYSICS OF NANO SCIENCE AND TECHNOLOGY	Elective				3	4	75

Pre-Requisites
Basic knowledge in Solid State Physics
Learning Objectives
➢ Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale. ➢ To provide the basic knowledge about nanoscience and technology. ➢ To learn the structures and properties of nanomaterials. ➢ To acquire the knowledge about synthesis methods and characterization techniques and its applications.

UNITS	Course Details
UNIT I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY	Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.
UNIT II: PROPERTIES OF NANOMATERIALS	Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior:Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).
UNIT III: SYNTHESIS AND FABRICATION	Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nanomanipulator.
UNIT IV: CHARACTERIZATION TECHNIQUES	Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

UNIT V: APPLICATIONS OF NANOMATERIALS	Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.

TEXT BOOKS	1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012). 2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010). 3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012). 4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002). 5. Nanotechnology and Nanoelectronics, D.P. Kothari, V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt.Ltd, New Delhi. (2018)
REFERENCE BOOKS	1. Nanostructures and Nanomaterials – HuozhongGao – Imperial College Press (2004). 2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA 3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J.H.Fendler John Wiley and Sons. (2007) 4. Textbook of Nanoscience and Nanotechnology, B.S.Murty, et al., Universities Press. (2012) 5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi.

WEB SOURCES	1. www.its.caltec.edu/feyman/plenty.html 2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm 3. http://www.understandingnano.com 4. http://www.nano.gov 5. http://www.nanotechnology.com

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	**K1, K2**
CO2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	**K1**
CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	**K2, K3**
CO4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	**K4**
CO5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

Elective -4-A. MICROPROCESSOR 8085 AND MICROCONTROLLER 8051	I YEAR – SECOND SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	MICROPROCESSOR 8085 AND MICROCONTROLLER 8051	ELECTIVE				3	4	75

Pre-Requisites
Knowledge of number systems and binary operations
Learning Objectives
➢ To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor ➢ To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051

UNITS	Course Details
UNIT I 8085 ARCHITECTURE AND PROGRAMMING	Functional Building Blocks of a Processor - 8085 Pinout - Hardware Architecture, Bus structure- Memory organization - data transfer concepts–Interrupts- Instruction set- Addressing Modes-Assembly Language Programs- subroutines- Timing Diagrams.
UNIT II: MEMORY I/O PERIPHERAL DEVICES INTERFACING AND **APPLICATIONS**	Memory Interface – memory mapped I/O & I/O mapped I/O- Generating Control Signals – Interfacing 2KX8 EPROM – 2KX8 RAM -Interfacing I/O ports to 8085-Hand shake signals - PPI8255- Interfacing 8255 to 8085-LED Interface- seven segment display interface - Programmable DMA controller- Programmable counter /interval timer.
UNIT III: 8051 MICROCONTROLLER	Introduction – Features of 8051 - Pin-out of 8051- architecture - PSW and Flag Bits, Register Banks and Stack, IO Ports Usage - Special Function Registers and their uses -Interrupt Structure- Interrupt Enable Register in 8051-Interrupt Priority Register in 8051- Software Generated Interrupts Register -Internal memory (RAM & ROM) Organization-External Memory.
UNIT IV 8051 INSTRUCTION	Instruction Set and Addressing modes: Data transfer instructions - Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical

SET AND ASSEMBLY LANGUAGE PROGRAMMING	operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic - Jump and CALL instructions: Types of Jumps - Subroutines – Assembly Language Programming.
UNIT V: 8051 INTERFACING APPLICATIONS	Basics of Data acquisition systems – Sensors and Transducers – examples- Multiplexed Seven segment display interface – Wave form generation by interfacing DAC – Interfacing ADC –Stepper motor interface - Measurement of electrical quantities (voltage and current) – Measurement of Temperature and Strain - Interrupt programming and serial communication with 8051.

TEXT BOOKS	1. A. NagoorKani, Microprocessors & Microcontrollers, RBA Publications (2009). 2. A. P. Godse and D. A. Godse, Microprocessors, Technical Publications, Pune (2009). 3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing (2013). 4. B. Ram, Fundamentals of Microprocessors & Microcontrollers, DhanpatRai publications New Delhi (2016). 5. V. Vijayendran, 2005, Fundamentals of Microprocessor-8085", 3rd Edition S.Visvanathan Pvt, Ltd. 6. 8051 Micro controller Architecture, Programming and Application by Kenneth .J. AyalaSecond Edition- PRI. 7. 8051 Micro controller and Embedded System by Muhammad Ali Mazidi and Janice Gillispi Mazidi – Pearson Education Publication – 2006

REFERENCE BOOKS	1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008) 2. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi. 3. J. Uffrenbeck, "The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi. 4. W. A.Tribel, Avtar Singh, "The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications", PrenticeHall of India, New Delhi.

WEB SOURCES	1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architectu re.html 2. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/ 3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/ 4. http://www.circuitstoday.com/8051-microcontroller 5. https://www.elprocus.com/8051-assembly-language-programming/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gain knowledge of architecture and working of 8085 microprocessor.	**K1**
CO2	Get knowledge of architecture and working of 8051 Microcontroller.	**K1**
CO3	Be able to write simple assembly language programs for 8085A microprocessor.	**K2, K3**
CO4	Able to write simple assembly language programs for 8051 Microcontroller.	**K3, K4**
CO5	Understand the different applications of microprocessor and microcontroller.	**K3,K 5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

Elective – 4-B. MATERIALS SCIENCE	I YEAR – SECOND SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	MATERIALS SCIENCE	ELECTIVE				3	4	75

Pre-Requisites
. Basic knowledge on different types of materials
Learning Objectives
➢ To gain knowledge on optoelectronic materials ➢ To learn about ceramic processing and advanced ceramics ➢ To understand the processing and applications of polymeric materials ➢ To gain knowledge on the fabrication of composite materials ➢ To learn about shape memory alloys, metallic glasses and nanomaterials

UNIT I: OPTOELECTRONIC MATERIALS	Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi- Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.
UNIT II CERAMIC MATERIALS	Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, almina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics
UNIT III POLYMERIC MATERIALS	Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers
UNIT IV COMPOSITE MATERIALS	Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites:fabrication and applications.

UNIT V: NEW MATERIALS	Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudoelasticity, examples and applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials,single walled and multi walled carbon nanotubes

TEXT BOOKS	1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007 2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008. 3. V. Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice- Hall India, New Delhi(For units 2,3,4 and 5) 4. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw-Hill 5. M. Arumugam, 2002, Materials Science, 3rd revised Edition, Anuratha Agencies
REFERENCE BOOKS	1. B. S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday. Textbook of Nanoscience and Nanotechnology. Springer- Verlag, 2012. 2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). Shape Memory and Super Elastic Alloys: Technologies and Applications, Wood head Publishing Limited, 2011. 3. Lawrence H. VanVlack, 1998. Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint, Addison-Wesley. 4. H. Iabch and H. Luth, 2002, Solid State Physics – An Introduction to Principles of Materials Science, 2nd Edition, Springer. 5. D. Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008.
WEB SOURCES	1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview 2. https://nptel.ac.in/courses/112104229 3. https://archive.nptel.ac.in/courses/113/105/113105081 4. https://nptel.ac.in/courses/113/105/113105025/ https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_M odules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Acquire knowledge on optoelectronic materials	**K1**
CO2	Be able to prepare ceramic materials	**K3**
CO3	Be able to understand the processing and applications of polymeric materials	**K2, K3**
CO4	Be aware of the fabrication of composite materials	**K5**
CO5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	**K1**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

Elective 4-C. CHARACTERIZATON OF MATERIALS	I YEAR – SECOND SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	CHARACTERIZATON OF MATERIALS	ELECTIVE				3	4	75

Pre-Requisites
Fundamentals of Heat and Thermodynamics, Basics of Optical systems, Microscopic systems, Electrical measurements and Fundamentals of Spectroscopy.
Learning Objectives
➢ To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA. ➢ To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques. ➢ To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes. ➢ To make the students understand some important electrical and optical characterization techniques for semiconducting materials. ➢ To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.

UNITS	Course details
UNIT I THERMAL ANALYSIS	Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.
UNIT II MICROSCOPIC METHODS	Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy –differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.
UNIT III ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY	SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- Scanning tunnelingmicroscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.

UNIT IV ELECTRICAL METHODS AND OPTICAL CHARACTERISATION	Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.
UNIT V X-RAY AND SPECTROSCOPIC METHODS	Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMSproton induced X-ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis-application - Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.

TEXT BOOKS	1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990. 2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979. 3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991 4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002. 5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press,(2008).
REFERENCE BOOKS	1. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction”, PrenticeHall, (2001). 2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging,Wiley-Liss, Inc. USA, (2001). 3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).Volumes 49 – 51, (2009). 4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986). 5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993)
WEB SOURCES	1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf 2. http://www.digimat.in/nptel/courses/video/113106034/L11.html 3. https://nptel.ac.in/courses/104106122 4. https://nptel.ac.in/courses/118104008 5. https://www.sciencedirect.com/journal/materials-characterization

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Describe the TGA, DTA, DSC and TMA thermal analysis techniques and make interpretation of the results.	**K1, K3**
CO2	The concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	**K2**
CO3	The working principle and operation of SEM, TEM, STM and AFM.	**K2, K3**
CO4	Understood Hall measurement, four –probe resistivity measurement, C-V, I-V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	**K3, K4**
CO5	The theory and experimental procedure for x- ray diffraction and some important spectroscopic techniques and their applications.	**K4,K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	2	2	2	2	2	3
CO2	3	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	2	3	2	2	2	2
CO4	2	2	2	3	2	3	2	2	2	2
CO5	2	2	2	2	2	2	3	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	2	2	2	2	2	3
CO2	3	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	2	3	2	2	2	2
CO4	2	2	2	3	2	3	2	2	2	2
CO5	2	2	2	2	2	2	3	2	2	2

ELECTIVE 5-A. SPECTROSCOPY	II YEAR – THIRD SMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	SPECTROSCOPY	Elective				3	5	75

Pre-Requisites
Thorough understanding of electromagnetic spectrum, mathematical abilities, knowledge of molecules, their structure, bond nature, physical and chemical behaviour
Learning Objectives
➢ To comprehend the theory behind different spectroscopic methods ➢ To know the working principles along with an overview of construction of different types of spectrometers involved ➢ To explore various applications of these techniques in R &D. ➢ Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds. ➢ Understand this important analytical tool

UNIT I: MICROWAVE SPECTROSCOPY
Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra - Problems.
UNIT II: INFRA-RED SPECTROSCOPY
Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra – Simple applications.

UNIT III: RAMAN SPECTROSCOPY
Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle- determination of N_2O structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- Surface Enhanced Raman Spectroscopy.
UNIT IV: RESONANCE SPECTROSCOPY
Nuclear and Electron spin- Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan
Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR
UNIT V: UV SPECTROSCOPY
Origin of UV spectra - Laws of absorption – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer -Simple applications

TEXT BOOKS

1. C N Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
2. G Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.
3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K. Sharma, 2015, *Spectroscopy,* Goel Publishing House Meerut.
5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7^{th} Edition), New Age International Publishers

REFERENCE BOOKS
1. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi. 2. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge. 3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York. 4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi. 5. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer Link

WEB SOURCES
1. https://www.youtube.com/watch?v=0iQhirTf2PI 2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5 3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee 4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview 5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.	**K2**
CO2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.	**K2, K3**
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	**K5**
CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	**K4**
CO5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	**K1, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

ELECTIVE -5B. CRYSTAL GROWTH AND THIN FILMS	II YEAR –THIRD SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	CRYSTAL GROWTH AND THIN FILMS	Elective				3	5	75

Pre-Requisites
Fundamentals of Crystal Physics
Learning Objectives
➢ To acquire the knowledge on Nucleation and Kinetics of crystal growth ➢ To understand the Crystallization Principles and Growth techniques ➢ To study various methods of Crystal growth techniques ➢ To understand the thin film deposition methods ➢ To apply the techniques of Thin Film Formation and thickness Measurement

UNITS	Course Details
UNIT I: CRYSTAL GROWTH KINETICS	Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - super saturation - equilibrium of finite phases equation of Thomson - Gibbs - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation - Growth from vapour phase solutions, solutions and melts - epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films
UNIT II: CRYSTALLIZATION PRINCIPLES	Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram - Super solubility - expression for super saturation - Metastable zone and introduction period - Miers TC diagram - Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.
UNIT III: GEL, MELT AND VAPOUR GROWTH	Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.

UNIT IV: THIN FILM DEPOSITION METHODS	Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.
UNIT V: THIN FILM FORMATION	Thin Film Formation and thickness Measurement Nucleation, Film growth and structure - Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques.

TEXT BOOKS	1. V. Markov Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition 2. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008) 3. M. Ohora and R. C. Reid, "Modeling of Crystal Growth Rates from Solution" 4. 4. D. Elwell and H. J. Scheel, "Crystal Growth from High Temperature Solution" 5. Heinz K. Henish, 1973, "Crystal Growth in Gels", Cambridge University Press. USA.
REFERENCE BOOKS	1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986) 2. P. Ramasamy and F. D. Gnanam, 1983, "UGC Summer School Notes". 3. P. SanthanaRaghavan and P. Ramasamy, "Crystal Growth Processes", KRU Publications. 4. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, NY 5. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London.
WEB SOURCES	1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrI O8kZl1D1Jp 2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7 KeTLUuBu3WF 3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA 53CMKFHPSi9m 4. https://www.youtube.com/playlist?list=PLXHedIxbyr8xIl_KQFs_R_oky3Yd1Emw 5. https://www.electrical4u.com/thermal-conductivity-of-metals/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	**K1**
CO2	Understand the Crystallization Principles and Growth techniques	**K2, K4**
CO3	Study various methods of Crystal growth techniques	**K3**
CO4	Understand the Thin film deposition methods	**K2**
CO5	Apply the techniques of Thin Film Formation and thickness Measurement	**K3, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

ELECTIVE 5-C. GENERAL RELATIVITY AND COSMOLOGY	II YEAR -III SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	GENERAL RELATIVITY AND COSMOLOGY	ELECTIVE				3	5	75

Pre-Requisites
Skill in mathematics and mechanics
Learning Objectives
➢ To give an introduction to students in the areas of general relativity and cosmology

UNITS	Course Details
UNIT I: TENSORS	Tensors in index notation - Kronecker and Levi Civita tensors - inner and outer products - contraction - symmetric and antisymmetric tensors - quotient law - metric tensors - covariant and contravariant tensors - vectors - the tangent space - dual vectors - tensors - tensor products - the Levi-Civita tensor tensors in Riemann spaces
UNIT I: TENSORS FIELD	Vector-fields, tensor-fields, transformation of tensors - gradient and Laplace operator in general coordinates - covariant derivatives and Christoffel connection - Elasticity: Field tensor - field energy tensor - strain tensor tensor of elasticity- curvature tensor
UNIT III: GENERAL RELATIVITY	The spacetime interval - the metric - Lorentz transformations - space-time diagrams - world-lines - proper time - energy-momentum vector - energymomentum tensor - perfect fluids - energy-momentum conservation - parallel transport - the parallel propagator - geodesics - affine parameters - the Riemann curvature tensor - symmetries of the Riemann tensor - the Bianchi identity
UNIT IV: TENSOR IN RELATIVITY	Ricci and Einstein tensors - Weyl tensor - Killing vectors - the Principle of Equivalence - gravitational redshift - gravitation as space-time curvature - the Newtonian limit - physics in curved space-time - Einstein's equations - the Weak Energy Condition - causality - spherical symmetry - the Schwarzschild metric - perihelion precession

UNIT V: COSMOLOGY	Expansion of the Universe - thermal history - and the standard cosmological model - Friedmann - Robertson-Walker type models of the Universe Primordial inflation and the theory of cosmological fluctuations - Theory and observations of the cosmic microwave background and of the large-scale structure of the Universe - Dark matter and dark energy - theoretical questions and observational evidence - inflation - origin of galaxies and other open problems

TEXT BOOKS	1. M. R. Spiegel, *Vector Analysis, Schaum'a outline series*, McGraw Hill, New York, 1974. 2. James Hartle, *Gravity: An introduction to Einstein's general relativity*, San Francisco, Addison-Wesley, 2002 3. Sean Carroll, *Spacetime and Geometry: An Introduction to General Relativity*, (Addison-Wesley, 2004). 4. Jerzy Plebanskiand Andrzej Krasinski, *An Introduction to General Relativity and Cosmology*, Cambridge University Press 2006 5. Meisner, Thorne and Wheeler: *Gravitation* W. H. Freeman & Co., San Francisco 1973
REFERENCE BOOKS	1. Robert M. Wald: *Space, Time, and Gravity: the Theory of the Big Bang and Black Holes*, Univ. of Chicago Press. 2. J. V. Narlikar, *Introduction to Cosmology*, Jones &Bartlett 1983 3. Steven Weinberg, *Gravitation and Cosmology*, New York, Wiley, 1972. 4. Jerzy Plebanski and Andrzej Krasinski, *An Introduction to General Relativity and Cosmology*, Cambridge University Press 2006 5. R Adler, M Bazin& M Schiffer, *Introduction to General Relativity*
WEB SOURCES	1. http://www.fulviofrisone.com/attachments/article/486/A%20First%20Course%20In%20General%20Relativity%20-%20Bernard%20F.Schutz.pdf 2. https://link.springer.com/book/9780387406282 3. https://ocw.mit.edu/courses/8-962-general-relativity-spring-2020/resources/lecture-18-cosmology-i/ 4. https://arxiv.org/abs/1806.10122 5. https://uwaterloo.ca/applied-mathematics/future-undergraduates/what-youcan-learn-applied-mathematics/relativity-and-cosmology

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Skillfully handle tensors	**K1**
CO2	Understanding of the underlying theoretical aspects of general relativity and cosmology	**K2**
CO3	Gain knowledge on space time curvature	**K1**
CO4	Equipped to take up research in cosmology	**K3, K4**
CO5	Confidently solve problems using mathematical skills	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	1	3	2	3	2	2	2	2
CO2	3	3	1	3	2	3	2	2	2	2
CO3	3	2	1	2	1	2	1	1	3	2
CO4	3	2	1	2	1	2	1	1	3	2
CO5	3	2	1	2	1	2	1	1	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	1	3	2	3	2	2	2	2
CO2	3	3	1	3	2	3	2	2	2	2
CO3	3	2	1	2	1	2	1	1	3	2
CO4	3	2	1	2	1	2	1	1	3	2
CO5	3	2	1	2	1	2	1	1	3	2

Elective 6-A. ELECTROMAGNETIC THEORY	II YEAR – FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	ELECTROMAGNETIC THEORY	Elective				3	6	75

Pre-Requisites
Knowledge of different coordinate systems, Laplace's equation, conducting & non-conducting medium, basic definitions in magnetism, propagation of electromagnetic waves, plasma

Learning Objectives

- To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables
- To understand Biot – Savart's law and Ampere's circuital law
- To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws
- To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves
- To grasp the concept of plasma as the fourth state of matter

UNIT I: ELECTROSTATICS
Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems. Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.

UNIT II: MAGNETO STATICS
Biot-Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.
UNIT III: MAXWELL EQUATIONS
Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution- Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.
UNIT IV: WAVE PROPAGATION
Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide. Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole
UNIT V: ELEMENTARY PLASMA PHYSICS
The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto-hydrodynamic waves - Alfven waves and magneto sonic waves.

TEXT BOOKS

1. D. J.Griffiths , 2002, Introductionto Electrodynamics, 3rd Edition, Prentice-Hall of India, New Delhi.
2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd edition, Narosa Publishing House, New Delhi.
3. J. D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd. New Delhi.
4. J. A. Bittencourt, 1988, Fundamentals of Plasma Physics, Pergamon Press, Oxford.
5. Gupta, Kumar and Singh, Electrodynamics, S. Chand & Co., New Delhi

REFERENCE BOOKS

1. W. Panofsky and M. Phillips, 1962, *Classical Electricity and Magnetism,* Addison Wesley, London.
2. J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications*, 5th Edition, WCB McGraw-Hill, New York.
3. B. Chakraborty, 2002, *Principles of Electrodynamics*, Books and Allied, Kolkata.
4. P. Feynman, R. B. Leighton and M. Sands, 1998, *The Feynman Lectures on Physics*, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA

WEB SOURCES
1. http://www.plasma.uu.se/CED/Book/index.html 2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html 3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html 4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/ 5. https://www.cliffsnotes.com/study-guides/physics/electricity-and-magnetism/electrostatics

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	**K1, K5**
CO2	Use Biot-Savart's law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems	**K2, K3**
CO3	Apply Maxwell's equations to describe how electromagnetic field behaves in different media	**K3**
CO4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	**K3, K4**
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

ELECTIV 6-B. QUANTUM FIELD THEORY	II YEAR – FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	QUANTUM FIELD THEORY	ELECTIVE				3	6	75

Pre-Requisites
Prior exposure on fundamentals of Quantum mechanics and Special Relativity will be essential.
Learning Objectives
➢ To school the students about the analytical and numerical techniques of nonlinear dynamics. ➢ To make the students understand the concepts of various coherent structures. ➢ To train the students on bifurcations and onset of chaos. ➢ To educate the students about the theory of chaos and its characterization. ➢ To make the students aware of the applications of solitons, chaos and fractals.

UNITS	Course Details
UNIT I: SYMMETRY PRINCIPLES	Relativistic kinematics, relativistic waves, Klein-Gordon (KG) equation as a relativistic wave equation, treatment of the KG equation as a classical wave equation: its Lagrangian and Hamiltonian, Noether's theorem and derivation of energy-momentum and angular momentum tensors as consequence of Poincaré symmetry, internal symmetry and the associated conserved current.
UNIT II: QUANTIZATION OF KLEIN-GORDAN FIELD	Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, definition of the vacuum and N-particle eigenstates of the Hamiltonian, vacuum expectation values, propagators, spin and statistics of the KG quantum.
UNIT III: QUANTIZATION OF DIRAC FIELD	Review of Dirac equation and its quantization, use of anti commutators, creation and destruction operators of particles and antiparticles, Dirac propagator, energy, momentum and angular momentum, spin and statistics of Dirac quanta.

UNIT IV: QUANTIZATION OF ELECTROMAGNETIC FIELDS	Review of free Maxwell's equations, Lagrangian, gauge transformation and gauge fixing, Hamiltonian, quantization in terms of transverse delta functions, expansion in terms of creation operators, spin, statistics and propagator of the photon.
UNIT V: PERTURBATIVE INTERACTION AT TREE LEVEL	Introduction to interacting quantum fields, Wick's Theorem, Feynman Diagram, Examples from quantum electrodynamics at the tree level: positron-electron and electron-electron scattering.

TEXT BOOKS	1. J. D. BjorkenandS. D. Drell,Relativistic Quantum FieldsDavid 2. An Introduction to Quantum Field Theory by M. Peskin and D. V. Schroeder 3. Quantum Field theory: From Operators to Path Integrals, 2nd edition by Kerson Huang 4. Quantum Field Theory by Mark Srednicki 5. Quantum Field Theory by Claude Itzykson and Jean Bernard Zuber.
REFERENCE BOOKS	1. V.B. Berestetskii,E.M.LifshitzandL.P.Pitaevskii,*QuantumElectrodynamics* 2. Introduction to the Theory of Quantized Fields by N. N. Bogoliubov and D. V. Shirkov (1959) 3. Quantum Field Theory by L. H. Ryder (1984) 4. Quantum Field Theory by L. S. Brown (1992) 5. Quantum Field Theory: A Modern Introduction by M. Kaku (1993)
WEB SOURCES	1. https://homepages.dias.ie/ydri/QFTNOTES4v2.pdf 2. https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/referencespapers.aspx?referenceid=2605249 3. https://archive.nptel.ac.in/courses/115/106/115106065/ 4. http://www.nhn.ou.edu/~milton/p6433/p6433.html 5. https://plato.stanford.edu/entries/quantum-field-theory/

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Understand the interconnection of Quantum Mechanics and Special Relativity	**K1**
CO2	Enable the students to understand the method of quantization to various field	**K2**
CO3	Employ the creation and annihilation operators for quantization	**K5**
CO4	Summarizes the interacting field, in quantum domain, and gives a discussion on how perturbation theory is used here.	**K1, K3**
CO5	Understand the concept of Feynman diagram	**K2**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	2	3	3	2	3
CO2	3	3	3	2	3	3	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	3	3	3	2	3	3	3	3	2	3
CO5	3	3	3	2	3	3	3	3	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	3	2	3	3	2	3
CO2	3	3	3	2	3	3	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	3	3	3	2	3	3	3	3	2	3
CO5	3	3	3	2	3	3	3	3	2	3

ELECTIVE 6-C. ADVANCED MATHEMATICAL PHYSICS	II YEAR - FOURTH SEMESTER

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
	ADVANCED MATHEMATICAL PHYSICS	ELECTIVE				3	6	75

Pre-Requisites
Good knowledge in basic mathematics
Learning Objectives
➢ To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics.

UNITS	Course Details
UNIT I: DISCRETE GROUPS	Definition of a group, subgroup, class, Lagrange's theorem, invariant subgroup, Homomorphism and isomorphism between two groups. Representation of a group, unitary representations, reducible and irreducible representations Schur's lemmas, orthogonality theorem, character table, reduction of Kronecker product of representations, criterion for irreducibility of a representation.
UNIT II: CONTINUOUS GROUPS	Infinitesimal generators, Lie algebra; Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group, D-matrices and their basic properties. Addition of two angular momenta and C.G. coefficients, Wigner-Eckart theorem.
UNIT III: SPECIAL UNITARY GROUPS	Definition of unitary, unimodular groups SU(2) and SU(3). Lie algebra of SU(2). Relation between SU(2) and rotation group. Lie algebra of SU(3) Gellmann's matrices. Cartan form of the SU(3). Lie algebra, roots and root diagram for SU(3). Weights and their properties, weight diagrams for the irreducible representations 3.3*-, 6,6 8, 10 and 10 of SU(3). Direct product of two SU(3) representations, Young tableaux method of decomposition of products of IR's illustrations with the representations of dim<10. C.G.coefficients for 3 x 3* and 3 x 6 representations. SU(3) symmetry in elementary particle physics, quantum numbers of hadrons and SU(2) and SU(3) classification of hadrons.

UNIT IV: TENSORS	Cartesian vectors and tensors illustration with moment of inertia, conductivity, dielectric tensors. Four vector in special relativity, vectors and tensors under Lorentz transformations, Illustration from physics. Vectors and tensors under general co-ordinate transformations, contravariant and covariant vectors and tensors, mixed tensors; tensor algebra, addition, subtraction, direct product of tensors, quotient theorem, symmetric and antisymmetric tensors.
UNIT V: TENSOR CALCULUS	Parallel transport, covariant derivative, affine connection. Metric tensor. Expression for Christoffel symbols in terms of and its derivatives (assuming D g = 0. Curvature tensor, Ricci tensor and Einstein tensor. Bianchi identities, Schwarzschild solution to the Einstein equation G=0.

TEXT BOOKS	1. A.W.Joshi, Group Theory for Physicists 2. D.B.Lichtenberg, Unitary Symmetry and Elementary Particles 3. E.Butkov, Mathematical Physics 4. J.V.Narlikar, General Relativity & Cosmology 5. R. Geroch, Mathematical Physics, The University of Chicago press (1985).
REFERENCE BOOKS	1. M.Hamermesh ***Group Theory*** 2. M.E.Rose: Elementary Theory of Angular Momentum 3. Georgi : Lie Groups for Physicists 4. E.A.Lord: Tensors, Relativity & Cosmology 5. P. Szekeres, A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry, Cambridge University Press.
WEB SOURCES	1. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particlesc4qsfejthkc0 2. https://physics.iith.ac.in/HEP_Physics/slides/poplawskitalk.pdf 3. https://www.hindawi.com/journals/amp/ 4. https://projecteuclid.org/journals/advances-in-theoretical-andmathematical-physics 5. https://www.springer.com/journal/11232

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gained knowledge of both discrete and continuous groups	**K1**
CO2	Apply various important theorems in group theory	**K3**
CO3	Construct group multiplication table, character table relevant to important branches of physics.	**K5**
CO4	Equipped to solve problems in tensors	**K4, K5**
CO5	Developed skills to apply group theory and tensors to peruse research	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	1	1	2	3	2
CO3	3	3	2	1	2	2	1	2	3	2
CO4	3	3	2	2	1	2	1	2	3	2
CO5	3	3	2	2	2	1	1	2	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	1	1	2	3	2
CO3	3	3	2	1	2	2	1	2	3	2
CO4	3	3	2	2	1	2	1	2	3	2
CO5	3	3	2	2	2	1	1	2	3	2