PERIYAR UNIVERSITY

SALEM-636 011

M.Sc. DEGREE Branch-III (B)-PHYSICS

[Choice Based Credit System (CBCS)]

REGULATIONS AND SYLLABUS

(Effective from the academic year 2022-2023 and thereafter)

M.Sc. BRANCH III (B) - PHYSICS

OBE REGULATIONS AND SYLLABUS

1. Preamble Department of Physics

Department of Physics was established in the year of 2004. From the very inception, the department has been conducting M.Sc and M.Phil and Ph.D degree programmes in Physics. The main objectives of the department are to provide high quality teaching and research. This creates knowledge and skill based society to challenge the current and future scientific and technology developments. The designed syllabi facilitate the stakeholders to perceive the wide spectrum of knowledge in physics and this will make them to pursue research in national laboratories in India and abroad and to hold key positions in scientific and academic arena at various capacities. This syllabi covers to teach several important core areas of physics and some elective and interdisciplinary subject areas, which allows the stakeholders to broaden their knowledge beyond pure physics. The subjects being taught in the department includes, Classical Mechanics, Mathematical Physics, Quantum Mechanics and Statistical Mechanics are the mathematical based analytical subjects of physics and this forms a good platform for learning other subjects in physics as well as physical and chemical sciences. Apart from that the Electronic subjects, Solid state physics, Electromagnetic theory, Spectroscopy, Modern Optics and Computer programming and simulation are some of the core and elective subjects intact in the curriculum. Experiments for the advanced level Electronics and General physics practicalhave designed to enrich the stakeholders to attain experimental understanding and computer simulations.

Creation of new knowledge by doing cutting edge research is the another goal of the department. To accomplish the same, the department involved research in the areas of structural investigation of crystalline materials by X-ray Crystallography, Molecular dynamics simulation and Quantum chemical calculations, Synthesis of new biomaterials, Energy materials, Fabrication of new solar cells, Supercapacitors and Molecular modeling. The research programmes being conducted in the Department met several challenges disseminate new materials, designing novel materials and molecules of medicinal importance.

2. General Graduate Attributes

Disciplinary knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of post-graduate programme of study.

Communication Skills: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.

Critical thinking: Capability to apply analytic thought to a body of knowledge; analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.

Problem solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply ones learning to real life situations.

Analytical reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problematizing, synthesizing and articulating; ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.

Cooperation/Team work: Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.

Scientific reasoning: Ability to analyze, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.

Reflective thinking: Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate and use a variety of relevant information sources; and use appropriate software for analysis of data.

Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

Multicultural competence: Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

Moral and ethical awareness/reasoning: Ability to embrace moral/ethical values in conducting one's life, formulates a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to ones work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.

Leadership readiness/qualities: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.

Lifelong learning: Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/ skill development/ reskilling.

3. Programme Specific Qualification Attributes

Sl. No	Programme specific qualification attributes	Level
1	Knowledge and Understanding level	K1, K2
2	Application level	K3
3	Analytical level	K4
4	Evaluation Capacity level	K5
5	Scientific or Synthesis level	K6

4. Vision

To educate the students to be the in-depth knowledgeable and creative persons in physics and interdisciplinary subjects leads them to nurture in science. And promote them to meet out the scientific and technological challenges ahead and to be the science leaders to create scientific environments in Indian academics and industries. The department envisioning to establish Centers to perform creative research in structural science, biomaterials and synthesis of new materials for harvesting solar energy, design high energy storage devices and molecular dynamics simulation.

5. Programme Objectives and Outcomes Programme Educational Objectives (PEOs)

PEO1: The main aim of the M.Sc (Physics) programme is to have enriched syllabus prepared based on the recent scientific developments in physics and its interdisciplinary areas and to meet out the requirements of today's academic, research and industry requirements.

PEO2: To teach core subjects of physics to students to acquire knowledge and to have in-depth understanding about the laws of physics, concepts, principles and solve analytical problems.

PEO3: To teach practical courses that is to attain knowledge in advanced physics experiments by independently perform the same, and to clarify the theory learned in core subjects. To introduce skill based courses training the students to handle advanced equipments and computational knowledge.

PEO4: To provide and teach certain popular courses which are not in conventional core courses considered as elective subjects essential for students to take up their research after completion of the postgraduate course.

PEO5: To provide training to students to perform research in physics and interdisciplinary areas, the course has a room that student to carry out research projects and enable the students to obtain research carrier in R & D labs and industry.

Programme Specific Objectives (PSOs)

PSO1: To educate the students how to use the methods of mathematical physics in broad spectrum of physics, particularly in classical and quantum mechanics.

PSO2: To teach quantum mechanics to students to understand the microscopic phenomena of all branches of physics. And to solve various problems using different exact and approximation methods of quantum mechanics, which helps students to resolve problems in quantum statistics, spectroscopy of molecules, and nuclear and particle physics.

PSO3: To teach the students to be specialized in condensed matter physics as it provides the fundamental science of solids and liquids, and it is the foundations of most technologies; in-depth understanding of this subject allows the students to do research in both basic sciences and technological applications.

PSO4: To develop the skill on programming and computational simulation techniques to resolve various numerical problems in physics, chemistry and biology.

PSO5: To develop the skill and ability of the students to design, conduct, observe, analyzes and report practical experiments. And to provide research training, particularly in X-ray crystallography, quantum chemical calculations, molecular dynamics simulation, nanoscience, biophysics, biomaterials, synthesis of novel materials, fabrication of solar cells, energy materials.

Programme Outcomes (Pos)

After completion of the M.Sc (Physics) programme the students able to

PO1: Apply the knowledge of mathematical physics to understand the complex problems in quantum physics, spectroscopy, condensed matter physics, nuclear and particle physics.

PO2: Critically analyze the complex problems in different core subject areas of physics and find the solution.

PO3: Apply the theoretical knowledge and creative ideas allow independently design new electronic devices and establish new research oriented microprocessor and microcontroller experiments.

PO4: Solve the scientific problems via computer simulation and programme writing skills also gained.

PO5: Apply the concepts, acquired research training, experimental/computational experience to work in concerned research areas.

6. Candidate's eligibility for admission

A candidate who has passed B.Sc. Degree Examinations in Branch III- Physics of this University or examinations of some other university accepted by the syndicate as equivalent there to shall be permitted to appear and qualify for the M.Sc Physics (CBCS) Degree Examinations of this university after a course of two academic year in the Department of Physics of Periyar University.

7. Duration of the programme

The two-year postgraduate programme in M.Sc. Physics consists of four semesters under Choice Based Credit System (CBCS).

8. CBCS-Structure of the programme

Course Component	No. of Courses	Hours of learning	Marks	Credits
Part A (Credit Courses)				
Core Courses				
Theory (12- theory papers)	12	72/Course	1200	48
Practical (4-Practicals)	4	72/Practical	400	16
Elective Courses	4	72/Course	400	16
Supportive Courses	1	54/Course	100	4
Research/Project	1	108	200	6
Human Rights	1	36	100	2
Total	**24**	**414**	**2400**	**92**
Self-Learning Credit Courses				
Online Courses (MOOC courses: NPTEL / Swayam) [Mandatory]	1	Self-Learning	100	2
Elective Foundation Courses: Value added courses (Mandatory)	1	Self - Learning	100	2
Elective Foundation Courses : Skill based course (Optional)	1	Self -Learning	100	2
Elective Foundation Courses : Job oriented course (Optional)	1	Self-Learning	100	2
Total	**4**	**-**	**400**	**8**

9. Curriculum Structure for each semester as per the courses alignment

Sem.	Course Code	Name of the Course	Credits	Hrs/ Week	Marks Int	Marks Ext	Total
I	22PGPHYC01	Core-1 : Mathematical Physics-I	4	5	25	75	100
	22PGPHYC02	Core-2 : Classical Mechanics	4	5	25	75	100
	22PGPHYC03	Core-3 : Electronics	4	5	25	75	100
	22PGPHYE___	Elective-I:	4	4	25	75	100
	22PGPHYC04	Core-4 : Practical-I : General Physics	4	8	40	60	100
	22PGPHYSC01	*Online course /Swayam courses	2	-	-	100	100
		Total	**22**	**27**	**-**	**-**	**600**
II	22PGPHYC05	Core-5 : Mathematical Physics-II	4	5	25	75	100
	22PGPHYC06	Core-6 : Quantum Mechanics-I	4	4	25	75	100
	22PGPHYC07	Core-7 : Thermodynamics and Statistical Mechanics	4	4	25	75	100
	22PGPHYE___	Elective-II:	4	4	25	75	100
	22PGPHYC08	Core-8 : Practical-II : Electronics	4	8	40	60	100
	22PGPHYS___	Supportive Course :	4	3	25	75	100
	06PHR01	Human Rights	2	2	25	75	100
		Total	**26**	**30**	**-**	**-**	**700**
III	22PGPHYC09	Core-9 : Quantum Mechanics-II	4	5	25	75	100
	22PGPHYC10	Core-10: Spectroscopy	4	5	25	75	100
	22PGPHYC11	Core-11 : Numerical Methods and Fortran Programming	4	5	25	75	100
	22PGPHYE___	Elective-III:	4	4	25	75	100
	22PGPHYC12	Core-12 : Practical-III : Microprocessors and Microcontroller	4	8	40	60	100
		Total	**20**	**27**	**-**	**-**	**500**
IV	22PGPHYC13	Core-13 : Electromagnetic Theory	4	4	25	75	100
	22PGPHYC14	Core-14 : Condensed Matter Physics	4	4	25	75	100
	22PGPHYC15	Core-15 : Nuclear and Elementary Particle Physics	4	4	25	75	100
	22PGPHYE___	Elective -IV:	4	4	25	75	100
	22PGPHYC16	Core-16 : Practical-IV: Computational Programming and Simulation	4	8	40	60	100
	22PGPHYC17	Core-17 : Project Work	6	6	-	-	200
		Total	**26**	**30**	**-**	**-**	**700**
		Seminar	**-**	**1**	**-**	**-**	**-**
		Total	**94**	**112**	-	-	**2500**

* Online courses are mandatory.

Add on Courses

Sem.	Add on Courses	Course Code	Credits	No. of Hours		Marks		Total Marks
				Theory	Practical	Theory	Practical	
II	Value Added Course	22PGVAC_	2	30	-	100	-	100
II	Field /Industrial Visit	22PGFV01	-	Minimum one day		Submit the Field Visit Report		-
III	Internship (Students are asked to do Internship offered by other Institution or Industry during the summer vacation immediately after Semester –II examinations)	22PGINS01	2	Minimum 15 days		Submit the Internship Report. The report will be evaluated by the expert committee and the committee will give the report as **Commended/ Highly commended**		-
III	Skill Based Course	22PGSBC_	2	15	15	50	50	100
IV	Job Oriented Course	22PGJOC_	2	15	15	50	50	100

Elective Courses	
Course Code	**Title of the Course**
22PGPHYE01	Nanoscience
22PGPHYE02	Microprocessors and Microcontroller
22PGPHYE03	Modern Optics
22PGPHYE04	Biophysics
22PGPHYE05	X-ray Crystallography
22PGPHYE06	Quantum Chemistry
22PGPHYE07	Molecular Physics
22PGPHYE08	Physics of Earth
22PGPHYE09	Photovoltaic Science
22PGPHYE10	Introductory Astronomy, Astrophysics and Cosmology
22PGPHYE11	Petrophysics
22PGPHYE12	Materials Physics and Processing Techniques
22PGPHYE13	Medical Physics
22PGPHYE14	Elements of Nanoscience and Nanotechnology
22PGPHYE15	Crystal Growth and Thin film Physics
22PGPHYE16	Advanced Spectroscopy
22PGPHYE17	Basic Concepts of Instrumentation
22PGPHYE18	Communication Electronics
22PGPHYE19	Semiconductor Devices - Theory
22PGPHYE20	Basic and Applications of Nanoscience
22PGPHYE21	Energy Physics
22PGPHYE22	Solar Cells
22PGPHYE23	Solar Energy Utilization
22PGPHYE24	Physics of Non-conventional Energy Resources

Course code	Title of the course
22PGPHYS01	Electronics in Daily Life
22PGPHYS02	Geophysics
22PGPHYS03	Molecular Biophysics
22PGPHYS04	Non-linear Optics
22PGPHYS05	Laser Physics and Applications

Course Code	Title of the course
22PGVAC01	Powder X-ray Diffraction and Analysis
22PGVAC02	Optical System Analysis and Design
22PGVAC03	Biomaterials
22PGVAC04	Solar Physics
22PGVAC05	Analytical Instrumental Methods
22PGVAC06	Radiation Physics

Skill based Courses	
Course Code	**Title of the course**
22PGSBC01	Design and Fabrication of Electrical Energy Storage Devices
22PGSBC02	C++ Programming
Job Oriented courses	
22PGJOC01	Solar Energy System Design
22PGJOC02	Medical Instrumentation

10. Credit Calculation

Method of Teaching	Hours	Credits
Lecture	1	1
Tutorial/Demonstration	1	1
Practical/Internship/Self-learning	2	1

11. CBCS – Scheme of Examinations Semester wise Structure

Sem.	Course Code	Name of the Course	Credits	Hrs/ Week	Marks		Total
					Int	Ext	
I	22PGPHYC01	Core-1 : Mathematical Physics-I	4	5	25	75	100
	22PGPHYC02	Core-2 : Classical Mechanics	4	5	25	75	100
	22PGPHYC03	Core-3 : Electronics	4	5	25	75	100
	22PGPHYE___	Elective-I:	4	4	25	75	100
	22PGPHYC04	Core-4 : Practical-I : General Physics	4	8	40	60	100
	22PGPHYSC01	Online course /Swayam courses	2	-	-	100	100
		Total	**22**	**27**	**-**	**-**	**600**
II	22PGPHYC05	Core-5 : Mathematical Physics-II	4	5	25	75	100
	22PGPHYC06	Core-6 : Quantum Mechanics-I	4	4	25	75	100
	22PGPHYC07	Core-7 : Thermodynamics and Statistical Mechanics	4	4	25	75	100
	22PGPHYE___	Elective-II:	4	4	25	75	100
	22PGPHYC08	Core-8 : Practical-II : Electronics	4	8	40	60	100
	22PGPHYS___	Supportive Course :	4	3	25	75	100
	06PHR01	Human Rights	2	2	25	75	100
		Total	**26**	**30**	**-**	**-**	**700**
III	22PGPHYC09	Core-9 : Quantum Mechanics-II	4	5	25	75	100
	22PGPHYC10	Core-10: Spectroscopy	4	5	25	75	100
	22PGPHYC11	Core-11 : Numerical Methods and Fortran Programming	4	5	25	75	100
	22PGPHYE___	Elective-III:	4	4	25	75	100
	22PGPHYC12	Core-12 : Practical-III : Microprocessors and Microcontroller	4	8	40	60	100
		Total	**20**	**27**	**-**	**-**	**500**
IV	22PGPHYC13	Core-13 : Electromagnetic Theory	4	4	25	75	100
	22PGPHYC14	Core-14 : Condensed Matter Physics	4	4	25	75	100
	22PGPHYC15	Core-15 : Nuclear and Elementary Particle Physics	4	4	25	75	100
	22PGPHYE___	Elective -IV:	4	4	25	75	100
	22PGPHYC16	Core-16 : Practical-IV: Computational Programming and Simulation	4	8	40	60	100
	22PGPHYC17	Core-17 : Project Work	6	6	-	-	200
		Total	**26**	**30**	**-**	**-**	**700**
		Seminar	**-**	**1**	**-**	**-**	**-**
		Total	**94**	**112**	-	-	**2500**

12. Examinations

Examinations are conducted in semester pattern. The examination for the semester I & III will be held in November/December and that for the semester II & IV will be in the month of April/May.
Candidates failing in any subject (both theory, practical and skill) will be permitted to appear for such failed subjects in the same syllabus structure at subsequent examinations within next 5 years. Failing which, the candidate has to complete the course in the present existing syllabus structure.

13. Scheme for Evaluation and Attainment Rubrics

Evaluation will be done on a continuous basis and will be evaluated four times during the course work. The first valuation will be in the 7thweek, the second valuation in the 11thweek, third valuation in the 16th week and the end – semester examination in the 19thweek. Evaluation may be by objective type questions, short answer questions, essays or a combination of these, but the end semester examination is a university theory examination with prescribed question paper pattern.

14. Attainment Rubrics for Theory Courses

Internal assessment Mark (Max. Marks : 25)

For the internal assessment mark 25, the evaluation is distributed to sessional tests, seminar and assignments as 15, 5 and 5 marks, respectively.
To decide the marks for the test, three sessional tests will be conducted in the following way

1. Sessional Test I will be held during seventh week for the syllabi covered till then.
2. Sessional Test II will be held during eleventh week for the syllabi covered between eighth and eleventh week.
3. Sessional Test III will be held during 16thweek for the syllabi covered between 12thweek and 16thweek.

The average of highest two marks scored of the three sessional tests will be taken for Internal assessment marks.

External examination (Max. Marks: 75)

At the end of every semester, an external examination will be conducted for 75 marks. This mark is based on different levels (K1, K2, K3, K4, K5, K6) of questions and the components of 75 marks in the question paper pattern are as follows.

20 Marks for objective type questions (Includes problems)

15 Marks for analytical type questions (Includes problems)

40 Marks descriptive type questions (Includes problems)

15. Question Paper Pattern (Theory)

PART	Approaches	Mark Pattern	K Level	CO Coverage %
A	One word (Answer all questions)	(20 x 1 = 20 (Multiple choice questions)	K1 & K2	26.7
B	100 to 200 words (Answer any three out of five questions)	3 x 5 = 15 (Analytical type questions)	K3 & K4	20
B	500 to 1000 words	5 x 8 = 40 (Essay type questions)	K4, K5 & K6	53.3

Note:
Core courses

- PART A: Four questions from each unit and among all questions at least five questions must be problem.
- PART B: One question from each unit. In this section, among all questions at least two questions must be Problem and other questions are analytical type.
- PART C: Two questions from each unit. In this section, among all questions at least one question must be a problem, the remaining questions are descriptive.

Elective courses

- PART A: Four questions from each unit, all are objective type.
- PART B: One question from each unit, all are analytical type.
- PART C: Two questions from each unit, all are descriptive type.

Supportive courses

- PART A: Four questions from each unit, all are objective type.
- PART B: One question from each unit, all are analytical type questions.

- PART C: Two questions from each unit, all are descriptive type questions.

PASSING MINIMUM

In order to pass a paper, a score of 50% marks minimum is compulsory both in internal + external. However, the score of 50% marks in the external examination is also compulsory. A candidate who has secured a minimum of 50 marks in all the courses prescribed in the programme and earned a minimum of 94 credits will be considered to have passed the Master's programme.

Value Added Courses/Skill based/Job Oriented Courses

(There is no Internal Assessment for these courses, the assessment only based on the external examination)

External Examination Maximum Marks: 50

Examination Time: 2 Hours

PART A: Five short answer type questions will be asked from the two units. Answer all questions.
(5x1=5 Marks)

PART B: Six questions will be asked from the two units, answer any three questions.
(3x5=15 Marks)

PART C: Three questions from each unit, all are descriptive type questions. Either or type questions.
(3x10=30 Marks)

Practical Examination Maximum Marks: 50

Value Added Courses:

No practical (examination) for Value added courses.

Skill based /Job oriented Courses:

Marks awarded for Practical examination/Submission of Training report: Maximum 50 marks.

PASSING MINIMUM (Value Added & Skill/Job oriented Courses)

In order to pass the paper, a score of 50% marks minimum is compulsory in the external examination (50% Practical for Skill/Job oriented courses also).

16. Attainment Rubrics for Lab Courses

In this programme, students have to complete three laboratory courses. The components of marks for the internal assessment test and external examination marks are as follows.

Division of marks for Practical

Maximum Internal assessment marks : 40

Maximum External examination marks : 60

The components of internal assessment 40 marks are:

Periodical Assessment (Observation) marks : 20

Test (Best 2/3) : 10

Record : 10

The components of External examination 60 marks are:

Experiments : 40

Viva-voce : 10

Record : 10

17. Attainment Rubrics for Research

In Fourth semester of this programme students should do one research project under the supervision of one the faculties of the department. At the end semester, student should submit the project report and it will be evaluated by the project supervisor (Internal examiner) and the external examiner. The viva-voce examination also conducted to assess the knowledge of the student and the results of the titled project. The marks will be awarded in the following way. Passing minimum for the project is 50% of the assigned 200 marks.

Examiners	**Maximum marks for 200**		
	Viva-voce	**Project Report**	**Total**
Internal	40	60	100
External	40	60	100
Total marks (Maximum)			200

18. Grading System

Evaluation of performance of students is based on ten-point scale grading system as given below.

Ten point scale			
Grade Marks	**Grade points**	**Letter Grade**	**Description**
91 – 100	9.1 - 10.0	O	Outstanding
80 – 90	8.0 - 9.0	D+	Excellent
75 – 79	7.5 - 7.9	D	Distinction
70 – 74	7.0 - 7.4	A+	Very Good
60 – 69	6.0 - 6.9	A	Good
50 – 59	5.0 - 5.9	B	Average
0 – 49	0.0	U	Re Appear
Absent	0.0	AAA	Absent

CORE COURSES

MATHEMATICAL PHYSICS - I

COURSE CODE: 22PGPHYC01 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To develop knowledge in mathematical physics and its applications.
- To develop expertise in mathematical techniques required in physics.
- To enhance problem solving skills.
- To enable students to formulate, interpret and draw inferences from mathematical solutions.

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Solve problems in orthogonality of vectors, eigen values and eigen vectors.
CO2	Study the Cayley-Hamilton's theorem.
CO3	Understand the algebraic operation and calculus in tensor.
CO4	Solve the analytical function in complex variable and use complex variable for solving the definite integrals.
CO5	Use the representation of group in Crystallography and Molecular symmetry.

Mapping of course outcome with the programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	M	L
CO2	H	M	L	M	L
CO3	H	M	L	M	L
CO4	H	M	L	M	M
CO5	M	M	L	M	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Vector analysis	Concept of gradient, divergence and curl - Gauss's divergence theorem, Green's theorem and Stoke's theorem (statement and proof) Curvilinear Coordinates; Orthogonal coordinates – Differential operators in curvilinear coordinates – spherical polar coordinates-Rotation and reflection in spherical coordinates- Application of vector in hydrodynamics.	18
II	Vector Spaces	Linear vector spaces- Subspaces- Bases and dimension - Linear independence and orthogonality of vectors-Gram-Schmidt orthogonalisation procedure - Orthonomalizing Physical Vectors-Operators; Commutation of Operators- Basis Expansion of Operators.	18
III	Tensor analysis	Definition of Tensors – Contravariant, covariant and mixed tensors – addition and subtraction of Tensors – Isotropic Tensor-Summation convention- Symmetry and Anti-symmetry Tensor – Contraction and direct product – Quotient rule-Pseudotensors - Levi-Civita Symbol - Dual tensors, irreducible tensors-Metric tensors-Christoffel symbols .	18
IV	Complex Variables	Functions of complex variable-Analytic functions-Cauchy-Riemann equations- integration in the Complex plane-Cauchy's theorem- Cauchy's integral formula-Taylor and Laurent expansions- Singular Points- Cauchy's residue theorem - poles - evaluation of residues - evaluation of definite integrals.	18
V	Group theory	Definition of a Group - Subgroups - Cyclic groups and abelian groups - Homomorphism and isomorphism of groups - Classes - Symmetry operations and symmetry elements - Representations of groups - Reducible and irreducible representations - Character tables for simple molecular types (C_{2v} and C_{3v} point group molecules).	18

Tutorial

Eigen values and Eigen vectors, Caley-Hemilton Therorem, symmetric and skew symmetric tensors, Analytic functions, Cauchy's integral formula-Taylor and Laurent expansions- Singular Points-Cauchy's residue theorem - poles - evaluation of residues - evaluation of definite integrals, groups-SU(2) groups.

Books for Study

1. Mathematical Physics - Satya Prakash, Sultan Chand & Sons; Sixth Edition, 2014.

2. Mathematical methods for Physicists - George Arfken Hans, WeberFrank E. Harris; Seventh Edition, Elsevier, 2012.

Books for Reference

1. Mathematical Physics - B.D. Gupta, Vikas Publishing House Pvt. Ltd, 1995.
2. Mathematical Physics -B.S.Rajput, 20th Edition, Pragati Prakashan, 2008.
3. Mathematical Physics - H.K. Dass and Rama Verma, S.Chand and Company Ltd, 2010.
4. Mathematical Physics - P.K. Chattopadhyay, Wiley Eastern Limited, 1990.
5. Introduction to Mathematical Physics - Charlie Harper, Prentice Hall of India Pvt. Ltd., 1993.
6. Applied Mathematics for Engineers and Physicists - L.A. Pipes and L.R. Havevill, McGraw Hill Publications Co., 3rd Edition, 1971.
7. Theory and Problems of Laplace Transforms - Murray R. Spigel, Schaum's outline series, McGraw Hill, 1986.
8. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern limited, 3rd Edition, 1995.

CLASSICAL MECHANICS

COURSE CODE: 22PGPHYC02 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To acquire the knowledge of Lagrangian mechanics, constraints and apply to the basic physical systems
- To understand and solve the Hamiltonian and canonical equations
- To learn Hamilton-Jacobi theory and get the knowledge of small oscillations
- To understand rigid body dynamics and study the Euler equations
- To acquire the knowledge about central force field and Theory of relativity.

COURSE OUTCOME: After completion of the course the students able to

CO1	Solve the equation of motion using Lagrangian equations
CO2	Understand and apply the equation of motion using Hamilton equations
CO3	Grasp Hamilton-Jacobi equations and eigen value equations
CO4	Understand the kinematics of the rigid body through Euler equation
CO5	Understand and solve the central force field problems and theory of relativity

Mapping of the course outcomes with programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	L
CO2	H	H	L	M	L
CO3	H	H	L	L	M
CO4	H	M	L	M	L
CO5	H	M	L	L	M

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4,K5,K6)	Hours of Instruction
I	Lagrangian formulation	System of particles- constraints and degrees of freedom-generalized coordinates, force and energy - D'Alemberts principle of virtual work-Lagrange's equation of motion-nonholonomic systems- applications of Lagrange equations of motion: free particle in space-Atwood's machine.	18
II	Hamilton's equation and Canonical Transformation	Calculus of variation--principle of least action-Hamilton's principle-Hamilton`s function-Lagrange's equation from Hamilton's principle-Hamilton's principle for nonholonomic system-variational principle- Hamilton's equations from variational principle. Cyclic coordinates - Canonical transformations-Hamilton's canonical equations. Poisson brackets	18
III	Hamilton-Jacobi theory and small oscillations	Hamilton-Jacobi equation for Hamilton's principle function-Example: Harmonic oscillator problem-Hamilton's characteristic function-Action-angle variable-application to Kepler problem in action angle variables Small oscillations – normal mode analysis – normal modes of a linear tri-atomic molecule	18
IV	Kinematics of rigid body	Independent coordinates of rigid body-Euler angle and Euler's theorem-angular momentum and kinetic energy of motion about a point-moment of inertia tensor –Euler equation of motion-torque free motion of a rigid body-heavy symmetrical top.	18
V	Central Force Problem and Theory of Relativity	Reduction to the equivalent one body problem-Centre of mass-Equation of motion and first integral-Kepler problem: Inverse-Square law of force-Scattering in a central force field-transformation of scattering to laboratory coordinates. Virial Theorem- Special theory of relativity- Lorentz transformations - Relativistic kinematics- mass–energy equivalence. Doppler effect-Minkowski space	18

Tutorial

Constraints, Degrees of freedom, Lagrange's equation of motion- Hamilton's equations- Hamilton-Jacobi method-frequencies of free vibrations- angular momentum and kinetic energy of motion about a point and top- Centre of mass- Relativistic kinematics.

Books for study

1. Classical Mechanics-H. Goldstein, C. Pooleand J. Safko, Pearson Education Asia, New Delhi, Third Edition, 2002.
2. Classical Mechanics - G.Aruldhas, PHI Learning Private Limited, New Delhi, 2015.
3. Classical Mechanics - Goldstein, Herbert, John Safko, and Charles P. Poole; Pearson, 2013.

Books for Reference

1. Classical Mechanics- S.L.Gutpa, V.Kumarand, H.V.Sharma, Pragati Prakashan, Meerut, 2016.
2. Classical Mechanics of Particles and Rigid Bodies - K.C.Gupta, New Age International Publishers, New Delhi, Third edition, 2018.
3. Classical Mechanics- N.C. Rana and P.J. Joag, Tata Mc Graw Hill, New Delhi, 2015.
4. Classical Mechanics- J.C. Upadhaya, Himalaya Publishing House Pvt. Ltd, Bangalore, Second edition, 2017.
4. Classical Mechanics, B.D. Gupta and Satya Prakash, Keder Nath Publishers, Meerut, Revised Edition, 2015.
5. Introduction to Classical Mechanics, R.G.Takwale and P.S.Puranik, Tata Mc GrawHill, New Delhi, 1989.

ELECTRONICS

COURSE CODE: 22PGPHYC03 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To learn about the various types of diode and its characteristics
- To study several theorems and different types of transistors
- To develop background knowledge and core expertise related to applications of OP-Amp.
- To interpret characteristics of memory and their classification
- To learn the fundamentals and applications of convertors

COURSE OUTCOME: After completion of the course the student will be capable to

CO1	Understand the diode characteristics
CO2	Understand the characteristics of various types of transistors such as UJT, FET along with their application in devices. Explores the concept of designing and operating principles of optoelectronic devices.
CO3	Design the operational amplifier and analyse, and evaluate its function.
CO4	Explain the function of semiconductor devices and its applications as the memory elements.
CO5	Design and analyse different data convertors.

Mapping of the course outcomes with programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	L
CO2	M	H	L	H	L
CO3	L	H	H	M	M
CO4	H	M	L	L	L
CO5	H	M	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Semiconductor diodes	Semiconductor- PN Junction diode - Diode junction capacitance – Diode resistance – Temperature dependence V/I characteristic - Zener diode- Varactor diodes- Tunnel diode- Photo diode - Schottky diode – Impatt diode- - Characteristics and Applications.	18
II	Transistor biasing and optoelectronic devices	Transistor Characteristics- Its configuration- Transistor biasing and Thermal stabilization: Need for biasing- operating point- Bias stability - Hybrid model – h-parameters - JFET – UJT- light emitting diode.	18
III	Operational amplifier applications	Operational Amplifier- Performance parameters- Types of Op-Amp- General purpose Op-Amp- Sample and Hold circuits, Applications of Op-Amp: Inverting, Non- inverting Amplifiers- Feedback amplifier - Adder- Subtractor- Differentiator- Integrator - Rectifier circuits - Clipper circuits- clamper circuits- Comparator- Active filters: Low, High and Band pass	18
IV	Semiconductor memories	Classification of memories- Static Shift Register and Dynamic Shift Register, ROM, PROM, EPROM and EEPROM principle and operation - Read & Write memory - Static RAM, dynamic RAM. Charge Couple Device (CCD) - Principle, Construction, Working.	18
V	Converter	Sampling theorem– DAC- Weighted resistor method – Binary Ladder network–A/D Conversion- types- Dual slope - Counter method- successive approximation – Voltage to current conversion and current to voltage conversion	18

Tutorial

Semiconductor devices, Device structure, device characteristics, frequency dependence and application, opto – electronic devices, operational amplifier and their devices, digital techniques and application. Measurement and control, signal conditioning and recovery, amplification, filtering and noise reduction.

Books for Study

1. Integrated Electronics - Millman and Halkias, TMH, 2017.
2. Digital Principles and Applications - Malvino Leach, 7th Edition, TMH, 2010.

Books for Reference

1. Modern Digital Electronics – R.P. Jain – Tata McGraw Hill, 2007.
2. Op-Amp and linear integrated circuits - R.F. Coughlin and F.F, Driscol, Prentice Hall of India, New Delhi, 1996.

3. Op-Amps and Linear Integrated Circits - Ramakant A. Gayakwad, Pearson Education: Fourth Edition, 2015.
4. Electronic Principles - Albert Malvino, David J Bates, 7th Edition, McGraw Hill, 2007.
5. Principles of Electronics - V.K. Mehta, 6th Revised Edition, S. Chand and Company, 2001.
6. Electronic Devices and Circuits - David A. Bell, 4th Edition, Prentice Hall, 2007.

PRACTICAL-I: GENERAL PHYSICS

COURSE CODE: 22PGPHYC04 **HOURS**

L	T	P	C
0	0	8	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To offer experiments based on the concepts of physics in optics, electrical properties, magnetic properties, mechanical properties etc.
- To provide hands on experience and develop skills to handle scientific equipments, perform measurements and analyze the data and compare with the standard data and understand the theoretically studied concepts.
- To understand the Zeeman effect from the experimental set-up and obtain the hydrogen spectra.
- To learn the analytical techniques to obtain the X-ray diffraction spectrum of crystalline samples from Powder-XRD and IR spectrum of material samples from FT-IR instrument.

COURSE OUTCOME: After completion of the course, the students will be able to

CO1	Perform experiments independently with variety of scientific equipments.
CO2	Understand and apply the physical phenomena such as diffraction, interference etc., to measure the material properties such as elastic modulus, compressibility, wavelength etc.,
CO3	Measure and compare the values of specific charge of electron, Planck's constant, Stefan's constant and analyze the reason for error.
CO4	Gain hands on experience to measure carrier type, carrier concentration, Hall coefficient, magnetic susceptibility, particle count by G.M. counter etc.,
CO5	Analyze and identify the crystalline phase and functional groups in materials by XRD and FT-IR respectively.

Mapping of course outcome with the program outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	M	L	H
CO3	H	H	L	M	L
CO4	H	M	L	L	L
CO5	M	H	L	L	M

LISTS OF EXPERIMENTS
(Any 15 experiments)

1. Cornu's method of determination of elastic constants –Young's modulus and Poisson's ratio of a transparent beam by formation Elliptical fringes.
2. Cornu's method of determination of elastic constants –Young's modulus of a transparent beam by formation Hyperbolic fringes.
3. Michelson's Interferometer - Determination of wavelength of the given source and the thickness and refractive index of given sheet.
4. Fabry Perot Etalon - Determination of thickness of air film.
   (i) Measurement of He-Ne Laser wavelength using meter scale (ii) Diffraction and
5. Interference experiments using Laser.
6. Rydburg's constant using constant deviation spectrometer.
7. Determination of refractive index of given liquid using hollow prism.
8. Determination of compressibility of a liquid and study of parameters - wavelength and velocity of the ultrasonic waves in liquid using ultrasonic interferometer at various temperatures.
9. Determination of velocity of ultrasonic waves in the given liquid for a different frequency using Aqua grating method.
10. Determination of Hall coefficients and carrier type of given semiconducting material using Four-probe method.
11. Four-Probe Method - Determination of resistivity of semiconductor at different temperatures.
12. Determination of dielectric constant of given solid Leachir wire method.
13. Microwave dielectric measurement of Liquids by using Waveguide Plunger Technique.
14. Study the Zeeman effect and determination the e/m of electron.
15. Study the magnetoresistance of the semiconductor.
16. Verification of Coulomb's law using Coulomb balance
17. Determination of specific charge of electron (e/m) by Thomson's method.
18. Determination of specific charge of electron (e/m) by Millikan's oil drop method.
19. G.M Counter - Verification of inverse square law, dead time, Poisson and Gaussian distributions.
20. Susceptibility measurement by Quincke's - Paramagnetic susceptibility of specimen.
21. Susceptibility determination of solid sample by Gouy's method
22. Determination of Stefan's constant.
23. Study of magnetic hysteresis in ferromagnetic materials.
24. Determination of self-inductance of ac coil by Anderson's method.
25. Study temperature characteristics and determine the band gap of given thermistor.
26. Study the photoelectric effect and determination Planck's constant.
27. Study the spectrum of hydrogen atom.
28. Determination of lattice parameters and crystallite size calculation from Powder X-ray diffraction patterns of NaCl crystal.
29. Polarization analysis and identification of crystal defects using polarization microscope.

30. Study the I-V characteristics of the given solar cell and find its spectral response.
31. Demonstration of functional group of given organic material using FT-IR spectrometer.

Books for Study

1. An Advanced Course in Practical Physics - D. Chattopadhyay, P. C. Rakshit; New Central Book Agency (P) Ltd; 8th Edition, 2007.
2. A Textbook of Advanced Practical Physics - S. K. Ghosh; New Central; Fourth Edition, 2000.

Books for Reference

1. Advanced Practical Physics for students - B. L. Worsnop and H. T. Flint; Littlehampton. Book Services Ltd; Ninth Revision Edition, 1951.
2. Physical Methods, Instruments and Measurements - Vol. 1-4, - Yuri M. Tsipenyuk; Russian Academy of Sciences, Russia, 2009.
3. Encyclopedia of Physical Science and Technology: Measurements Techniques and Instrumentation - Robert Allen Meyers Academic Press, 2007.

MATHEMATICAL PHYSICS – II

COURSE CODE: 22PGPHYC05 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To develop knowledge in mathematical physics and its applications.
- To develop expertise in mathematical techniques required in physics.
- To enhance problem solving skills.
- To enable students to formulate, interpret and draw inferences from mathematical solutions.

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Study the ordinary second order differential equations with variable coefficients.
CO2	Construct the Recurrence relation of Legendre's differential equation and Bessel's differential equation.
CO3	Study the Hermite differential equation and find its solution.
CO4	Apply the partial differential equations to find the solution of wave and heat equations.
CO5	Represent the Fourier cosine and sin series in the periodic functions.

Mapping of course outcome with the program outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	M	L
CO2	H	M	L	M	L
CO3	H	M	L	M	L
CO4	H	M	L	M	M
CO5	M	M	L	M	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Differential Equations	Homogeneous linear equations of second order with constant coefficients and their solutions – ordinary second order differential with variable coefficients and their solution by power series and Frobenius methods – extended power series method for indicial equations.	18
II	Special Functions-I	Gamma and Beta function-Legendre's differential equation: Legendre polynomials -Generating functions-Recurrence relation-Rodrigue's formula -Orthogonality; Bessel's differential equation: Bessel polynomials -Generating functions-Recurrence relation- Rodrigue's formula– Orthogonality.	18
III	Special Functions–II	Hermite differential equation–Generating functions – Hermite polynomials - Recurrence relations – Rodrigue's formula - Orthogonality: Laguerre differential equations–Generating functions - Laguerre polynomials- Recurrence relation - Rodrigue's formula – Orthogonality.	18
IV	Partial Differential Equations	Singular points - regular and irregular singular points; Frobenius method; Fuch's theorem; Linear independence of solutions -Wronskian, second solution. Sturm-Liouville theory; Hermitian operators; Completeness	18
V	Integral Transforms	Fourier and Laplace transforms and their inverse transforms; Transform of derivative and integral of a function; Solution of differential equations using integral transforms.	18

Tutorial

First and Second order differential equation, Solution of First and Second order differential equation, Legendre's differential equation, Laguerre's differential equation, Bessel's differential equation, Hermite differential equation, Laplace, Wave and Heat Equations in two and three dimensions, One-dimensional problems, Fourier series and Transform, Laplace Transforms.

Books for Study

1. Mathematical Physics –Satya Prakash, Sultan Chand & Sons; Sixth Edition, 2014.
2. Mathematical methods for Physicists - George Arfken Hans, WeberFrank E. Harris; Seventh Edition, Elsevier, 2012.

Books for Reference

1. Mathematical Physics - B.D. Gupta, Vikas Publishing, 1995.
2. Mathematical Physics - B.S. Rajput, 20th Edition, PragatiPrakashan, 2008.

3. Mathematical Physics - H.K. Dass and Rama Verma, Chand and Company Ltd., 2010.
4. Mathematical physics - P.K. Chattopadhyay, Wiley Eastern Limited, 1990.
5. Introduction to Mathematical Physics - Charlie Harper, Prentice Hall of India Pvt. Ltd, 1993.
6. Applied Mathematics for Engineers and Physicists - L.A. Pipes and L.R.Havevill, 3rd Edition, McGraw Hill, 1971.
7. Theory and problems of Laplace Transforms - Murray R. Spigel, International edition, McGraw Hill, 1986.

QUANTUM MECHANICS-I

COURSE CODE: 22PGPHYC06 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the fundamentals of wave mechanics.
- To study the stationary state and eigen spectrum of systems using Schrodinger equation. And to understand the identical particles.
- To study the exactly soluble eigen value problems.
- To know the matrix formulation of quantum theory and how it can be used to understand the representation of time evolution of operators and states.
- To study the angular momentum.

COURSE OUTCOME: After completion of the course, the student will be able

CO1	To explain the wave mechanics based on quantum principles.
CO2	To solve the stationary state problems and interpret the identical particles in terms of the concepts of quantum mechanics.
CO3	To know how to exactly solve some eigen value problems using Schrodinger equation.
CO4	To know the matrix formulation of quantum theory and solve eigen value problems, and elucidate the matrix representation of time evolution of operators and states.
CO5	To interpret the formulation of scattering theory and the partial wave analysis.

Mapping of course outcome with the program outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	H	L	H
CO3	H	H	L	H	L
CO4	H	M	H	L	L
CO5	M	H	L	H	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Foundations of wave mechanics	Postulates of wave mechanics –adjoint and self-adjoint operators- degeneracy- eigen value, eigen functions- Hermitian operator- parity - observables- Physical interpretation- expansion coefficients- momentum eigen functions- Uncertainty principle- states with minimum value –commuting observables. Matter waves- Equation of motion-Schrodinger equation for the free particle– physical interpretation of wave function- normalised and orthogonal wave functions-expansion theorem- admissibility conditions- stationary state solution of Schrodinger wave equation- expectation values- probability current density- Ehrenferts theorem.	15
II	Stationary state and eigen spectrum and Identical particles	Time independent Schrodinger equation –Particle in a square well potential –Bound states– eigen values, eigen functions– Potential barrier– quantum mechanical tunneling- alpha emission. Identical Particles and Spin: Identical Particles– symmetry and antisymmetric wave functions– exchange degeneracy –Spin and statistics: Pauli's exclusion principle-Slater determinant- spin and Pauli's matrices.	15
III	Exactly soluble eigen value problems	One dimensional linear harmonic oscillator-properties of stationary states- abstract operator method- Angular momentum operators- spherical symmetry systems- Particle in a central potential– radial wave function- Hydrogen atom: solution of the radial equation- stationary state wave functions- bound states- the rigid rotator: with free axis-in a fixed plane- 3-Dimentional harmonic oscillator.	14
IV	Matrix formulation of quantum theory and equation of motion	Quantum state vectors and functions- Hilbert space- Dirac's Bra-Ket notation- matrix theory of Harmonic oscillator - Equation of motions- Schrodinger, Heisenberg and Interaction representation.	14
V	Angular momentum	Angular Momentum: commutation relation of J_Z, J_+, J_- - eigen values and matrix representation of J_2, J_Z, J_+, J_- - Spin angular momentum – spin ½ , spin-1- addition of angular momenta- Clebsch-Gordan coefficients.	14

Tutorial

New developments in Quantum mechanics**:** Quantum gravity vs General theory of relativity and Quantum teleportation and Quantum cryptography.

Books for Study

1. A Text book of Quantum Mechanics – G. Aruldhas, Prentice Hall of India Pvt., Ltd., 2002.
2. Quantum Mechanics- Satya Prakash, Kedar Nath, Ram Nath and Co. Publications, 2018.

Books for Reference

1. Quantum Mechanics– Theory and applications -A. K. Ghatak and Lokanathan, Macmillan India Ltd Publication, Fifth Edition, 2015.
2. Quantum Mechanics- Leonard I. Schiff, McGraw- Hill International Publication, Third Edition,1968.
3. Quantum Mechanics- V. K. Thankappan, New Age International(P) Ltd. Publication, Second Edition, 2003.
4. Quantum Mechanics- E. Merzbacher, John Wiley Interscience Publications, Third Edition, 2011.
5. Quantum Mechanics (Vol.I) – Claude Cohen- Tannoudji, Bernard Diu, Franck Laloë, John Wiley Interscience Publications, First Edition,1991.
6. Quantum Mechanics- Pauling &Wilson, Dover Publications, New Edition, 1985.
7. Principle of Quantum Mechanics - R. Shankar, Plenum US Publication, Second Edition, 1994.

THERMODYNAMICS AND STATISTICAL MECHANICS

COURSE CODE: 22PGPHYC07 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To provide a phenomenological introduction to thermodynamics through thermodynamics postulates, quantities and relations.
- Studying the micro and macroscopic properties of the mater through the statistical probability laws and distribution of particles.
- Understanding the classical and quantum distribution laws and their relations.
- Studying transport properties, different phases of maters, equilibrium and non-equilibrium process.

COURSE OUTCOME: After completion of the course, the student will be capable of

CO1	Explain the basic concepts of statistical mechanics fundamentals and Laws of Thermodynamics.
CO2	Apply knowledge and demonstrates the various types of Ensembles
CO3	Understanding statistical mechanics of quantum fluids (bosons or fermions). To understand the classical limit and strongly degenerate quantum systems, including various distributions using GCE partition functions.
CO4	Understanding fluctuations of macroscopic properties of thermodynamic systems about their equilibrium values.
CO5	Understanding first-order and second order phase transitions such as the liquid-gas phase transition. To be able to apply the Gibbs' phase rule that governs the number of freely variable thermodynamic variables at a specified phase transition.

Mapping of the course outcomes with programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	M	L	L	H
CO2	H	H	M	L	L
CO3	H	M	H	L	M
CO4	H	M	H	L	M
CO5	H	H	M	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Thermodynamics, microstates and macrostates	Basic postulates of thermodynamics – Phase space and ensembles – Fundamental relations and definition of intensive variables – Intensive variables in the entropic formulation – Equations of state – Euler relation, densities - Gibbs-Duhem relation for entropy - Thermodynamic potentials– Maxwell relations – Thermodynamic relations – Microstates and macrostates – Ideal gas – Microstate and macrostate in classical systems – Microstate and macrostate in quantum systems – Density of states and volume occupied by a quantum state	15
II	Microcanonical, canonical and grand canonical ensembles	Microcanonical distribution function – Two level system in microcanonical ensemble – Gibbs paradox and correct formula for entropy – The canonical distribution function – Contact with thermodynamics - Partition function and free energy of an ideal gas –The grand partition function – Relation between grand canonical and canonical partition functions – One-orbital partition function	14
III	Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann distributions	Bose-Einstein and Fermi-Dirac distributions – Thermodynamic quantities – Non-interacting Bose gas and thermodynamic relations – Chemical potential of bosons – The principle of detailed balance – Number density of photons and Bose condensation - Thermodynamic relations for non-interacting Fermi gas – Fermi gas at zero and low temperature – Fermi energy and Fermi momentum - Maxwell-Boltzmann distribution law for microstates in a classical gas - Physical interpretation of the classical limit – Fluctuations in different ensembles	15
IV	Transport and non-equilibrium processes	Derivation of Boltzmann transport equation for change of states without and with collisions – Boltzmann equation for quantum statistics – Equilibrium distribution in Boltzmann equation – Transport processes; One speed and one dimension - All speeds and all directions - Conserved properties - Distribution of molecular velocities – Equipartition and Virial theorems – Random walk - Brownian motion - Non-equilibrium process; Joule-Thompson process - Free expansion and mixing - Thermal conduction - The heat equation.	14
V	Heat capacities, ising model and phase transitions	Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas – Heat capacity of Bose gas –One-dimensional Ising model and its solution by variational method – Exact solution for one-dimensional Ising model - Phase transitions and criterion for phase transitions – Classification of phase transitions by order and by symmetry – Phase diagrams pure system - Theory of Super fluidity liquid helium.	14

Tutorial

Laws of thermodynamics and their consequences-Thermodynamic potentials, Maxwell relations, Chemical potential, phase equilibria, phase phase-micro- macro-states. Micro-canonical, canonical and grand canonical ensembles- patrician functions, Free energy and its connection with thermodynamics quantities, Bose-Fermi gases.

Books for Study

1. Fundamentals of Statistical Mechanics - B.B. Laud, New Age International Publishers, Second Edition, 2012.
2. Statistical Mechanics- V. Kumar and S.L. Gupta, Pragati Prakashan, Twenty Fourth Edition, 2011.
3. Fundamentals of Statistical and Thermal Physics Paperback - Reif, Sarat Book Distributors, 2010.

Books for Reference

1. Elementary Statistical Physics - C. Kittel, John Wiley & Sons, 2004.
2. Statistical Mechanics - R.P. Feynman, Addison Wesley, First Edition, 1998.
3. Statistical Physics - R.K. Pathria, Pergamon, Oxford, Third Edition, 2011.
4. Statistical and Thermal Physics - F. Reif, McGraw Hill, Fifth Edition, 2010.
5. Statistical Mechanics - Kerson Huang, John Wiley & Sons, Second Edition, 2008.
6. Statistical Mechanics, Gupta & Kumar, 20th Edition, Pragati Prakashan, Meerut, 2003.
7. Statistical Mechanics -B.K.Agarwal and M.Eisner, Second Edition, New Age International Private Limited, Delhi, 2016.

<u>**PRACTICAL – II: ELECTRONICS**</u>

COURSE CODE: 22PGPHYC08 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To learn about the various types of diode and its characteristics.
- To study several theorems and different types of transistors.
- To develop background knowledge and core expertise related to applications of Op-Amp.
- To learn the fundamentals and applications opto-electronic devices.
- To interpret characteristics of digital systems.

COURSE OUTCOMES: At the end of the course the student will have skill and able to

CO1	Develop an active expertise in using and constructing electronic circuits.
CO2	Recognize various components such as resistor, capacitor, IC's, voltmeter, ammeter, LED, switches etc., and its usage in circuit designs.
CO3	Learn practical competence in principles, construction and V-I characteristics of several devices like JFET, UJT.
CO4	Assemble simple practical circuits using the electronic components.
CO5	Perform several experiments, in addition, also can precisely read and examine the obtained results.

Mapping of course outcome with the program outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	L	L	H
CO3	H	H	L	L	L
CO4	H	M	L	L	L
CO5	M	H	L	L	M

LIST OF EXPERIMENTS
(Any twenty Experiments)

1. Construction of regulated power supply
2. Design Zener diode as voltage regulator.
3. JFET – Characteristics and design of amplifier.
4. UJT- Characteristics and Design of Relaxation Oscillator.
5. Design of square wave generator (Astable) using IC741 and 555 timers.
6. Design of monostable multivibrator using IC741 and 555 timers.
7. Design of Schmidt's triggers using IC741 and 555 timers.
8. Generation of sine wave form using Op-amp.
9. Design of frequency doubling and phase angle detection circuits using Op-amp.
10. Phase locked loop using IC556.
11. Design and study of phase shift oscillator.
12. Photo transistor characteristic.
13. Photo diode characteristic.
14. Binary addition and subtraction (4 bits)- 7483IC
15. Study of (i) Multiplexer and Demultiplexer (ii) Encoders and Decoders
16. Study the characteristics of BJT in common emitter configuration.
17. Study of Flip-Flops using IC7400
18. Design of Counters and Shift Registers using 7476/7473IC
19. BCD Counters – Seven segment display
20. Design of R/2R ladder and Binary weighted method of DAC using 741IC
21. Study the forward and reverse bias V-I characteristics of PN junction diode.
22. Arithmetic Operations using Op-amp IC741 (Addition, Subtraction, Multiplication & Division)
23. Design of Active filters (Low pass, High pass and Band pass filters)
24. Solving simultaneous equations using Op-amp.
25. Study the Non - Inverting Amplifier and Non – Inverting Summer using IC741.
26. Study the operation of basic logic gates and verify the Boolean expressions from logic circuit

Books for Reference

1. Advanced Practical Physics Volume I – Dr.S.P.Sing, Pragathi Prakasan, Educational Publishers, 17^{th} Edition, 2011.
2. Practical Physics and Electronics – C.C. Ouseph, U.J.Rao, V. Vijayendran S. Viswanath (Printers and Publishers) Pvt Ltd., First Edition, 2007.

QUANTUM MECHANICS – II

COURSE CODE: 22PGPHYC09 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the approximation methods and solve the time independent problems.
- To study the approximation methods for time dependent perturbation theory.
- To study the theory of variation method and solve the problems.
- To study the theory of relativistic quantum mechanics and field quantization.
- To study the quantum theory of atomic and molecular structures.

COURSE OUTCOME: After completion of the course, the student will be able

CO1	To solve the time independent problems using approximation methods.
CO2	To solve problems of perturbed systems using approximation methods for time dependent perturbation theory.
CO3	To solve eigen value problems using variation method.
CO4	To interpret the theory of relativistic quantum mechanics and field quantization.
CO5	To apply quantum theory to understand the atomic and molecular structures.

Mapping of course outcome with the program outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	H	H	H
CO3	H	H	L	L	L
CO4	H	M	H	L	L
CO5	M	H	L	H	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Approximation methods for time dependent perturbation theory	Time dependent Perturbation theory – first order transitions– constant perturbation -transition probability: Fermi Golden Rule– Periodic perturbation –harmonic perturbation– adiabatic and sudden approximation. Semi-classical theory of radiation –Einstein's coefficients– absorption- induced emission- spontaneous emission– Einstein's transition probabilities- dipole transition- selection rules– forbidden transitions	18
II	Variation method	Variation method: Variation Principle– upper bound states-ground state of Helium atom– Hydrogen molecule- WKB approximation-Schrodinger equation- Asymptotic solution- validity of WKB approximation- solution near a turning point– connection formula–Bohr-Summer field quantization condition-tunnelling through a potential barrier.	18
III	Scattering theory	Scattering theory Formulation of scattering theory – Born approximation and its validity –Born series – screened coulombic potential scattering from Born approximation. Partial wave analysis : Asymptotic behaviour – phase shift – scattering amplitude in terms of phase shifts – differential and total cross sections – optical theorem-scattering length and effective range– Ramsauer -Townsend effect – scattering by square well potential.	18
IV	Relativistic quantum mechanics and quantization of the field	Schrodinger relativistic equation- Klein- Gordan equation-charge and current densities– interaction with electromagnetic field— nonrelativistic limit- Dirac relativistic equation–Diracmatrices-plane wave solution– existence of electron spin–negative energy state of electron Field quantization: Classical field equation – Lagrangian form and Hamiltonin - Formulation- quantization of field –quantization of schrodinger equation- Relativistic fields-Klein-Gordan field-Dirac field –Quantization of electromagnetic field.	18
V	Quantum theory of atomic and molecular systems and	Central field approximation: Thomas Fermi statistical method-Hartree and Hartree -Fock approximations (self consistent fields) – Density functional theory Molecules: Born- Oppenheimer approximation– Application: the hydrogen molecule I on (H_2^+)-Molecular orbital theory: LCAO-hydrogen molecule.	18

Tutorial

New developments in Quantum mechanics: Quantum computing, Quantum entanglements and Black hole paradox: Quantum mechanics & General theory of relativity

Books for Study

1. A Text book of Quantum Mechanics -P.M. Mathewsand, K.Venkatesan, Tata Mc Graw– Hill Publications, Second Edition,2010.
2. Quantum Mechanics- Satya Prakash, Kedar Nath Ram Nath and Co. Publications, 2018.
3. Claude Cohen -Tannoudji, Bernard Diu, Franck Laloë – Quantum Mechanics (Vol.II), John Wiley Publications, 2008.

Books for Reference

1. Quantum Mechanics V.K.Thankappan, New Age International (P) Ltd. Publication, Second Edition, 2003.
2. Quantum mechanics - Franz Schwabl, Narosa Publications, Fourth Edition, 2007.
3. Molecular Quantum mechanics - P.W.Atkins and R.S. Friedman, Oxford University Press publication, Fifth Edition, 2010.
4. Quantum Mechanics -Theory and Applications -A.K. Ghatak and Lokanathan, Macmillan India Ltd Publication, Fifth Edition, 2015.
5. Quantum Mechanics- Leonard I. Schiff, McGraw- Hill International Publication, Third Edition, 1968.
6. Quantum Mechanics- E. Merzbacher, John Wiley Interscience Publications, Third Edition, 2011.
7. Fundamental principles of Quantum mechanics with elementary applications - Edwin C. Kemble, Dover Publications, Re-issue Edition, 2005.
8. Principle of Quantum Mechanics - R. Shankar, Plenum US Publication, Second Edition, 1994.

SPECTROSCOPY

COURSE CODE: 22PGPHYC10 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To give advanced knowledge about the interactions of EM radiation with matter and their applications in spectroscopy like IR, Raman, NMR, ESR, NQR and Mossbauer's spectroscopy.

COURSE OUTCOME: After the completion of the course the student will be capable of

CO1	Gets an insight about the basic quantum description of microwave spectroscopy.
CO2	Understand the vibrational spectroscopy methods and will have basic knowledge on IR
CO3	Obtain knowledge on Raman spectra and its applications
CO4	Acquire knowledge on spin resonance spectroscopy.
CO5	Acquire knowledge on quadrupole interaction and its application to spectroscopy.

Mapping of course outcome with the program outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	L	L	H
CO3	H	H	L	L	L
CO4	H	M	L	L	L
CO5	M	H	L	L	M

<u>**Syllabus**</u>

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4,K5,K6)	Hours of Instruction
I	Microwave spectroscopy	Rotation of Molecules – Rigid Rotor (Diatomic Molecules) – Expression for the Rotational Constant - Intensity of Spectral Lines – Effect of Isotopic Substitution - Molecular Parameters (Bond Length, Bond Angle, Dipole Moment) from Rotation Spectra – Techniques and Instrumentation.	18
II	Infrared spectroscopy	Vibrational energy of a diatomic molecule- Infrared selection rules-Vibrating diatomic molecule-Diatomic vibrating rotator-Vibrations of polyatomic molecules- Rotation vibration spectra of polyatomic molecules-Normal modes of vibration in crystal-IR spectrophotometer-Instrumentation-Sample handling techniques-Fourier Transform Infrared spectroscopy-Applications -Infrared synchrotron radiation-Principle, properties and applications	18
III	Raman spectroscopy	Introduction-Theory of Raman scattering-Rotational Raman spectra-Vibrational Raman spectra-Mutual Exclusion principle-Raman spectrometer-Sample handling techniques-Polarization of Raman scattered light-Structure determination using IR and Raman spectroscopy- Resonance Raman scattering-Nonlinear Raman phenomena-Preliminaries- Stimulated Raman scattering-Inverse Raman effect-Coherent Anti-Stokes Raman scattering - Surface-enhanced Raman spectroscopy (SERS), and tip-enhanced Raman spectroscopy (TERS).	18
IV	Nuclear magnetic and electron spin resonance spectroscopy	Basic principles – Quantum theory of NMR - magnetic resonance – relaxation processes – chemical shifts – spin-spin coupling - Fourier Transform NMR –Instrumentation – Applications. 2D NMR Spectroscopy – Principle, experiment, spectra representation Basic principles – Quantum theory - g-factor – Nuclear Interaction and Hyperfine structure – Relaxation effects - Hyperfine interaction – line widths – ESR spectrometer – Instrumentation – applications.	18
V	Nuclear quadrupole resonance And mossbauer spectroscopy	Basic theory - Nuclear Electric quadrupole interaction – Energy levels – Transition frequency – Effect of magnetic field – Instrumentation – applications. Mossbauer effect - recoilless emission and absorption - hyperfine interaction - chemical isomer shift - magnetic hyperfine and electric quadruple interactions – Instrumentation – Advances in instrumental architecture - applications.	18

Tutorial

Relativistic corrections of energy levels of hydrogen atom spectrum, LS and JJ coupling schemes. Vibrational spectra of gaseous diatomic and polyatomic molecules, calculation of population of energy levels, inter nuclear distance, wave length of stokes and anti-stokes lines. Spin-spin coupling between two and more nuclei, Hyperfine and fine (Triplets) structure study of ESR, calculation of resonance frequency, field, line width, chemical shift. Einstein coefficients (A and B) of radiation, calculation of rate of spontaneous and stimulated emission process.

Books for Study

1. Fundamentals of Molecular Spectroscopy - C.N.Banwell, Tata McGraw Hill, 32^{nd} reprint, 2010.
2. Spectroscopy - Vol. 2, B.P.Straughan and S.Walker, Chapmen & Hall, 1976.
3. Molecular Structure and Spectroscopy - G. Aruldhas, Prentice-Hall of India Pvt. Limited, 2007.
4. Biomedical Applications of Synchrotron Infrared Micro spectroscopy – David Moss, RSC Publishing, 2011.
4. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR – D.N. Sathyanarayana, I.K. International Publishing House PVT. Ltd. 2^{nd} Edition, 2013.
5. Surface- and Tip-enhanced Raman Spectroscopy for Catalysis: Fundamentals and Applications (Catalysis Series) - Bert M Weckhuysen, RSC, 2022.

Books for Reference

1. Nuclear Magnetic Resonance - Atta-Ur-Rahman, Springer Verlag, 1986.
2. Laser and Nonlinear optics - B.B.Laud, New Age International Publishers, Third Edition, 2011.
3. Spectroscopy - H.Kaur, Pragati Prakashan Educational Publishers, 2010.

NUMERICAL METHODS AND FORTRAN PROGRAMMING

COURSE CODE: 22PGPHYC11 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- The course on Numerical Analysis and Computational Physics has been framed to obtain the knowledge of programming in FORTRAN, roots of equation, interpolation, curve fitting, Numerical differentiation, numerical integration and numerical solution of ordinary differential equations.

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Develop a comprehensive understanding on numerical error analysis in physical measurements.
CO2	Demonstrate the accurate numerical methods to solve differentiation and integral equations.
CO3	Understand the Newton's interpolation formula in unequal intervals for numerical problem.
CO4	Learn how to obtain numerical solution of ordinary differential equation using power series approximation and Euler's Runge-Kutta method.
CO5	Understand the basic in FORTRAN program and Implement numerical method in FORTRAN.

Mapping of course outcomes with programme outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	H	L	H
CO2	M	H	H	L	H
CO3	H	H	H	L	L
CO4	H	M	H	L	L
CO5	M	H	H	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Solution of Algebraic Equations	The iteration method - The method of false position – Newton – Raphson method – Convergence and rate of convergence - Simultaneous linear algebraic equations: Gauss elimination method – Jordon's modification –Gauss-Seidel method of Iteration.	18
II	Numerical Differentiation and Integration	Newton's forward and backward difference formula to compute derivatives – Lagrange's Interpolation and Newton Divided difference formula. Numerical integration: the trapezoidal rule, Simpson's rule – Extended Simpson's rule	18
III	Numerical Solutions Of Ordinary Differential Equations	Nth order ordinary differential equations – Power series approximation – Solutions of Taylor series – Euler's method – Improved Euler's method – Runge-Kutta method – second and fourth order – Runge-Kutta method for solving first order differential equations	18
IV	FORTRAN Programming	Integer and floating point arithmetic, Precision, Variable types, Arithmetic statements, Input and output statements, Control statements, Executable and non-executable statements, Arrays, Repetitive and logical structures, Subroutines and functions, Operation with files, Creation of executable programs.	18
V	Simulation	Generation of uniformly distributed random integers, Statistical tests of randomness, Monte-Carlo evaluation of integrals and error analysis, Non-uniform probability distributions, Importance of sampling, Rejection method, Molecular diffusion and Brownian motion as random walk and their Monte-Carlo simulation	18

Tutorial

The method of false position, Newton-Raphson method, Convergence and rate of convergence, Gauss elimination method, Jordon's modification, Gauss-Seidel method, Runge-Kutta method- second and fourth order, Runge-Kutta method for solving first order differential equations, trapezoidal rule, Simpson's rule.

Books for Study

1. Introductory Methods of Numerical Analysis - S.S.Sastry, Prentice Hall of India, New Delhi, Third Edition, 2005.
2. Programmer's Guide to Fortran90 - Brainerd and Walter S, Springer publication, 1996.

Books for Reference

1. Numerical Mathematical Analysis - James B.Scarborough, Oxford & IBH Publishing Co., Pvt. Ltd., Sixth Edition, 1958.
2. Introductory Methods of Numerical analysis - S.S. Sastry, Prentice - Hall of India, New Delhi, Third Edition, 2003.
3. Numerical Methods in Science and Engineering - The National Publishing Co. Madras, Third Edition, 2001.
4. A Guide to Monte Carlo Simulations in Statistical Physics: Landau and Binder. Cambridge University Press, 2009.
5. Simulation and The Monte Carlo Method, Reuven Y. Rubinstein and Dirk P. Kroese, Wiley Third edition, 2017.

PRACTICAL III: MICROPROCESSORS AND MICROCONTROLLER

COURSE CODE: 22PGPHYC12 **HOURS**

L	T	P	C
0	0	8	4

MAXIMUM MARKS: 100

OBJECTIVES:

- To develop background knowledge and core expertise on Microprocessor 8085.
- To write assembly language programs of Microprocessor for various applications.
- Also provides a basic understanding of design and operation of Microprocessor 8086
- To know the architecture aspects of microcontrollers.
- To know the importance of different peripheral device and their interfacing to Microcontroller.

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

CO1	Write simple ALP for 8 and 16 bit arithmetic operations using 8085 and 8051.
CO2	Learn the ALP program of microprocessors/microcontrollers-based systems such as code conversion, arranging numbers in ascending and descending orders.
CO3	Develop a capability to handle analog signals in digital devices.
CO4	Gain knowledge on interfacing various I/O devices.
CO5	Construct an expanded system by connecting several hardware as needed also integrates timer and counter functions.

Mapping of course outcome with the programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	M	L	H	M
CO2	H	H	M	H	L
CO3	H	M	H	H	M
CO4	H	M	H	H	M
CO5	H	H	M	H	H

LIST OF EXPERIMENTS
(Any twenty experiments)

Microprocessors 8085 and 8086

1. Arithmetic operations- 8 bit and 16 bit.
2. Code conversion (BCD to Binary and Binary to BCD).
3. Arranging numbers in ascending and descending orders.
4. Temperature Conversions (F to C & C to F).
5. Determination of factorial of the given number.
6. Display and roll of a message.
7. Solving simple expressions.
8. Square and square root of the given number.
9. Sum of the "n" numbers.
10. Stepper motor interfacing.
11. Temperature controller measurements (Digital thermometer).
12. Traffic light controller.
13. Arithmetic operations using 8086 microprocessors.
14. Find the number of occurrence of a character in the sentence.
15. Find the largest and smallest number in an array of data
16. Conversion of Hexadecimal number into its equivalent ASCII number.

Microcontroller 8051

17. Arithmetic operations- 8 bit and 16 bit.
18. Solving simple expressions.
19. Array operations (Biggest and Smallest number).
20. Square and square root of the given number.
21. Stepper motor interfacing.
22. Seven segment display interfacing.
23. Find the largest and smallest element in an array.
24. Sum of a series of 8 bit data.

Books for Study and Reference

1. Microprocessor Architecture, programming and application with 8085 - Ramesh S. Gaonkar, Wiley Eastern, 1987.
2. Introduction to Microprocessors software, hardware and programming - Lance A. Leventhal, Prentice Hall of India, 1978.

ELECTROMAGNETIC THEORY

COURSECODE: 18PGPHYC13 **HOURS**

MAXIMUM MARKS:100

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To study the fundamental Gauss's Theorem in electrostatics.
- To study the Biot-Savart Law and Ampere's Law to study the magnetic field.
- To evaluate the solution of wave equation in one dimension system.
- To study the energy and momentum in electromagnetic waves.
- To learn the plasma behavior in magnetic field.

COURSE OUTCOME: After completion of the course the students able to

CO1	Apply the fundamental theorem for divergences (Gauss's Theorem) in specific situations.
CO2	Apply Biot-Savart Law and Ampere's Law to study the magnetic field due to a current distribution.
CO3	Find the solution of wave equation in one dimension system.
CO4	Describe the energy and momentum in electromagnetic waves.
CO5	Describe the dispersion relations in plasma.

Mapping of course outcomes with programme outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	L	L	H
CO3	H	H	L	L	L
CO4	H	M	L	L	L
CO5	M	H	L	L	M

Syllabus

Unit	Unit Title	Intended learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Electrostatics	Coulomb's law; the electric field-line, flux and Gauss's Law in differential form the electrostatic potential; conductors and insulators; Gauss's law - application of Gauss's law-curl of E-Poisson's equation: Laplace's equation-work and energy in electrostatics-energy of a point charge distribution energy of continuous charge distribution-induced charges - capacitors Potentials Laplace equation in one dimension and two dimensions - Dielectrics - induced dipoles-Gauss's Law in the presence of dielectrics.	15
II	Magnetostatics	Lorentz force-magnetic fields-magnetic forces-currents-Biot-Savart Law-divergence and curl of B-Ampere's Law - Electromagnetic induction - comparison of magnetostatics and electrostatics-Magnetic vector potential Magnetization: effect of magnetic field on atomic orbit -Ampere's Law in magnetized materials-ferromagnetism.	14
III	Electromotive Force	Ohm's Law-electromotive force-motional emf - Faraday's Law-induced electric field inductance-energy in magnetic field - Maxwell's equation in free space and linear isotrophic media-continuity equation - Poynting theorem. Electromagnetic waves in vacuum: Waves in one dimension - wave equation – sinusoidal waves-reflection and transmission-Polarization.	14
IV	Electromagnetic Waves	The wave equation for E and B-Monochromatic Plan waves-energy and momentum in electromagnetic waves - electromagnetic waves in matters -TE waves in rectangular wave guides the co-axial transmission line. Potentials: potentials and fields - scalar and vector potentials-Gauge transformation - Coulomb Gauge and Lorentz Gauge - Lorentz force law in potential form.	15
V	Application of Electromagnetic Waves	Dynamics of charged particles in static and uniform electromagnetic fields - Radiation from moving charges and dipoles and retarded potentials. Introduction to plasma-dispersion relations in plasma. Plasma behavior in magnetic field-Plasma as a conducting field-Pinch effect- Instabilities in Plasma-hydromagnetic waves-Alfen waves.	14

Tutorial

Electrostatics: Gauss's Law and its applications, Laplace and passion equations, boundary value problems. Magnetostatics: Amphere‟s theorem. Elecromagnetic induction.Maxwell‟s equations in free space and linear isotropic media; boundary conditions on the fields at interfaces.Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors.Reflection and refraction, polarization, Fresnel‟s law, interference, coherence, and diffraction.Dynamics of charged particles in static and uniform electromagnetic fields.Dispersion relations in plasma.Lorentz invariance of Maxwell‟s equation.Transmission lines and wave guides.Radiation from moving charges and dipoles and retarded potentials.

Book for Study

1. Introduction to Electrodynamics – David J. Griffiths, 4th Edition, Pearson, 2012.
2. Electromagnetic Theory and Electrodynamics –Sathya Prakash, Kedar Nath Ram Nath and Co, 2017.
3. Electromagnetics - B.B Laud, Wiley Eastern Company, 2000.
4. Fundamentals of Electromagnetic -Wazed Miah, Tata Mc Graw Hill, 1980.
5. Basic Electromagnetics with Application - Narayana rao, (EEE) Prentice Hall, 1997.

Books for Reference

1. Fundamentals of Electromagnetic Theory – John R.Reitz, Frederick J Milford and Robert W.Christy, Third edition, Narosa Publishing House, New Delhi, 1998.
2. Classical Electrodynamics – J.D. Jackson, II Edition, Wiley Eastern Limited, 1993.
3. Electromagnetic Fields and Waves – P. Lorrain and D.Corson, 1987.
4. Electromagnetics, B.B Laud, Wiley Eastern Company, 2000.

CONDENED MATTER PHYSICS

COURSECODE: 22PGPHYC14 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand the basic concepts of crystal structure and diffraction
- To learn the lattice dynamics in solid state materials
- To study the various theories of heat capacity models
- To understand the electron propagation in condensed matter
- To study basic theories of magnetic properties
- To grasp the superconducting phenomena and applications

COURSE OUTCOME: After completion of the course, the students able to

CO1	Understand the basics of crystal structure and chemical bonding
CO2	Get the knowledge of dynamic nature of the crystalline materials
CO3	Understand the propagation characteristics of electron in solid state materials
CO4	Understand the knowledge about various kind of magnetism in electron models
CO5	Comprehend basic theories of superconductivity and its applications

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	H	H	M	L	H
CO3	H	H	H	L	H
CO4	H	H	L	L	H
CO5	H	H	M	L	H

<u>**Syllabus**</u>

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Crystal structure	Elementary concepts of crystals- Reciprocal lattice-Laue equations-Miller indices-Brillouin zones-Point groups and Space groups-Bravais lattice-Crystal symmetry-Structure factor-Atomic scattering factor-Crystal diffraction- Bragg's law- Ewald's sphere construction- Atom to crystal structure- Single Crystal X-ray diffraction	14
II	Lattice dynamics and Thermal properties	Theory of vibrations of monoatomic and diatomic lattices- -acoustical, optical, transverse and longitudinal modes-Phonon- Theories of phonon-specific heat and thermal conduction. Dispersion relation-Phonon quantization-Thermal conductivity-Umklapp process-Specific heat capacity of solids-Einstein, Debye model-Drude model of thermal conductivity- Debye model.	15
III	Metals and Theory of electrons	Metals-Heat capacity of electron gas- Fermi- Dirac distribution- Electron gas in three dimensions- Nearly free electron model- review of electron in a periodic potential-Kronig Penny model-Limitation. Electron & hole mobility - Hall effect- Thermo electric power	14
IV	Dielectric and magnetic properties	Classification of polarization- Clausius-Mossotti relation- Ferro electric crystals- Ferro electric domains-Polarization catastrophe- Landau theory of phase transition. Quantum theory of paramagnetism- Curie law- Domain theory- Neel temperature-Ferrimagnetism- Ferrites- Multiferroic Materials-Spintronics	14
V	Superconductivity	Occurrence of superconductivity- destruction of superconductivity by magnetic fields- Meissner effects-Type I and Type II superconductors- electron-phonon interaction- Cooper pairs and BCS theory-London equation- Coherence length-penetration depth-Josephson effect and applications SQUIDS- High temperature superconductivity. Ginzburg Landau theory – Super current tunnelling	15

Tutorial

Miller indices-Structure factor-Bragg's law-Neutron diffraction- Specific heat capacity-Fermi energy-Chemical potential-Cohesive energy-Carrier concentrations- Polarization-Dipole moment- Clausius-Mossotti relation-Curie point- Neel temperature- Coherence length-penetration depth.

Books for Study

1. Introduction to Solid State Physics, Charles Kittel, 7th Edition, Wiley India Pvt. Ltd., New Delhi, 2004.
2. Solid State Physics, Rita John, Tata Mc Graw Hill Publications, 2014.
3. Solid State Physics – Structure and Properties of Materials -M. A. Wahab, Narosa, New Delhi, 1999.
4. Solid State Physics: Introduction to the Theory - J.D. Patterson, B.C. Bailey - Springer Publications, 2007.
5. Elementary Solid State Physics – Principles and Applications, M. Ali Omar - Pearson, 1999.

Books for Reference

1. Solid State Physics - J. Blakemore, 2nd Edition, W. B. Saunders Co, Philadelphia, 1974.
2. Solid State Physics - C. M. Kachhava, Tata Mcgraw Hill, New Delhi, 1990.
3. Solid State Physics -N. W. Aschroft and N. D., Mermin, Rhinehart and Winton, New York. 1976.
4. Introduction to Superconductivity - M. Tinkham, Tata Mcgraw Hill, New Delhi, 1996.
5. Introduction to Nanoscience and Nanotechnology -K. K. Chattopadhyay, A. N. Banerjee, PHI Learning private Ltd., Delhi, 2014.
6. Electrical Engineering Materials - J. Dekker, Prentice Hall of India, 1975.
7. Problems and Solutions in Solid State Physics - S.O. Pillai, New Age international Publishers, New Delhi, 1994.
8. Ferroelectrics - A.K. Bain, P. Chand, Wiley, 2017.
9. Dielectric phenomena in solids with emphasis on physical concepts of electronic processes - Kwan Chi Kao, Elsevier Academic Press, 2004.
10. Intermediate Quantum Theory of Crystalline solids - Alexander O. E. Animalu, Prentice Hall of India, New Delhi, 1978.
11. The Physics of Solids – Essentials and Beyond - Eleftherios N. Economou, Springer, 2010.

NUCLEAR AND ELEMENTARY PARTICLE PHYSICS

COURSE CODE: 22PGPHYC15 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To introduce students the fundamental principles and concepts governing nuclear and particle physics.
- To know about nuclear physics scientific and technological applications as well as their social, economic and environmental implications.
- To understand the concept of elementary particles.

COURSE OUTCOME: After the completion of the course the student will be capable of

CO1	Understand of nuclear forces, interactions and factors affecting the stability of the nucleus.
CO2	Explain the various nuclear models.
CO3	Calculate the kinematics of nuclear reactions.
CO4	Explain the different forms of radioactivity and account for their occurrence.
CO5	The four fundamental interactions in nature and classify the elementary particles and nuclear states in terms of their quantum numbers.

Mapping of the course outcomes with programme outcome

Course Outcome	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	H	H	L	L	H
CO2	H	H	M	L	H
CO3	H	H	H	L	H
CO4	H	H	L	L	H
CO5	H	H	M	L	H

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Nuclear forces	Characteristics of Nucleus Forces – Exchange forces and tensor forces – charge independence-Spin dependence of Nucleus Forces - Meson theory of nuclear forces- Ground state of deuteron- Nucleon-nucleon scattering singlet and triplet parameters – Nucleon-Nucleon scattering: Cross-section, Differential Cross-section, Scattering Cross-sections – magnetic moment- Quadrupole moment – S and D state admixtures - Effective range theory of n-p scattering at low energies.	15
II	Nuclear models	Binding energy & mass defect – Weizacker's formula – mass parabola - Liquid drop model - Bohr -Wheeler theory of fission- Activation energy for fission- Shell model- Spin –Orbit coupling-Spins of nuclei- Magnetic moments – Schmidt lines- Electric quadrupole moments - Collective model of Bohr and Mottelson: Nuclear vibration – Nuclear rotation –Nelson model.	14
III	Nuclear reactions	Nuclear reaction – Q-value – Nuclear reaction cross section – Direct Nuclear Reactions: Knock out reaction, Pick-up reaction, Stripping reaction – Compound nucleus theory – Formation – Disintegration energy levels – Partial wave analysis of Nuclear reaction cross-section - Resonance Scattering and Reaction cross-section (Breit-Wigner dispersion formula) – Scattering matrix - Reciprocity theorem – Absorption cross section at high energy. Nuclear reactors: Gas cooled reactor – Fast Spectrum reactors.	14
IV	Radioactive decays	Alpha decay - Beta decay – Fermi theory of beta decay – Shape of the beta spectrum – decay rate Fermi-Curie plot – Fermi & G.T Selection rules - Comparatives half - lives and forbidden decays- Gama decay - Multipole radation – Angular momentum and parity selection rules – Internal conversion. Detectors: Liquid ionization detectors – Organic scintillators – Gaseous ionization detectors – Detector efficiency and resolution	14
V	Elementary particle physics	Classification of elementary particles - Types of interaction between elementary particles – Hadrons and leptons – Symmetry and conservation laws – Strangeness and associate production - CPT theorem – classification of hadrons – Quark model - Isospin multiples - SU(2) - SU(3) multiplets - Gell-Mann - Okubo mass formula for octet and decuplet hadrons – Phenomenology of weak interaction hadrons and leptons The origin of mass: The Higgs Boson – theoretical background – Experimental searches	15

Tutorial

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi empirical mass formula, liquid drop model. Nature of the nuclear forces, form of nucleon- nucleon potential, charge independence and charge –symmetry of forces. Deuteron problem - Evidence of shell structure, single particle model, its validity and limitations- Rotational spectra -Elementary ideas of alpha, beta and gamma decays and their selection rules - Fission and fusion - Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Fundamental forces-elementary particles and their quantum numbers- Gellmann-Nishijima formula- quark model- CPT invariance – Symmetry arguments-Parity-Relativistic kinematics.

Books for Study

1. Concepts of Nuclear Physics, B. B. Cohen, TMGH, Bombay, 1971.
2. Introductory Nuclear Physics, K. Krane, Wiley, New York, 1987.
3. Nuclear Physics, V. Devanathan, Narosa Publishing house 2012.
4. Introduction to Elementary Particles, D. Griffiths, 2nd Ed., Wiley-Vch, 2008.
5. Nuclear Physics, S.N. Ghoshal, S. Chand and Co., II edition, 1994.
6. Nuclear Physics, D.C. Tayal, Himalaya Publishing House Pvt., Ltd., V edition, 2018.
7. Nuclear Physics, Irving Kaplan, Narosa Publishing House, 2012.
8. Basic Nuclear Physics and Cosmic Rays, B.N. Srivatsava, Pragati Prakashan publications, Meerut, Edition: XVII, 2016.
9. Nuclear Reactor Design - Yoshiaki Oka, Springer, 2013.
10. Elements of Nuclear Physics, M.L. Pandya and P.R.S Yadav, KedarNath Ram Nath publications, Meerut, 2016.
11. Radiation and Detectors: Introduction to the Physics of Radiation and Detection Devices Lucio Cerrito, Springer International Publishing, 2017.
12. Nuclear and Particle Physics: An Introduction – B.R. Martin, Wiley, 2nd Edition, 2008

Books for Reference

1. Atomic Nucleus - R. D. Evans, Mcgraw-Hill NY, 1955.
2. Theoretical Nuclear Physics -J. M. Blatt and V. F. Weisskopf, Berlin, 1979.
3. Introduction to Nuclear Physics Addision-Wesley, H. Enge, Reading MA, 1975
4. Nuclear Physics -R. R. Roy and B. P. Nigam, Wiley Eastern, Madras, 1993.
5. Nuclear Physics - D.C. Tayal, A. Bohr and B. R. Mottelson, Vol. I Benjamin Reading,1969.

PRACTICAL– IV: COMPUTATIONAL PROGRAMMING AND SIMULATION

COURSE CODE: 22PGPHYC16 **HOURS**

L	T	P	C
0	0	8	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To learn the basic computational programming – functions, arrays, loops, conditional statements, procedures.
- To utilize FORTRAN as a computational language to find the solution algebraic, differential and integral equations by numerical methods.
- To identify different types of models and simulations.

COURSE OUTCOME: After completion of the course the students able to

CO1	Understand the functions, arrays, loops, conditional statements, procedures in FORTRAN programming language.
CO2	Construct the algorithms for solution of integral, differential and algebraic equations.
CO3	Write the FORTRAN program to solve the algebraic simultaneous equations by numerical method.
CO4	Compute the FORTRAN program to find the solution of differential equations by numerical equation.
CO5	Simulate the wave functions of simple harmonic oscillator and elastic constants.

Mapping of the course outcomes with programme outcome

Course outcome	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	H	H	M	H	L
CO2	M	H	M	H	L
CO3	H	H	M	H	L
CO4	M	M	M	H	L
CO5	M	M	M	H	L

LIST OF EXPERIMENTS

(Any 15 Experiments)

1. Program to Read a set of numbers, count them and print the largest and smallest numbers in the list and their positions in the list.
2. Program to find ascending and descending order of numbers and characters.
3. Program to find Eigen values and Eigen vectors of a matrix.
4. Program for matrix addition, subtraction and multiplication.
5. Program for transpose of a matrix.
6. Program to solve simultaneous linear algebraic equation - Gauss elimination method.
7. Program to solve simultaneous linear algebraic equation - Gauss-Seidel iteration method.
8. Program to integrate any function or tabulated data using trapezoidal rule.
9. Program to integrate any function or tabulated data using Simpson‟s rule.
10. Program to compute the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method.
11. Least-Square curve fitting - Straight line fit.
12. Roots of algebraic equations – Newton-Raphson method.
13. Numerical differentiation – Euler method.
14. Evaluation of definite integrals – Monte Carlo method.
15. Numerical simulation of wave functions of simple harmonic oscillator.
16. Computer simulation of Kroning-Penney model.
17. Computer simulation of Leneard-Jones potential, binding parameters, elastic constants.
18. Computation of wave functions and their interpretation for various potentials.
19. Simulation of a wave functions for a particle in a critical box.
20. Write a program to solve heat equation – finite difference method.

Books for Study

1. Programming and Computing with FORTRAN 77/90 - P .S. Grover, Allied Publishers, 1992.
2. Programmer's Guide to FORTRAN90, Brainerd and Walter S, Springer publication, 1996.

Books for Reference

1. Elements of Parallel Processing, V. Rajaraman, Printice Hall, India, 1990.
2. Fundamentals of Computers, V. Rajaraman, Printice Hall, India, 2013.

PROJECT WORK

COURSE CODE: 21PGPHYC17 **MAXIMUM MARKS : 200**

CREDIT: 6

In Fourth semester of this programme, students should do one research project under the supervision of one of the faculties of the department. At the end semester, the student should submit the project report and it will be evaluated by the project supervisor (Internal examiner) and the external examiner. The viva-voce examination will also be conducted to assess the knowledge of the student and the results of the titled project. Further details are given in Section 17.

ELECTIVE COURSES

NANOSCIENCE

COURSE CODE: 22PGPHYE01 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To make the students to understand the basics of nanoscience, various physical and chemical properties of nanomaterials and their applications.

COURSE OUTCOME: After the completion of the course the student will be capable of

CO1	Explain the quantum approach to the field of nanoscience.
CO2	Identify and apply state of art fabrication method for preparing nanomaterials of metals, semiconductors and ceramics.
CO3	Describe the particle size induced changes in magnetism
CO4	Describe the effect of particle size reduction on specific heat, melting point etc and chemical properties.
CO5	Apply and transfer interdisciplinary approaches for biomedical field and other fields.

Mapping of the course outcomes with programme outcome

Course outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	H	H	M	L	H
CO3	H	H	H	L	H
CO4	H	H	L	L	H
CO5	H	H	M	L	H

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Introduction to the nanoworld	Introduction - Historical perspective on Nanomaterial - Classification of Nanomaterials – Quantum mechanics of low dimensional systems– Boundstates and density of states:3D,2D, 1D and 0D – Quantum confinement - Quantum wells, wires and dots - size dependent properties- single electron tunneling – Engineered nanopores – measurement (BET analysis).	14
II	Synthesis of nanomaterials	Reduction of size –Synthesis of metal nanoparticles and structures– Routesto arrangements– background on reverse Micellar solution – Synthesis of Semiconductors – Cadmium Telluride Nanocrystals – Cadmium sulfide Nanocrystals–Alloy Semiconductors– Synthesis of Ceramics– Bondings and defects- Chemical, Physical and Mechanical properties of Ceramics. Specialized growth techniques for nanostructures – modified substrate – cleaved-edge surface – induced strain – thermally annealed quantum well	15
III	Nanoparticles and magnetism	Magnetismin particles of reduced size and dimensions– Single domain particles and super paramagnetism – magnetism in clusters of nonmagnetic solids – magnetic behaviour of small particles – diluted magnetic semiconductors(DMS) – Fe – DMS and II-VIM, DMS and their applications – Magnetic properties of small clusters – theoretical predictions and experimental observations	15
IV	Chemical and catalytic aspects of nanocrystals	Nanomaterials in Catalysis–size controlled and shape dependent catalytic activity and effect of strain and alloying–Nanoparticles as new Chemical reagents– Specific Heat and Melting Points of Nanocrystalline Materials: Specific Heat of Nanocrystalline materials – melting points of Nanoparticle materials.	14
V	Application of nanomaterials	Molecular Electronics and nano electronics, band gap engineered quantum devices – nanomechanics– carbon nanotube emitters, photo electrochemical cells – photonic crystal and Plasmon wave guides - Biological applications: nanoboats - Magnetosomes – polymer containers – liposomes	14

Books for Study

1. Nanoscale Materials in Chemistry- Kenneth J. Klabunde, A John Wiley &Sons, Inc., Publication, 2009.
2. Nanoscience and Nanotechnology : Fundamentals to Frontiers - M.S.Ramachandra Rao, Shubra Singh, Wiley, First Edition, 2013.
3. Nanoscopic Materials Size dependent phenomena – E. Roduner, RSC Publishing, 2005.

4. Nanobiotechnology: Concepts, Applications and Prospective – C.M. Niemeyer and C.A. Mirkin, Wiley India PVT. Ltd., 2004.

Books for Reference

1. Introduction to Nanotechnology- Charles P. Poole, Frank J. Owens, Wiley– India, 2009.
2. Nanostructures and Nanomaterials synthesis, properties and applications – Guozhong Gao, Imperial College Press, London, 2004.
3. Metal Oxides -V.Henrich, P.A.Cox, Cambridge University Press, New York, 1994.
4. NATO ASI Series, Science and Technology of Nanostructured Magnetic Materials – Ed. George C. Hadjipanyis and Gary A.Prinz, Plenum Press, New York, 1991.
5. Introduction to Magnetism and Magnetic Materials - D.Jiles, Chapman and Hall, London,1991.
6. Physics and Chemistry of Metal Cluster Compounds- J.de Jongh, Kluwer Academic Publishers, Dordrecht,1994.

MICROPROCESSORS AND MICROCONTROLLER

COURSE CODE: 22PGPHYE02 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To develop background knowledge and core expertise on Microprocessor 8085.
- To write assembly language programs of Microprocessor for various applications.
- To provide basic understanding of design and operation of Microprocessor 8086.
- To know the architecture aspects of Microcontrollers.
- To know the importance of different peripheral device and their interfacing to Microcontrollers.

COURSE OUTCOMES: After completion of the course, the student will be capable to

CO1	Explain the basic concepts of digital fundamentals using microprocessor 8085. Also, familiarize its internal architecture and operation.
CO2	Illustrate how to select an appropriate microprocessor to meet specified programme and provide assembly language programmes that solve real-world control applications.
CO3	Apply knowledge and demonstrates rapid programming of microprocessor 8086 through pipeling and identifies various addressing modes with detailed transfer instructions.
CO4	Distinguish the properties of microprocessor and microcontroller and explains the basic concepts and design of microcontroller 8051.
CO5	Acquire the basic ideas related to the instruction set and addressing modes of the microcontroller 8051 ad applies it to write an assembly language programme for various real-world problems.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	H	H	M	L	H
CO3	H	H	H	L	H
CO4	H	H	L	L	H
CO5	H	H	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Microprocessors 8085 Architecture	Intel 8085 microprocessor: Introduction – Pin configuration- Architecture and its operations - Machine cycles of 8085Register structure- Instruction classification: number of bytes, nature of operations- Instruction format. Vectored and non-vectored interrupts	14
II	8085 Assembly Language Programming	Instruction set: Data transfer operations - Arithmetic operations Logical operations – Branching and machine control operations. Addressing modes. Steps involved in programming-flowchart- Writing assembly language programs: Sum of N numbers, Arithmatic opearation. Exchange the contents of memory location	15
III	Microprocessor 8086	Intel 8086 microprocessor: Introduction – Architecture: Pin configuration- Operating modes: Minimum mode, Maximum mode. Register organization- Bus opearation- Memory segmentation Addressing modes- Instruction set. Arithmetic and Logical Instruction- Interrupts: Hardware interrupts – Software interrupts. Simple programs	14
IV	Microcontroller 8051 Architecture And Programming	Introduction to microcontroller. Difference between microprocessor and microcontroller. 8051 microcontroller: Pin configuration, Architecture and Key features. - Instruction set: Data transfer instructions - Arithmetic instructions – Logical instructions- Branching instructions- Single bit instructions Addressing modes. Simple programs using 8051 instruction set.	15
V	Interfacing of I/O And Memory With 8085 & 8051	Basic concepts of programmable device - interface of ADC and DAC. Interfacing I/O Ports, External memory, counters and Timers - Serial data input/output, Interrupts – Interfacing 8051 with ADC, DAC, LED display, Keyboard, Sensors and Stepper motor.	14

Books for Study

1. Microprocessors and its applications - A. P. Godse and D. A. Godse, Technical Publications, Pune, 2019.
2. The 8051 Microcontroller - Kenneth J.Ayala, Penram International-India, 1997.
3. Introduction to Microprocessors - Aditya P.Mathur, Tata McGraw Hill Company, 2ndEdition, 2018.

Books for Reference

1. Microprocessor Architecture, Programming and Applications with 8085/8080 - Ramesh S. Gaonkar, New Age International 6th edition, 2013.

2. Microprocessors and Interfacing-Programming and Hardware, Douglas V. Hall - Tata McGraw Hill, 1993.
3. Advanced Microprocessors and Interfacing - Badri Ram, Tata McGraw Hill, 2001.
4. The 8051 Microcontroller and Embedded systems - Muhammad Ali Mazidi and Janice Mazidi - Pearson Education, 2000.
5. The 8051 Microcontroller Architecture, Programming and Applications - Kenneth J. Ayala. Penram International publishing Pvt. Ltd., Second edit, 1996.

MODERN OPTICS

COURSE CODE: 22PGPHYE03 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand basics of light and propagation of light
- To understand and study the excitons and the luminescence
- To learn the basics of nonlinear optics and to study their effects
- To study the image of processing techniques of Holography
- To understand and study the various types of optical microscopic instrumentation techniques

COURSE OUTCOMES: On the successful completion of the course, students will be able to

CO1	Explain the basic concepts applied in Optics. Understands the basic phenomenon such as Dispersion, Optical anisotropy, birefringence and polarization
CO2	Understand the optical excitons and their properties
CO3	Grasp the knowledge of nonlinear optical phenomena in higher order
CO4	Describe the various aspects of holography and image processing
CO5	Understands the optical principles of several microscopes and imaging for practical application.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	M	L	L	H
CO3	M	L	L	L	H
CO4	L	L	L	L	L
CO5	L	L	L	L	M

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4,K5,K6)	Hours of Instruction
I	Basic concept of optics and Light Propagation	Optical materials- optical coefficients- Lenses- Electromagnetic wave propagation - phase velocity - group velocity - energy flow - Wave motion - equation - superposition of waves - Optical anisotropy, birefringence.	14
II	Excitons	Basic concept, free excitons in external electric and magnetic fields, Free Excitions at light densities, frenkel excitons. Luminescence: Light emission in solids, Inter band luminescence, photoluminescence: Excitation and relaxation, degeneracy, Electroluminescence: General Principles of electroluminescence.	15
III	Non-Linear Optics	Non-linear optics – principle - nonlinear wave equation - second order nonlinearities - second harmonic generation - phase matching -frequency conversion - electro optic effect - three wave mixing. Third order non-linear optics - third harmonics generation - optical Kerr effect	14
IV	Holography	Basic Principles of Holography - Recording of amplitude and phase - The recording medium - Reconstruction of original wave front- Image formation by wave front reconstruction - Gabor Hologram - Limitations of Gabor Hologram - Off axis Hologram. Multilayer films	15
V	Optical microscopy & imaging techniques	Basics of optical microscopy - bright field and dark field microscopy - polarizing microscopy - fluorescence microscopy - light sheet fluorescence microscopy - nonlinear optical microscopy - two photon fluorescence microscopy. .	14

Books for Study

1. From Sight to Light: The Passage from Ancient to Modern Optics, A.Mark Smith,University of chicago press, 2014.
2. History of modern optics and optoelectronics development in Chinaby Gan, Fuxi; Tian, Shouyun, world scientific /world century, 2014.
3. Modern optics and photonics: atoms and structured media, G G Gurzadian; Gagik Yu Kryuchkyan; Aram VPapoyan; Erevani Petakan Hamalsaran, World Scientific Pub.Co., 2010.
4. A text book of Optics - N.Subramaniyam, Brijlal and M.N.Avadhanulu, S.Chand & Co, NewDelhi, Twenty fifth edition, 2012.

Books for Reference

1. Modern Optical Engineering - W.J. Smith, Third Edition, McGraw-Hill, 2000.
2. Introduction to Fourier optics - J.W. Goodman, Roberts and Company publishers, Third Edition, 2005.
3. Lasers and Non-Linear optics - B.B. Laud, Wiley, Second Edition, 1992.
4. Introduction to Optical Microscopy - J. Mertz, Roberts & Company publishers, First Edition, 2010.
5. Introduction to Optics -F.L. Pedrotti and L.S.Pedrotti, Prentice Hall International, Wilmington, Third Edition, 2006.
6. Optics - Eugene Hecht, Pearson, New York, Fifth Edition, 2013.
7. Fundamental Optics - Francis Jerkins and Harvey White, McGraw Hill Inc., New Delhi, Fourth Edition, 2011.

BIOPHYSICS

COURSE CODE: 22PGPHYE04 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand the applications of various microscopic tools in cell biology.
- To understand the fundamentals of macromolecular structure and the analytical techniques in characterizing biomolecular interactions and its structure.

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Understand the cell organization
CO2	Know the available tools in cell biology
CO3	Understand the macromolecular structure
CO4	Learn the biomolecule separation
CO5	Interpret the optical and diffraction techniques

Mapping of the course outcomes with programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	M	L	L	M
CO2	M	M	L	H	H
CO3	M	L	L	L	H
CO4	L	L	M	L	L
CO5	H	L	H	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Cell organization	Cell as the basic structural unit- Origin & organization of Prokaryotic and Eukaryotic cell- Cell size & shape- Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell)- Internal architecture of cells- cell organelles- compartment & assemblies membrane system- Ribosome- Polysomes- Lysosomes- Peroxisomes- Connection between cell & its environment- Extracellular Matrix.	14
II	Tools in Cell biology	Light microscope- Resolving Power- Phase contrast microscope- Detection of small differences in refractive indices- Interference microscope-, Dark field microscope- Polarization microscope- Fluorescence microscope- Cytophotometry methods- Flowcytometry& cell sorting- Electron microscopy- specimen preparation- Scanning Electron Microscopy (SEM)- Transmission Electron Microscopy (TEM)-Applications.	14
III	Macromolecular structure	Nucleic acid structure: Chemical structure of the nucleic acid - Conformational possibilities of monomers and polymers- Double helix structure of DNA- Polymorphism of DNA- DNA nanostructures and the structure of transfer RNA. Proteins structure: Amino acids and the primary structures of proteins – Secondary – Tertiary - Quaternary structure and virus structure.	14
IV	Separation techniques	Centrifugation**:** Principle of centrifugation –Analytical ultracentrifugation – Differential centrifugation – Density gradient centrifugation. Chromatography**:** Principles of chromatography– Paper chromatography – Thin layer chromatography (TLC) – Gas liquid chromatography (GLC) – High performance liquid chromatography (HPLC). Electrophoresis: Principles – Factors affecting the migration of substances – Supporting media in electrophoresis – Gel electrophoresis – Polyacrylamide gel electrophoresis (PAGE) – Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE).	15
V	Optical and diffraction techniques	Circular Dichroism and optical rotator dispersion-: Plane, circular and elliptical polarization of light- Absorption by oriented molecules- Dichroic ratio of proteins and nucleic acids- Circular dichroism (CD) - optical rotatory dispersion (ORD) - Relation between CD and ORD- Application of ORD in conformation and interactions of biomolecules. Crystallization of proteins- preparation of heavy metal derivatives- Patterson synthesis- isomorphous replacement methods- structure factors of centro-symmetric and non-centrosymmetric crystals- General remarks on Protein-Structure	15

		determination from X-ray diffraction data-Neutron diffraction-, Electron diffraction-, Synchrotron diffraction, Application in Biomolecular structural studies.	

Books for Study and Reference

1. The Cell: A Molecular Approach - Geoffrey M.Cooper, ASM Press, 2013.
2. Biophysics – Vasantha Pattabhi, N. Gautham, Narosa Publishing, 2009.
3. Biophysics - P.S. Mishra, VK Enterprises, 2010.
4. Biophysics - M.A. Subramanian, MJP Publishers, 2005.
5. Bioinstrumentation - L.Veerakumari, MJP Publishers, 2006.
6. Fundamentals of Biochemistry - A.C. Deb, New central book agency, 2011.

X-RAY CRYSTALLOGRAPHY

COURSECODE: 22PGPHYE05 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the production of X-rays, crystals and its symmetry and their properties.
- To understand the X-ray intensity data collection techniques, data reduction and structure solution and refinement using crystallographic method.

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Explain the production of X-rays, diffraction, lattice and symmetry of crystals
CO2	Know the data collection techniques for the single crystals
CO3	Reduce the data to useable form and determine the space group symmetry
CO4	Understand the phase problem and solve the structure
CO5	Refine the structure and analyze the errors

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	M	L	L	H
CO3	M	L	L	L	H
CO4	L	L	L	M	L
CO5	L	L	M	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	X-Rays	X-rays sources – conventional generators-construction and geometry-sealed tube–rotating anode generators–choice of radiation – X-ray optics: filters–monochromators–collimators-safety. Diffraction of X-rays : Lattice–Lattice planes-Miller indices–X-ray diffraction-reciprocal lattice–relation between direct and reciprocal space–Bragg's law in reciprocal lattice–sphere of reflection. Symmetry of crystals: Crystal systems and symmetry – unit cell – space lattices–– point groups– space groups–screw axes–glide planes-equivalent positions–space group. Crystals: Crystallization – growing crystals – choosing a crystal – crystal mounting–alignment	15
II	Data collection techniques for Single crystals	Laue method–Single crystal diffraction cameras: rotation and oscillation method – Ewald construction – Weissenberg and Precession methods. Single crystal diffractometers-Instrument geometry– determination of unit cell–orientation matrix–Intensity data collection–Unique data–equivalent reflections – selection of data–Intensity measurement methods: Film methods–Counter methods-Area detectors–CCD's–Image plates.	14
III	Data reduction, Structure factors and Fourier synthesis	Integration of intensity–Lorenz and Polarization corrections – absorption–deterioration or radiation damage – scaling – Interpretation of Intensity data. Structure factors and Fourier syntheses: Structure factor – Friedel's Law – exponential and vector form – generalized structure factor –Anomalous scattering and its effect– Calculation of structure factors and Fourier syntheses.	15
IV	Phase Problem	Phase Problem: Methods of solving Phase Problem: Direct methods – Patterson methods – Heavy atom methods – molecular replacement.	14
V	Refinement of Crystal structures and Errors	Weighting – Refinement by Fourier syntheses – Locating hydrogen atoms- identification of atom types – Least squares – goodness of fit– Least square and matrices. Relationship between Fourier and Least squares. Errors and Derived results: Random and systematic errors–derived results – molecular geometry – absolute configuration– thermal motion.	14

Books for Study

1. X-ray Structure Determination – G.H. Stout and L.H. Jensen, John Wiley Publications, Second Edition, 1989.
2. Structure Determination by X-ray Crystallography - Ladd and Palmer, Plenum Publishing Corporation, Second Edition, 2013.

Books for Reference

1. Fundamentals of Crystallography - C. Giacovazzo, Oxford Press, Second Edition, 2011.
2. X-ray Crystallography - Woolfson, Cambridge University Press Publications. Second Edition, 1997.
3. Elements of X-ray Crystallography - Leonid V. Azaroff, , McGraw Hill Publications, 1968.
4. Crystal Structure analysis for Chemist and Biologist – J.P. Glusker, M. Lewisand M. Rossi, VCH Publishers Inc, 1994.
5. Crystal, X-ray and Proteins – D. Sherwood, and J. Cooper, Oxford University Press, 2010.
6. An Introduction to Crystallography – F.C. Phillips, John Wiley Publications, 1971.

QUANTUM CHEMISTRY

COURSECODE: 22PGPHYE06 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- The main objective of this paper is to impart basic knowledge about quantum chemistry to the student.

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Know the different *ab-initio* methods
CO2	Interpret the operator concepts
CO3	Understand the simple spectroscopic applications
CO4	Use the LCAO Techniques in orbital study
CO5	Understand the molecular symmetry

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	L	H	M	H	L
CO2	M	L	L	L	H
CO3	H	L	H	L	M
CO4	L	H	L	H	L
CO5	H	H	M	M	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	*Ab-initio* methods	Accuracy and scaling-Classes of methods- Hartree–Fock(HF)- Post HF methods- Multi- configurational self- consistent field(MCSCF). Density functional theory- Variational formulation- LDA	14
II	Operator Concepts	Operators-second, third, fourth postulates of QM, derivative of an operator with respect to time –Eigen functions and position operator- Dirac Delta function-projection operator- density operator and density matrix.	15
III	Simple spectroscopic applications	Quantum mechanical picture of chemical bonding–Symmetry aspects of molecular orbital–Valence bond–M- O bond theories–Comparison – Heitler–London theory for H_2 molecules	15
IV	LCAO Techniques	Hybridization–Molecular orbital of CH_4, C_2H_4, C_2H_2, Benzene, Water- Hydrogen bonding.	14
V	Symmetry	Types of symmetry operations, point groups-properties- determination and representation-character table-symmetry properties and quantum mechanics.	14

Books for Study

1. IntroductoryQuantumChemistry4th Edition.A.K.Chandra,TataMcGrawHill,9th reprint, 2003.
2. Quantum Chemistry-3rd Edn. –R.K.Prasad, New Age International Publishers, New Delhi, 2007.
3. AtomicStructureandthechemicalbond-4th Edition–Manas Chanda, TMH, New Delhi, 2000.

Books for Reference

1. ElementaryofQuantumChemistry–F.Piler,Mc-GrawHill,1968.
2. Nature of Chemical Bond -L.Pauling,–3rd edition., Oxford, 1975.
3. Quantum Chemistry – Eyring, Walter & Kimbel, John Wiley & Sons, 2005.

MOLECULAR PHYSICS

COURSECODE: 22PGPHYE07 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To provide the fundamental knowledge on the structure and dynamics of the molecules through various theories
- Studying the relation between molecular interactions and properties
- Providing phenomenological theories on reaction dynamics and transport properties

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Know the molecular structure and bonding
CO2	Interpret the molecular symmetry
CO3	Explain the molecular interactions and molecular mechanism
CO4	Perform the molecular reaction dynamics simulations
CO5	Understand the electron transfer, electronic structure and spectra

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	H	M	H	M
CO2	H	M	L	L	H
CO3	M	L	H	L	M
CO4	L	M	L	M	L
CO5	H	H	M	M	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Molecular structure and bonding	Chemical bonding - The VSEPR model - Valence bond theory – The hydrogen molecule - Homonuclear diatomic molecules - Polyatomic molecules - Molecular orbital theory –Homonuclear diatomic molecules – Heteronuclear diatomic molecules – Bond properties - Polyatomic molecules - Molecular shape in terms of molecular orbitals - Molecular structure, properties and conformations	15
II	Molecular symmetry	Symmetry elements and operations – The symmetry classification of molecules – Some immediate consequences of symmetry – Applications to molecular orbital theory – Character tables and symmetry labels – Vanishing integrals and orbital overlap - Vanishing integrals and selection rule.	15
III	Molecular interactions and mechanics	Electric properties of molecules - Electric dipole moments - Polarizabilities - Relative permittivity's - Interactions between dipoles - Repulsive and total interactions - Molecular interactions in gases - Potential energy (force field) in molecular mechanics – Various energy terms in force field – Newtonian and Hamiltonian dynamics – Phase space trajectories	14
IV	Molecular reaction dynamics	Collision theory – Diffusion controlled reactions – Reactive collisions – Potential energy surfaces – Transition state theory – The Eyring equation – Thermodynamic aspects - Microscopic–macroscopic connection - Zero-point Vibrational energy - Molecular electronic, rotational, Vibrational and translational partition functions.	14
V	Electron transfer, electronic structure and spectra	The rates of electron transfer processes – Theory of electron transfer processes – Crystal-field theory - Ligand-field theory - Electronic spectra of atoms - Electronic spectra of complexes - Charge-transfer bands - Selection rules and intensities - Luminescence	14

Books for Study and Reference

1. Physical Chemistry - P.Atkins and J. Depaula Oxford University Press, 2009.
2. Inorganic chemistry - P. Atkins, T. Overton, J. Rourke and M. Weller, Oxford University Press, 2009.
3. Essential of Computational Chemistry - Theories and Models - Christopher J. Cramer, John Wiley & Sons, 2nd Edition, 2004.

PHYSICS OF EARTH

COURSE CODE: 22PGPHYE08 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand the physical structure and behavior of the earth as well as geomagnetic properties of rocks in the Earth's crust.
- To study the basics of Solar system and the earth.
- To obtain the fundamental knowledge about gravitation and its anomalies.
- To have idea about thermal history of earth.
- To provide the knowledge on the types of elastic properties.
- To learn the Geomagnetism and Paleomagnetism.

COURSE OUTCOME: After completion of the course, the student will be capable of

CO1	Understand the origin of earth
CO2	Understand the gravitational anomalies.
CO3	Understand the thermal history of earth.
CO4	Acquire knowledge about earth's elasticity
CO5	Get knowledge of geomagnetism and paleomagnetism

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	L	M	M	L	L
CO2	M	M	M	L	M
CO3	L	M	L	L	M
CO4	M	M	L	L	M
CO5	M	M	L	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Solar System	The earth and the solar system – Important physical parameters and properties of the planet earth; Stress and Strain, Wave and motion, Seismic waves. Travel time Tables and Velocity – Depth curves – Variation of Density within the Earth.	14
II	Gravitation	Rotation of the Earth - Gravitational attraction, Gravitational Theory, Measurements of Gravity, Gravity meters - Principles and method of measuring gravity - Gravity anomalies-Local and regional variations.	14
III	Thermal history of earth	Thermal history of the Earth. Temperature in the Primitive Earth and the Earth's surface and interior. Thermal conductivity. Generation of heat in the Earth. Heat flow measurements, methods and results	14
IV	Elastic properties	Elastic constants and Elastic process in the earth. Earth's free rotation. Latitude variation. Tides of the Solid earth. Numerical values of Love's numbers. Rigidity of the Earth. Bulk modules in the earth. Poisson's ratio in the Earth, Young's modulus and Lame's constant.	15
V	Geomagnetism and paleomagnetism	Geomagnetism and paleomagnetism-Earth's magnetic field. Origin-Theory of earth's magnetic field. Magneto hydrodynamics of the Earth. Magnetic reversals. Polar wandering. Tectonic movements and its relation to paleomagnetism - Measurement of magnetic properties of rocks.	15

Books for Study and Reference

1. Physics of the Earth and Planets - A.H.Cook, Macmillan, 1973.
2. Physics of the Earth's Interior - Gutenberg, International Geophysics series, Vol.1 Academic press, 1959.
3. Physics and Geology - J.A.Jacobs, R.D.Russel and J.T.Wilson, 1974.
4. The Dynamic Earth - P.J.Wyllie, International student edition, John Wiley and sons, 1971.
5. Applied Goephysics - A.S.Eve and Keys,D.A, Cambridge University, 1954.
6. The Solid Earth: An Introduction to Global Geophysics - C.M.R. Fowler, Cambridge University press, 1990.
7. Geomagnetic reversals and Plate tectonics - Alan Cox, Freeman and company, 1973.

PHOTOVOLTAIC SCIENCE

COURSECODE: 22PGPHYE09 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the basics of solar cell structure and to get knowledge about silicon and cadmium Telluride solar cell.
- To study the structure and preparation methods of dye sensitized solar cells.
- To analyses the deposition techniques of DSSC fabrication.
- To learn the energy band structure belongs to conduction and valence band density of states.
- To study the fabrication of dye sensitized solar cells.

COURSE OUTCOME: After completion of the course, the student will be capable of

CO1	Understand the type of solar cells and its fundamentals.
CO2	Understand the amorphous silicon solar cell.
CO3	Understand the theoretical aspects of CdTe solar cells.
CO4	Acquire the knowledge of dye sensitized solar cell and its characteristics and applications.
CO5	Know the different deposition techniques for fabrications of dye sensitized solar cell.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	M	H	L	M
CO2	H	L	M	L	M
CO3	H	L	H	L	M
CO4	H	L	M	L	M
CO5	H	H	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Solar cell basics	Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell. Solar Cell Fundamentals: solar cell boundary condition - generation rate - solution of the minority carrier diffusion-terminal characteristics – solar cell I-V characteristics –properties of efficient solar cell – life time and surface recombination effects.	15
II	The physics of solar cells	Introduction - Fundamental Properties of Semiconductors: crystal structure - energy band structure - conduction and valence band density of states - equilibrium carrier concentrations -light absorption - recombination carrier transport semiconductor equations - minority carrier diffusion equation - PN-Junction Diode Electrostatics.	15
III	Solar cell fabrications	Solar cell fabrication: Wafer based solar cell fabrication: Czochralski Process- Multicrystalline Si ingot fabrication- PN Junction formation; Metal contacts; Thin film PV device fabrication- Thin film deposition techniques: LPCVD, APCVD, PECVD- Tandem Solar cell fabrication- Photovoltaic module fabrication and optimization	14
IV	Cadmium telluride solar cells	Introduction – CdTe Properties and Thin-film Fabrication Methods - Condensation/Reaction of Cd and Te_2Vapors on a Surface- Galvanic Reduction of Cd and Te Ions at a Surface- Precursor Reaction at a Surface-Window Layers –CdTeAbsorber Layer and $CdCl_2$Treatment - CdS/CdTe Intermixing	14
V	Dye sensitized solar cells	Introduction to Dye-Sensitized Solar Cells - Structure and Materials - Mechanism and charge transfer kinetics – Characteristics - DSSC Fabrication - preparation of TiO_2 Colloid - Preparation of TiO_2electrode - Redox Electrolyte - Counter electrode - Assembling the cell and cell performance.	14

Books for Study and Reference

1. Hand book of Photovoltaic Science and Engineering -Antonio Luque, Steven Hegedus, Second Edition,2011.
2. Renewable Energy Resources - John Twidell, Tony Weir, Taylor and Francis Group, 2006.
3. Organic Photovoltaics- C.J.Brabec, J.Parisi, V.Dyakonov, N.S.Sariciftci, 2003.
4. Solar Energy - A.P.Agarwal, S.Chand & Co,1983.

INTRODUCTORY ASTRONOMY, ASTROPHYSICS AND COSMOLOGY

COURSECODE: 22PGPHYE10 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS:100

COURSE OBJECTIVES

- To develop analytical skills and the ability to understand the astronomical situation.
- To achieve a good understanding of physical laws and principles.
- To gain experience with measurement techniques and equipment, and develop the ability to assess uncertainties and assumptions.

COURSE OUTCOME: After completion of the course, the students will be able to

CO1	Apply the Kepler's laws and Newtonian concept of gravity to study the importance in astronomy.
CO2	Apply the trigonometric Parallax-Inverse Square Law to study the function of the stars and Galaxies.
CO3	Describe the stellar evolution to study the lives and deaths of stars.
CO4	Describe the Doppler Effect-Hubble's Law to study the cosmological principle
CO5	Find the cosmological constants in the universes

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	L	L	H
CO3	H	H	L	L	L
CO4	H	M	L	L	L
CO5	M	H	L	L	M

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	History of astronomy	Introductory History of Astronomy-Ptolemy's Geocentric Universe- Copemicus" Heliocentric Universe- Tycho Brahe and Galileo's Observations-Kepler's Laws of Planetary Motion-Newtonian Concept Of Gravity-Highlights of Einstein's Special and General Theory Of Relativity-Curved Space Time-Evidence of Curved Space Time-Bending Of Light-Time Dilation.	14
II	Stars & galaxies	Stars and Galaxies-Distances-Trigonometric Parallax-Inverse Square Law- Magnitude of Stars-Apparent Magnitude-Absolute Magnitude and Luminosity- Color and Temperature-Composition of Stars-Velocity. Mass and Sizes of Stars-Types of Stars Temperature Dependence-Spectral Types- Hertzsprung- Russell (HR) Diagram Spectroscopic Parallax.	14
III	Lives and death of stars	Stellar Evolution-Mass Dependence-Giant Molecular Cloud-Protostar-Main Sequence Star-Subgiant, Red Giant, Supergiant-Core Fusion-Red Giant (Or) Supergiant-Planetary Nebula(Or) Supermova-White Dwarfs-Novae And Supernovae- Neutron Stars-Pulsars Black Holes-Detecting Black Holes-The Sun- Its Size and Composition-Sun's Interior Zones-Sun"s Surface-Photosphere-Chromosphere-Corona-Sun's Power Source Fusion Reaction Mechanism.	15
IV	Cosmology-I	Introduction to Cosmology-Basic Observations and implications-Olbers Paradox - Expanding Universe-Gravitational Redshift-Doppler Effect-Hubble's Law and the Age of the Universe Cosmological Principle-The Perfect Cosmological Principle- Observation and interpretation of Cosmic Microwave background Radiation (CMBR)- Evidence Supporting the General Big Bang Theory-Salient features of Steady State Theory.	15
V	Cosmology-II	Fate of the Universe-Dependence on Mass (Curvature of Space)-Critical density-Open Universe-Closed Universe-Homogenous and Isotropic Freidman-Robertson-Walker Universes-Deriving the Geometry of the Universe from the Background Radiation Flatness Problem-Horizon Problem-Inflation and its effect on the universe-The Cosmological Constant.	14

Books for Study and Reference

1. Lectures on Astronomy, Astrophysics and Cosmology -Luis A. Anchordoqu, Cornell University, 2016.
2. Lecture Notes of Astronomy, -Milwaukee, Department of Physics, University of Wisconsin, 2009.
3. Astrophysics of the Solar System -K.D. Abhayankar, Universities Press, 1999.
4. An Introduction to Planetary Physics - Kaula. W.M.John Wiley & Sons Inc,1969.
5. Astrophysics of the Sun - Harold Zirin., Cambridge University Press, 1988.

PETROPHYSICS

COURSECODE: 22PGPHYE11 **HOURS**

MAXIMUM MARKS:100

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To impart knowledge on various properties and their mechanisms of remanance.
- To learn the classification of rock forming minerals and geophysical methods.
- To study the importance of seismic waves and radioactive dating.

COURSE OUTCOME: After completion of the course the students able to

CO1	Find the anisotropic minerals and neels theory to study remanance properties.
CO2	Apply the curic point determination to study the geomagnetic elements of the earth.
CO3	Find the importance of the rock forming minerals.
CO4	Describe the variation of 'g' and elastic constants for seismology.
CO5	Find the Geochronology and their relation to study the radioactive properties.

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO 5
CO1	H	H	L	L	H
CO2	M	H	L	L	H
CO3	H	H	L	L	L
CO4	H	M	L	L	L
CO5	M	H	L	L	M

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Petrology & Remanance properties	Petrology-Anisotropic minerals- Magneto crystalline anisotropy-Dipolar anisotropy-Single ion anisotropy-Anisotropic exchange-Constants Magnetic properties of mineral systems- Solid-Solid - Solution of oxides of iron-magnetite, haematite magnemites, titano magnetites, titono magnemites, hematite- illmenite solid solution and pyrhotites - Intrinsic properties, magnetization process, weak field remanance. Remanance properties- NRM, TRM, CRM, DRM, VRM, PRM-their mechanisms-Thermal demagnetization technique - partial TRM - additive law - Neel's theory of TRM. Primary and Secondary magnetization-Testing for stability of remanance.	15
II	Geomagnetic elements	Geomagnetic elements of the earth - Field variation and detection - The Magnetic observatory-mapping of secular variations. Diurnal variation of magnetic disturbances - initial susceptibility of rocks- single and multidomain cases - Curic point determination and its importance. Laboratory and field instruments for magnetic measurements-Astatic magnetometer-spinner magnetometer-Fluxgate magnetometer. Proton procession magnetometer - Theory, practice and applications.	15
III	Classification of rock forming minerals	Classification of rock forming minerals- physical properties of minerals with special reference to optical properties-elementary details of a polarizing microscope and petrographic analysis. Geophysical prospecting - different methods - Geophysical properties of rocks and minerals-Resistivity methods - Two current electrode method- different electrode layouts - measuring equipment - application to ground water survey.	14
IV	Seismology	Primary wave (P-waves) and elasticity wave (S-wave) – density within the earth – pressure distribution – variation of 'g' and elastic constants - earth quakes – Elementary ideas about Ritter's scale.	14
V	Geochronol ogy	Geochronology-the geological time scale-archaeo-magnetic dating - Radio active methods of dating Rubidium, Strontium method - Potassium Argon method – Thermo-luminescence dating and interpretation of data.	14

Books for Study and Reference

1. Introduction to Geophysics-Howell, McGraw Hill Book Co.2012.
2. Introduction to Geophysics-G.D. Garland, 2d Edn. Saunder's Book Co, 1971.
3. Paleomagnetism: Principles and Applications –D. H. Tarling, Chapmann and Hall, 1983.
4. Paleomagnetism and plate tectonics-Mc Elhinny, Cambridge University Press, 1973.
5. Introduction to Geophysical prospecting-Dobrin, McGraw Hill Book Co, 1960.
6. Solid State Physics-RL Singhal, Kedarnath Ramnath & Co., Meerut, 1993.
7. Solid State Physics-A.J. Dekker, Prentice Hill, 1957.
8. Fundamentals of Solid State Physics – B. S. Sexana and R. C. Gupta and P. N. Sexana, Pragati Prakashan, Meerut, 1993.
9. Applied Geophysics in the Search of Minerals – A. S. Eve and D. A. Keys, 4^{th} Edn. Cambridge University Press, 1954.
10. Rock and Mineral magnetism - W.O. Reilly, Blackmoore, 1984.

MATERIALS PHYSICS AND PROCESSING TECHNIQUES

COURSE CODE: 22PGPHYE12 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To impart knowledge on various materials growth, synthesis and processing Techniques.
- To learn the structural, morphology, and surface characterization techniques.

COURSE OUTCOME: After the completion of the course the student will be capable of

CO1	Get an overview of various methods of crystal growth
CO2	Describe various plasma methods of material synthesis
CO3	Understand the various vacuum techniques
CO4	Explain various nanomaterial growth techniques
CO5	Understand the working principle and instrumentation of various characterization techniques

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	H	H	M	L	H
CO3	H	H	H	L	H
CO4	H	H	L	L	H
CO5	H	H	M	L	H

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of instruction
I	Crystal growth	Significance of crystal growth-Naturally occurring crystal growth processes-Crystal growth processes in laboratory and industrial scale-Classification of crystal growth methods-Growth from solutions - Nucleation: Homogeneous and heterogeneous, Solubility phase diagram-Saturation-Super saturation- Metastable zone width-Slow evaporation and slow cooling methods, Growth from gel-Growth from flux-Growth from melt- Bridgeman-Stockbarger method-Czochralski pulling method- Growth from vapour-Sublimation method.	15
II	Plasma processing	Basics of plasma: Introduction, Types of plasma; Properties of plasma; V-I characteristics; Advantages of plasma processing. Thermal plasma: Principles of plasma generation - DC plasma torches; AC plasma torches; RF plasma torches, Plasma spraying; Structure of sprayed deposits, Plasma spheroidization; Plasma decomposition; Treatment of hazardous wastes – Synthesis of ultrafine/nanopowders. Plasma melting and remelting. Non-thermal plasma: Glow discharge plasma, Plasma reactors for surface treatment: Corona& DBD atmospheric pressure surface treatment reactors.	15
III	Vacuum techniques	Units and range of vacuum – Formulas for important quantities – Qualitative description of pumping process – Surface processes and out gassing – Gas flow mechanism – Classification of pumps :Positive displacement pumps – Kinetic pumps – Entrapment pumps - Classification of pressuregauges : Total pressure gauges –Hydrostatic pressure gauges - Thermal conductivity gauges –Ionization gagues – Vacuum system : simple rotary, diffusion, turbo molecular, ultra-high vacuum and cryo-pumped systems.	14
IV	Growth technique of thin films and nonmaterial	Plasma arc discharge – sputtering-chemical vapour deposition-pulsed laser deposition-molecular beam epitaxy-Electrochemical deposition-SILAR method Solid-State Reaction - Sol-Gel Technique - Hydrothermal growth - Ball Milling – Combustion synthesis – Sono chemical method - Microwave synthesis – Co precipitation.	14
V	Characterization tools	Working principles and instrumentation – XRD – XPS – AES- SIMS - RBS– LEED - AFM – SEM - STM	14

Books for Study and Reference

1. Handbook of Thin Film Technology- Maissel and Glange, McGraw Hill, First Edition, 1970.
2. Vacuum Technology- A. Roth, North Holland Third Edition, 1990.

3. Fundamentals of Vacuum Techniques- Pipko A, Pliskosky V, MIR Publishers First Edition, 1984.
4. Thin Films Phenomena- K. L. Chopra, McGraw Hill, First Edition, 1969.
5. Ultra High Vacuum Technology- Allied Publishers, D. K. Avasthi, A. Tripathi, A. C. Gupta, Allied, 2002.
6. Thin Film Solar Cells- Kasturi Lal Chopra, Suhit Ranjan Das, Plenum Press, New York, 1983.
7. Basic Vacuum Technology- A.Chambers, R.K.Fitch and B.S.Halliday, IOP Publishing Ltd, 2nd Edition, 1983.
8. Vacuum Technology- A.Roth, Elsevier Science. 3rd Edition, 1990.
9. Non-equilibrium processing of materials (Chapter – 6)- C. Suryanarayana, Pergamon, 1999.
10. Thermal plasma processing- P.V. Anantha padmanabhan and N. Venkataramani, Pergamon materials series, 1999.
11. Industrial plasma engineering - Applications to Nonthermal plasma processing (Vol. 2)- J. Reece Roth, Institute of Physics Publishing, Bristol, 2001.
12. Thermal plasmas– Fundamentals and Applications (Vol. 1)- Maher I. Boulos, Pierre Fauchais and Emil Pfender, Springer Science, NY, 1994.
13. Low temperature plasma physics- Rainer Hippler, Sigismund P fau, Martin Schmidt, Karl H. Schoenbach, Wiley-Vch, Berlin, 2001.

MEDICAL PHYSICS

COURSE CODE: 22PGPHYE13 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand the general concepts in radiation and its interaction and dose Measurement.
- To apply the physics concepts in clinical trials.
- To educate scientifically the principles of radiation and its effect in the medical field.
- To emphasize the significance of various medical techniques and therapy.

COURSE OUTCOME: After the completion of the course the student will be capable of

CO1	Get an overview radiation dosimetry
CO2	Understand the interaction of gamma rays and X-rays with matter
CO3	Plan treatment plan for radiation therapy
CO4	Explain image guided radiation therapy
CO5	Understand the functional details of MRI

Mapping of the course outcomes with programme outcome:

Course outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	H	H	M	L	H
CO3	H	H	H	L	H
CO4	H	H	L	L	H
CO5	H	H	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Basic Concepts In Radiation Dosimetry	Definitions of Dosimetric Quantities –unit sand relationship between DQ –linear energy transfer-tissue weighting factor-charged particle equilibrium-biological effects of radiation.	14
II	Interaction of gamma rays and X-Rays with matter	Introduction-types of interaction with matter –over all interaction of photons with matter.	14
III	Treatment planning in radiation therapy	Photon beam treatment planning-electron beam treatment planning. Modern Radiation Therapy Planning and Delivery	14
IV	Image - Guided Radiation Therapy	Introduction – Rationale of IGRT-current available IG techniques –traditional IGRT technologies– real time tracking systems– image registration and correction strategies– image guided Adaptive treatment (IG-ART) - management of respiratory motion.	15
V	Magnetic resonance imaging(MRI)	MRI – contrast sin MRI– Physiological and functional MRI– MRI safety– future MRI applications. CT and MRI Radiotherapy: CT based treatment simulation and planning – MRI in Radiotherapy – nanoparticle based contrast agent.	15

Books for Study:

1. Introduction to Medical Physics– Muhammad Maqbool–Springer International publishing 2017.

ELEMENTS OF NANOSCIENCE AND NANOTECHNOLOGY

COURSE CODE: 22PGPHYE14 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To develop the basic knowledge about nanoscience and technology
- To acquire the knowledge about classification, synthesis methods and characterization techniques and its applications

COURSE OUTCOME: After the completion of the course the student will be capable to

CO1	Get an overview of nanoscience and nanotechnology
CO2	Classify nanomaterials
CO3	Identify and apply state of art fabrication methods for preparing different nanomaterials
CO4	Apply different characterization techniques to analyze nanomaterials
CO5	Describe the applications of nanomaterials

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	H	H	M	L	H
CO3	H	H	H	L	H
CO4	H	H	L	L	H
CO5	H	H	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Overview of nanoscience	Nano revolution of the 20th century, Properties at Nanoscale (optical, electronic and magnetic). Theory, definitions and scaling.	14
II	Different classes of nanomaterials	Metal and Semiconductor Nanomaterials, Quantum dots, Wells and Wires, Molecule to Bulk Transitions Bucky Balls and Carbon Nanotubes, engineered multifunctional nanoparticles.	14
III	Synthesis of nanomaterials	Top-down (Nanolithography, CVD), bottom-up(sol-gel processing, chemical synthesis).Wet Deposition Techniques, Self-assembly (Supramolecular approach),Molecular Design and theoretical Modeling. Specialized growth techniques for nanostructures – modified substrate – cleaved-edge surface – induced strain – thermally annealed quantum well	15
IV	Characterization	TEM, SEM and SPM Technique, Fluorescence Microscopy and Imaging, BET analysis.	14
V	Applications	Solar Energy Conversion and Catalysis, Molecular Electronics and Printed Electronics Nanoelectronics, Polymers with a special architecture, Liquid Crystalline Systems, Linear and Nonlinear Optical and Electro Optical properties, Applications in Displays and other devices, Advanced Organic Materials for Data Storage, Photonics, Plasmonics, Chemical and Biosensors, Nanomedicine and NanoBiotechnology.	15

Books for Study

1. Nanostructured Materials and Nanotechnology -Hari Singh Nalwa, Academic press, 2002.

CRYSTAL GROWTH AND THIN FILM PHYSICS

COURSE CODE: 22PGPHYE15 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand the basics and theories of crystal growth
- To learn various methods involved in crystal growth.
- To study the basics of thin film technology and their instrumentation
- To get the knowledge in the basic material characterization techniques

COURSE OUTCOME: After completion of the course the students will be able to

CO1	Develop a comprehensive understanding the basics on nucleation theories and crystal growth principles.
CO2	Get the knowledge of various types of crystal growth and solution growth techniques
CO3	Learn the methods of gel growth and melt growth techniques.
CO4	Learn how to make thin film materials based on physical and chemical methods
CO5	Understand the materials identification by X-ray, FT-IR instrumentation and learn property analysis by UV-Vis spectrum, hardness methods and photoluminescence

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	H	L	H
CO2	M	M	H	L	M
CO3	H	M	M	M	M
CO4	M	M	H	L	M
CO5	M	H	H	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4,K5,K6)	Hours of Instruction
I	Basic Concepts, Nucleation and Kinetics of Growth	Introduction to crystal growth - Super saturation– Nucleation– Types of nucleation – Formation of critical nucleus Classical theory of nucleation: Gibbs Thomson equations for vapour and solution – Kinetic theory of nucleation. Classification of crystal growth methods	14
II	Crystallization Principles and Growth Techniques	Solvents and solutions – Solubility diagram – Super solubility – Expression for super saturation – Metastable zone and induction period – Miers TC diagram – Solution growth – Low and high temperatures solution growth – Slow cooling and solvent evaporation methods- Criteria for optimizing solution growth parameter	15
III	Gel, Melt and Vapor Growth Techniques	Principle of gel technique – Structure and importance of gel – Advantages of gel growth - Melt technique – Czochralski growth – Bridgeman method – Hydrothermal growth – Vapor-phase growth – Physical vapor deposition – Chemical vapor deposition.	14
IV	Thin Film Deposition Techniques	Vacuum evaporation - Evaporation from a source and film thickness uniformity - Mechanisms and yield of sputtering processes – DC and rf sputtering – Thin film structure- Structural defects and their incorporation- Thin film devices- Fabrication and applications. Spray pyrolysis – Electro deposition – Sol-gel technique.	14
V	Characterization Techniques	X–ray diffraction – Powder and single crystal – Fourier transform infrared analysis – Transmission– UV-Vis-NIR spectrometer – Vickers micro hardness – X-ray photoelectron spectroscopy for chemical analysis. Basic principles and operations of SEM and TEM- Nonlinear Optical phenomenon (qualitative) - Kurtz powder SHG method.	15

Books for Study

1. Crystal Growth for Beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy-I.V. Markov, 2nd edition, 2004.
2. Crystal Growth Process and Methods -P. Santhanaragavan and P. Ramasamy, KRU Publications, Kumbakonam, 2001.
3. Thin Film Fundamentals –Goswami, New Age, New Delhi, 2008.
4. Instrumental Methods of Analysis - H.H. Willard, L.L. Meritt, J.A. Dean, F.A. Sette,CBS Publishers, New Delhi, 1986.
5. Materials Characterization Techniques -S. Zhang, L. Li and A. Kumar, CRC Press, Bota Racon, 2009.

Books for Reference

1. Crystal Growth Process - J.C. Brice, John Wiley, New York, 1986.
2. Materials Science of Thin Films2nd edition -M. Ohring, Academic Press, Boston, 2002.
3. Characterization of Materials, (VolumeI) -E. N. Kaufmann, John Wiley, New Jersey, 2012.

ADVANCED SPECTROSCOPY

COURSE CODE: 22PGPHYE16 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the UV Spectroscopy and energy level of molecular orbitals.
- To comprise the basics of many important technologies and research tools.
- To know the basic principles and applications of non-linear spectroscopic tools.

COURSE OUTCOME: After completion of the course the students will be able to

CO1	Develop a comprehensive understanding on the optical spectral concepts and energy level of molecular orbitals.
CO2	Demonstrate the concept of atomic level absorption and emission spectroscopic methods and their instrumentation
CO3	Understand the surface enhanced Raman spectroscopy and their applications
CO4	Learn how to obtain the knowledge on surface level electronic interactions and their spectroscopic methods
CO5	Understand the basics of nonlinear phenomena in Raman scattering and its instrumentation

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	H	L	H
CO2	M	H	H	L	M
CO3	H	M	H	L	H
CO4	H	M	H	L	H
CO5	M	H	H	L	M

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	UV Spectroscopy	Energy levels, Molecular orbitals – Theory of UV spectra – Franck Condon Principle – transition Probability, measurement of spectrum – Types of transition in Organic molecules – Types of absorption bands – transition in metal complexes – Selection rules – Electronic spectra in poly atomic molecules – Chromophore concept – Application of UV Spectroscopy.	15
II	Atomic Absorption and Emission Spectroscopy	Atomic Absorption Spectroscopy (AAS): Principle of AAS– single beam Spectrophotometer –Applications of AAS - Atomic emission Spectroscopy – Principle of AES, Advantages - Instrumentation– Applications of AES –Difference between AAS and AES.	15
III	Surface Enhanced Raman Scattering (SERS) and FT Raman Spectroscopy	Surfaces for SERS study – Enhancement mechanism – Instrumentation and sampling techniques - Surface selection rules – SERS microprobe – SERS study of bio molecules – SERS in medicine –Use of Laser FT Raman Spectroscopy: Principle, Instrument, sample handling methods and applications.	14
IV	Surface Spectroscopy	Electron energy loss spectroscopy (EELS) – Reflectance Absorbance – IR spectroscopy (RAIRS) – Inelastic helium scattering – Photo electron spectroscopy (PES) – X-ray photo electron spectroscopy (XPES).	14
V	Non-Linear Spectroscopic Phenomena	Nonlinear Raman phenomena – Hyper Raman effect – Experimental Technique – Stimulated Raman scattering – Inverse Raman effect – Photo acoustic Raman scattering – Multiphoton spectroscopy.	14

Books for Study

1. Fundamentals of Molecular Spectroscopy- 4th Edition -N. Banwell and E. M. McCash Tata Mc Graw-Hill, New Delhi,1994.
2. Molecular structure and spectroscopy -G. Aruldhas, Prentice Hall of India Pvt. Ltd., New Delhi, 2001.
3. Spectroscopy, 5th Edition -H.Kaur, A. Pragati Prakashan, 2009.
4. Molecular Spectroscopy -P. S. Sindhu, Tata Mc Graw-Hill, New Delhi, 1990.
5. Vibrational Spectroscopy - D.N. Sathyanarayana, New age International Publishers, 2021.

Books for Reference

1. Spectroscopy and molecular structure-G. W. King, Hoit Rinchart and WinstenInc, London,1964.
2. Photo electron and Auger spectroscopy- T. A. Carlson, Plenum Press,1975.
3. Basic Laser Raman spectroscopy- J .Loder, Hezdan and Son Ltd.,1970.
4. NQR Spectroscopy- T. P. Das, E. L. Hehn, Academic Press,1958.
5. Basic Principles of Spectroscopy - Raymond Chang Mc Graw-Hill Kogakusha, 1980.
6. Principles of Instrumental Analysis- Douglas A. Skoog, James J.Leary, 4thEdition, Harcourt Brace College Publishers, NewYork,1992.
7. Solid State Chemistry and its Applications- Anthony R.West, John Wiley & Sons, New York,2003.
8. Atomic spectroscopy - K.P. Rajappan Nair, MJP publication, Chennai, 2012.

BASIC CONCEPTS OF INSTRUMENTATION

COURSE CODE: 21PGPHYE17 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study of impart aspects of basic and dynamic concepts of instruments
- To learn important differences and application of various transducers
- To understand the applications of transducers in different thermometers and acoustic measurement meters

COURSE OUTCOME: After completion of the course the students will be able to

CO1	Develop a comprehensive understanding on the basic characteristics of the instruments with impedance matching
CO2	Demonstrate the dynamic characteristics of the instrument
CO3	Understand the various types of transducers
CO4	Learn how to utilize the different types of thermometers
CO5	Understand the basics of flow measurement and acoustic measurement meters

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	H	L	H
CO2	M	H	H	L	M
CO3	H	M	H	L	H
CO4	H	M	H	L	H
CO5	M	H	H	L	M

Syllabus

Unit	Unit Title	Intended Learning Chapters (K1, K2, K3, K4,K5,K6)	Hours of Instruction
I	Static Characteristics of Instruments	Types of errors– Static Performance Parameters– Accuracy, Precision, Resolution –Linearity– Hysteresis– Dead Band– Backlash– Drift- Impedance loading and Matching.	14
II	Dynamic Characteristics of Instruments	Dynamic Response: Periodic Input Harmonic Signal- First order – Second order system- Response to step input and transient input– Compensation networks.	14
III	Analog and Digital Transducers	Analog transducers: Electrochemical– Potentiometric Resistive– Inductive– Capacitive– Piezo-Electric transducers –Digital transducers: Frequency Domain, Electromagnetic Frequency Domain– Opto-Electrical Frequency Domain–Vibrating String Transducers.	14
IV	Transducers–I	Moderate Pressure: Manometers, Elastic Transducers– High Pressure measurement– Temperature measurements: Non-Electrical Methods– Bimetallic Thermometer– Liquid in Glass Thermometer –Pressure Thermometers– Electrical Methods: Electrical Resistance Thermometers.	15
V	Transducers–II	Flow Measurement: primary or Quantity Meters–Positive Displacement Meters- Acoustic Measurements –Sound Level Meter– Frequency Analysis of Noise Signal– Sound Intensity Measurements–Microphones –Capacitor Type–Piezo Electric Crystal Type– Electrodynamic Type.	15

Books for Study

1. Instrumentation Measurement and Analysis– B.C. Nakra & K.K. Chaudhry, TMH, New Delhi, Third Edition, Seventh Reprint, 2011.

Books for Reference

1. Measurement System– E.D. Doebelin, Mc-Graw Hill, 1990.
2. Principles of Industrial Instrumentation– Patranbis D, TMH, New Delhi, 1976.

COMMUNICATION ELECTRONICS

COURSE CODE: 22PGPHYE18 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand the basic concepts of communication and optical communication system.
- To identify different types of modulation and multiplexing formats.
- To learn the fundamentals and applications of communication electronics
- To develop background knowledge and core expertise on communication electronics
- To acquire a basic understanding of optical communication system and compute a simple optical power budget

COURSE OUTCOMES: After completion of the course, the student will be capable of

CO1	Demonstrate and analyze different characteristics parameters of antenna for real time applications.
CO2	Explain waveguide theory and able to understand the operation of different microwave sources (i.e. Reflex Klystron, Gunn Diode).
CO3	Demonstrate the basic principle of radar engineering and familiarize TV Transmission and Reception.
CO4	Describe basic components of communication system and concept of modulation, its needs.
CO5	Understand some basic properties and applications of optical fibers.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	L
CO2	M	H	L	H	L
CO3	L	H	H	M	M
CO4	H	M	L	L	L
CO5	H	M	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Antennas and Wave propagation	Physical concept of radiation, retarded potentials, Antenna parameters Terms and Definition-Effect of Ground on Antennas-Grounded λ/4-Ungrounded Antenna λ Antenna- Antenna Arrays-Broadside and End Side Arrays-Antenna Gain-Directional High Frequency Antennas –Sky Wave Propagation- Ionosphere- Magneto Ionic Theory- Ground Wave Propagation.	15
II	Microwaves	Microwave Generation- Multicavity Klystron-Reflex Klystron-Magnetron- Travelling Wave Tubes (TWT) and other Microwave Tubes- MASER- Gunn Diode	14
III	Radar and Television	Elements of a RadarSystem- 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.	14
IV	Communication Electronics	Analog and Digital Signals- Modulation- Types of Modulation-Amplitude modulation theory-Frequency spectrum of the AM wave- Representation of AM- Power relations in the AM wave-Generation of AM- Basic requirements- Description of frequency and phase modulation- Characteristics of AM and FM - Mathematical representation of FM - Frequency spectrum of the FM wave- Effects of noise on carrier.	15
V	Optical Fibres	Propagation of Lightinan Optical Fibre- Brewster angle – total internal reflection – concept of coherence-Acceptance angle-Numerical Aperture- Step and Graded Index Fibres- Optical Fibreas a Cylindrical Wave Guide- Fibre Losses and Dispersion-Applications.	14

Books for Study

1. Electronic Communication System-George Kennedy &Davis -Tata McGraw Hill, 4th edition, 1989.
2. Optical fibre and fibre optic communication systems– S.K. Sarkar - S. Chand Pub, 2007.
3. Electronics Devices and circuits – Sanjeev Gupta and Santhosh Gupta, Dhanpat Rai Publications, 2010.

Books for Reference

1. Principles of Communication Systems – Taub Schilling, TMH, 1986.
2. Communication Systems - Simon Haykin, John Wiley & Sons, 2005.
3. Electronics & Radio Engineering - F.E.Terman, McGraw Hill, 1955.
4. Communication Systems - Carlson -McGraw Hill,3rd Edition, 1986.

SEMICONDUCTOR DEVICES – THEORY

COURSE CODE: 22PGPHYE19 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- Understand basic concepts of energy bands and charge transport phenomenon
- Familiarize with semiconductor device fabrication steps and its characteristics
- To develop background knowledge and core expertise related to MOSFET
- Acquire knowledge and apply it to various microwave technology
- To understand the various applications of photonic devices

COURSE OUTCOME: After completion of the course the student will be capable of

CO1	Provide the basic knowledge and also give an overview of physics in semiconductor
CO2	Gain knowledge in semiconductor devices and design techniques
CO3	Study the characteristics of MOSFET and its applications
CO4	Develop the fundamental concepts and techniques used in microwave technology
CO5	Acquires an ability to analyse and design different photonic devices.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	L
CO2	M	H	L	H	L
CO3	L	H	H	M	M
CO4	H	M	L	L	L
CO5	H	M	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Semiconductor physics-energy bands and carrier transport phenomena	Energy bands: Semiconductor Materials, Basic Crystal Structure, Basic Crystals Growth Technique, miller indices, reciprocal lattice Valence Bonds, Energy Bands, Intrinsic Carrier Concentration, Fermi-Dirac distribution function, Donors and Acceptors, Calculation of Fermi Level ,Non-degenerate and degenerate Semiconductor. impurity doping: basic diffusion process, diffusion equation, diffusion profiles; Carrier Transport Phenomena: Carrier Drift: mobility, resistivity, Hall Effect; Carrier Diffusion: diffusion process, Einstein Relation, current density equation; Generation and Recombination Processes: direct and indirect recombination, surface recombination, Auger recombination; Continuity Equation, The Haynes-Shockley Experiments; Thermionic Emission Process, Tunnelling Process: i.e Schrodinger equation; High Field Effects.	15
II	Semiconductor device :p-n junction	Basic Fabrication Steps: Oxidation, Lithography; Thermal Equilibrium Condition: Band Diagram, Equilibrium Fermi Level; Depletion Region: Abrupt junction, Linearly Graded junction; Depletion Capacitance, Current-Voltage Characteristics: generation-recombination and high-injection effects; Charge Storage and Transient Behaviour, Junction Breakdown: tunnelling effect;, Avalanche multiplication, Heterojunction; Bipolar Transistor basics: Bipolar transistor Action: operation in the active mode; Static Characteristics of Bipolar Transistor; frequency response	15
III	Semiconductor device	MOSFET and Related Devices: The MOS Diode: the ideal MOS diode, metal & semiconductor work function, method the SiO2 -Si MOS diode, CCD; MOSFET fundamental: linear and saturation regions, types of MOSFET, threshold voltage control; MOSFET scaling: short-channel effect, scaling rules; CMOS and BiCMOS: Latch-up; MOSFET on insulator: thin film transistor; MOS Memory structures: DRAM, SRAM, Nonvolatile memory; the power MOSFET; MESFET and Related Devices: Metal-Semiconductor Contacts: i.e the Schottky barrier, semiconductor work function, Ohmic contact; MESFET: Devices structure, principles of operation,	14

		high-frequency performance	
IV	Microwave diode, quantum-effect-and hot electron device	Basic Microwave Technology: i.e IEEE microwave frequency bands; Tunnel diode: I-V characteristics; Impatt diode: static & dynamic characteristics, field distributions and generated carrier densities; transferred-electron devices: i.e negative differential resistance, device operation; quantum-effect devices: resonant tunneling diode, energy of electrons; hot-electron devices: ballistic-transistor, hot-electron diodes transistors and HBT, real-space-transfer transistor	14
V	Photonic device	Radiative Transitions & Optical Absorption: radiative transistor, and laser operation Boltzman distribution, optical absorption, optical absorption coefficients; LED: visible LEDs, bandgap semiconductors, Snell's law, orangic LED, Infrared LED ; Semiconductor Laser: laser operation, energy bandgap, carrier & optical confinement, optical cavity & feedback, basic laser structure, quantum-well laser, energy of charge particle Photodetector: photoconductor, photodiode, quantum efficiency, p-i-n photodiode, heterojunction phtodiode, avalanche photodiode) 4.5 Solar Cell: solar radiation, p-n junction solar cell, conversion efficiency, solar cells, optical concentration	14

Books for Study and Reference

1. Semiconductor Devices Physics and Technology - S. M. Sze, Wiley Publication, 2nd Edition, 1985.
2. Physics of semiconductor devices - S.M. Sze and Kwok K. NgWiley, Third Edition, 2007.
3. Solid State Electronic Devices – B. G Streetman, S Banerjee, Prentice Hall, 6th Edition, 2009.
4. Semiconductor Physics and Devices: Basic Principles- D. A. Neamen, McGraw-Hill, 3rd Edition, 2003.

BASICS AND APPLICATIONS OF NANOPHYSICS

COURSE CODE: 22PGPHYE20 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM OBJECTIVES: 100

COURSE OBJECTIVES:

- To comprehend the quantum concepts of heterostructure
- To understand the basic concepts in nanoscience.
- To explore the field of nanomaterials.
- To have a deep knowledge of the fundamentals of nano molecular materials.

COURSE OUTCOME: After completion of the course the student will be capable of

CO1	To gain knowledge in basic quantum concept of heterostructure.
CO2	Provides the basic knowledge about quantum wells and low dimensional system
CO3	Acquires an ability to understand the concept of lithography.
CO4	Develops an ability to analyse the types of characterization and properties of Nanomaterial's.
CO5	To learn about the different applications of Nanomaterial's.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	L
CO2	M	H	L	H	L
CO3	L	H	H	M	M
CO4	H	M	L	L	L
CO5	H	M	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Basic quantum concept of hetero structure	General Properties of Heterostructures–Growth of Heterostructures –MBE & MOCVD; Band Engineering, Layered Structures: Quantum Wells and Barriers; Doped Heterostructures, Strained Layer, Si–Ge Heterostructures, Wires and Dots; Optical Confinement– Effective Mass Approximation, Effective Mass theory in Heterostructures.	15
II	Quantum wells and low dimensional systems	Infinite Deep Square Well, Square Well of Finite Depth, Parabolic and Triangular Wells; Low Dimensional Systems, Occupation of Sub bands, Two and Three Dimensional Potential Wells: Cylindrical, Parabolic, Spherical and Coulomb Potential(2D &3D) Wells, Further Confinement Beyond Two Dimensions, Quantum Wells in Heterostructured.	15
III	Nanostructure fabricated by nano pattering	Introduction – Lithography: Nanomanipulation and Nanolithography, Soft Lithography, Assembly of Nanoparticles and Nanowires, Other Methods for Microfabrication	14
IV	Characterizatio n and properties of nanometerial	Introduction: Structural Characterization, Chemical Characterization, Physical Properties of Nanomaterials, Electrical Conductivity, Ferroelectrics, Dielectrics and Superparamagnetism.	14
V	Application of Nanomaterias	Introduction–Molecular Electronics and Nano Electronics, Nanobots, Biological Application of Nanomaterials, Catalysisby Gold Nanoparticles; Band Gap Engineered Quantum Devices: Quantum Well and Quantum Dot; Nanomechanics, Carbon Nanotube Emitters, Photo electrochemical Cells, Photonic Crystals and Plasma Waveguides	14

Books for Study and Reference

1. The Physics of Low Dimensional Semiconductors– Hohn H.Davies–CambridgeUniversity Press, 1998.
2. Nanostructures and Nanomaterials– Huozhong Gao–Imperial College Press, 2004.

ENERGY PHYSICS

COURSE CODE: 22PGPHYE21 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To know and study about the availability of renewable energy sources.
- To understand the wind energy conversion technology.
- To study the methods for biogas production from bio-waste.
- To construct solar cell for energy conversion applications.
- To identify the materials for magneto hydro dynamic generator.

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Describe the renewable and non-renewable energy sources.
CO2	Understand the renewable energy conversion technology especially wind and hydrogen energy conversion and its storage.
CO3	Acquire the knowledge on energy conversion technology from biomass.
CO4	Explore the concept of solar to electrical energy conversion method using solar cell.
CO5	Understand the magneto hydro dynamic generator for energy conversion application.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	M	L	M
CO2	H	M	L	L	H
CO3	H	H	M	L	H
CO4	M	H	L	L	L
CO5	M	M	L	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Energy Source	Introduction to energy source - Energy sources and their availability- Types of energy - Prospects of renewable energy-Extra terrestrial solar radiation- Effect of earth's atmosphere – Measurement and estimation of solar radiation.	14
II	Bio-energy	Biomass conversion Technologies–wet and dry process–Photosynthesis. Biogas Generation: Introduction – basic process and energetic – methods for maintaining biogas production – advantage of anaerobic digestion – factors affecting bio digestion and generation of gas. Classification of Biogas plants: continuous and batch type–the dome and drum types of Biogas gas plants–biogas from wastes fuel–properties of biogas– utilization of biogas.	15
III	Solar Energy	Solar cells for direct conversion of solar energy to electric powers- Solar cell parameter–Solar cell electrical characteristics –Efficiency – Single crystal silicon solar cells – Polycrystalline silicon solar cells–Cadmium sulphide solar cells. Applications of Solar Energy: solar distillation- solar water heating-solar pumping - solar furnace-solar cooking-solar green house.	14
IV	Wind Energy harvesting	Wind Energy harvesting: Fundamentals of Wind energy-Wind Turbines and different electrical machines in wind turbines- Power electronic interfaces, and grid interconnection topologies	14
V	Piezoelectric Energy harvesting	Piezoelectric Energy harvesting: Introduction- Physics and characteristics of piezoelectric effect- materials and mathematical description of piezoelectricity- Piezoelectric parameters and modeling piezoelectric generators-Piezoelectric energy harvesting applications- Human power	15

Books for Study

1. RenewableEnergyResources-JohnTwidell&TonyWeir,Taylor&FrancisGroup, 2006.
2. Principles of Solar Engineering – Kreith and Kreider, McGraw HillPub, 1978.
3. Applied Solar Energy-A.B.Meinelandand A.P.Meinal,1976.

Books for Reference

1. Solar Energy- M.P.Agarwal, S.,Chand & Co, 1983.
2. Solar Energy- S.P.Sukhatme,TMH, 1996.
3. Non-conventional Energy Sources - G.D.Rai, Khauna Publication, 2004.

SOLAR CELLS

COURSE CODE: 22PGPHYE22 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand the fundamentals of solar energy
- To study and understand the principle of solar cells
- To study the charge transport in semiconductor junction
- To construct the silicon based solar cells
- To understand the development of solar cell recent technologies

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Gain an understanding of the available solar energy and the current solar energy conversion
CO2	Able to comprehend the challenges in sustainable energy processes, perform cost analysis, design photovoltaic systems
CO3	Understand the physics of charge transport properties at semiconductor junction
CO4	Acquire the knowledge on silicon based solar cells
CO5	Understand the performance of next generation solar cells

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	M	L	L	H
CO3	M	H	L	L	H
CO4	M	H	L	L	L
CO5	M	M	L	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Introduction to Solar Cells and Sunlight	Outline of solar cell developments–Physical sources of sunlight–solar intensity at the Earth's Surface–direct and diffused radiation–apparent motion of the sun – solar insolation data– Types of solar energy converter– Photons in, electrons out– Basic principles of Photo-voltaic.	14
II	Semiconductor Materials, Properties and its Characteristics	Basics of crystal structure and orientations- Basic concepts– electron states in semiconductors – semiconductor in equilibrium– impurities and doping-semiconductor under bias-drift and diffusion– semiconductor transport equations– photo-generation– recombination– formulation of the transport problem	14
III	Junction Investigations	Origin of photovoltaic action– work function and types of junction –Homo-junctions–metal semiconductor junction – semiconductor-semiconductor junctions– electrochemical junction – organic material junctions– surface and interface states – p-n junction– dark and illuminated current - effect of temperature – efficiency loss-short circuit current-open circuit voltage – introduction to various resistance	15
IV	Design, Fabrication and Characterization of Silicon Solar Cells	Basic silicon Solar cells-Basic theoretical performance – Major considerations for solar cell fabrication – doping of the substrate – Back surface fields – to player limitations–top contact design – optical design – spectral response–cell fabrication process–surface treatment– etching–doping and diffusion–contact formation–solar cell measurement (IV)–analysis of the output-future direction in silicon cell de sign.	15
V	Towards Third And Fourth Generation Solar Cells	Thin film solar cells - Transparent conducting oxides-Chalcogenide solar cells- Organic photovoltaics- Perovskite, Dye sensitized solar cells- Hybrid organic- Inorganic solar cells- Multi-junction solar cells.	14

Books for Study

1 . Solar Cells operating Principles, Technology and System applications - Martin A.Green Published by The University of New South Wales, 1982.
2. The Physics of Solar Cells - Jenny Nelson, Imperial College Press, 2013.

Books for Reference

1 . Light-Induced Redox Reactions in Nanocrystalline Systems, Anders Hagfeldtt and Michael Gratzel, Chem, EPFL Sceintific Publications, 1995.

2. Solar Energy Fundamentals, Technology and Systems, KlausJäger, Olindo Isabella, Arno H.M. Smets, René A.C.M.M. van Swaaij Miro Zeman, Delft University of Technology, 2014.

SOLAR ENERGY UTILIZATION

COURSE CODE: 22PGPHYE23 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

OBJECTIVES:

- To understand the radiation analysis at earth surface
- To study Solar thermal energy harvesting
- To explore the basic understanding of solar heater
- To study Solar photovoltaic conversions
- To understand the Fuel cell and Hydrogen Energy

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	To understand the solar radiation at the earth surface
CO2	Acquire the comprehend knowledge on solar collectors
CO3	Understand the construction of solar heater
CO4	Acquire the knowledge about solar cells
CO5	To design sustainable energy solution for various end uses

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	M	L	M
CO2	H	M	L	L	H
CO3	H	H	M	L	H
CO4	M	H	L	L	L
CO5	M	M	L	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Heat Transfer & Radiation Analysis	Conduction, Convection and Radiation–Solar Radiation at the earth's surface- Determination of solar time–Solar energy measuring instruments.	14
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.	14
III	Solar Heaters	Types of solar water heater - Solar heating system – Collectors and storage tanks–Solar ponds–Solar cooling systems	14
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, Anti reflective coatings, metallization.	15
V	Solar Hydrogen	Hydrogen Energy-Solar Hydrogen through photo electrolysis and photocatalytic process. Physics of material characteristics for production of solar hydrogen- Brief discussion of various storage processes- new storage modes, Various factors relevant for safety-use of Hydrogen as fuel- use in vehicular transport-hydrogen for electricity generation, Fuel Cells.	15

Book for Study

1. Solar energy utilization-G.D. Rai– Khanna publishers–Delhi, 1987.
2. Solar energy– Principles of thermal collection& storage – S.P. Sukhatme, TMH, Delhi,1984.
3. Renewable Energy: Power for a sustainable Future by Godfrey Boyle, Oxford, 2012.

Book for References

1. Energy–An Introduction to Physics – R.H. Romer, W.H. Freeman,1976.
2. Solar energy thermal processes – John A. Drife and William, 1974.

PHYSICS OF NON-CONVENTIONAL ENERGY RESOURCES

COURSE CODE: 22PGPHYE24 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To know the recourse of non-conventional Energy resources
- To able to construct the solar thermal collector
- To understand the geothermal energy and hydropower station
- To study the work function of wind power generating system
- To explore technology for bio-energy production

COURSE OUTCOME: After completion of the course, the student will be able to

CO1	Understand the availability of non-conventional Energy resources
CO2	Acquire the knowledge to design the solar collector
CO3	Obtain the fundamental knowledge on geothermal energy and hydropower station
CO4	Acquire the knowledge about work function of wind energy system
CO5	Acquire the concept to construct the bio energy production reactor

Mapping of the course outcomes with programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	M
CO2	H	M	L	L	H
CO3	M	H	L	L	H
CO4	M	H	L	L	L

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Non-Conventional Energy Resources and Solar cell	Non-conventional energy resources; Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations.	14
II	Solar Thermal Energy	Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.	15
III	Geothermal Energy and Hydro Energy	Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. Hydropower resources- hydropower technologies-environmental impact of hydro power sources.	14
IV	Wind Energy	Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, Concentrations and augments, wind characteristics. Performance and limitations of energy conversion systems.	14
V	Bio Energy and Ocean Thermal Energy Conversion	Bio Energy: Availability of bio-mass and its conversion theory. Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations. Wave and Tidal Wave: Principle of working, performance and limitations.	15

Books for Study

1. RenewableEnergyResources–JohnTwidell&TonyWeir,Taylor&FrancisGroup, 2006.
2. Principles of Solar Engineering – Kreith and Kreider, McGraw Hill Pub, 1978.
3. Applied Solar Energy-A.B.MeinelandA.P.Meinal,1976.

Books for Reference

1. Solar Energy- M.P. Agarwal, S., Chand & Co, 1983.
2. Solar Energy- S.P. Sukhatme, TMH, 1996.
3. Non-conventional Energy Sources - G.D. Rai, Khauna Publication, 2004.

SUPPORTIVE COURSES

ELECTRONICS IN DAILY LIFE

COURSE CODE: 22PGPHYS01 **HOURS**

L	T	P	C
3	0	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To provide an opportunity for the students from other curriculum to understand the Physics of Electronics
- To understand the construction and operating principles of Electrical, Electronic and communication devices.
- To acquire a knowledge to analyze and design popular electronic technologies.
- To present idea on antennas for communication systems with related issues.
- To know the safety mechanism on handling the electrical and electronic equipment.

Course Outcomes: At the end of the course the students will be able to

CO1	Understand the function of different components of electronic circuit.
CO2	Learn and acquire the basic knowledge of various home appliances such as Iron box, Fan, Electric oven etc., being used in day to day life.
CO3	Study various display system and their applications.
CO4	Learn the various elements of communication electronics such as Mobile radio, optical fibre, transmission lines, internet etc.,
CO5	Gain knowledge on safe handling and prevention methods while handling electrical and electronic devices

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	H	L	M	H	H
CO3	H	L	H	M	L
CO4	M	L	L	L	L
CO5	M	H	L	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Fundamentals of electronic components	Electrical and Electronic Symbols – passive and active components- Resistors – Capacitors- Resistance wale – Capacitor wale – Electrical quantities – Electrical formulas – Magnetism – Meters – Fuse wire Vacuum diodes - Transistors – Integrated chips.	11
II	Electrical appliances	Switch board – Main box – Metal circuit breakers (MCB) – AC – DC currents – Two Phase – Three Phase electrical connections- Method of Earthing – generators – uninterrupted power supply (UPS)- stabilizer – voltage regulators. Electrical devices: Iron box – Fan – Electrical Oven – water Heaters Air conditioners – Refrigerators – washing machines-.	11
III	Electronic home appliances	Radio – Audio taper veaulem, Classification of home appliances - speaker- televisions – VCR – CD Players – DVD – calculators – Computers – scanner – Printer – Digital Camera – LCD Projectors – Display devices.	11
IV	Communication electronics	Principles of optical fiber Cables (OFC) – Telephone – Mobile phones – wireless phone - Antenna - Internet - Intranet.	10
V	Safety mechanism	Handling Electrical appliances - Power saving methods –- Prevention Methods - Protection of Hi–Fi electronic devices.	11

Books for Study and Reference

1. Electronics and Mathematics Data book – S.S. Kam ble, Allied publishers Ltd, 1997.
2. Study of electrical appliances and Devices - Bhatia, Kanna Publications, Seventh Edition, 2014.

GEOPHYSICS

COURSE CODE: 22PGPHYS02 **HOURS**

L	T	P	C
3	0	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand origin of earth, earth's magnetism and gravimetric.
- To have the knowledge about earth quake.
- To obtain the fundamental concept of gravitational anomalies.

COURSE OUTCOME: After completion of the course, the students will be capable of

CO1	Understand the origin of earth.
CO2	Understand the earth's magnetism and its implications.
CO3	Acquire knowledge earth's elasticity, wave motion and earth quake.
CO4	Explain earth's thermal effect.
CO5	Understand gravimetry and geological survey for minerals and oils.

Mapping of course outcomes with programme outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	L	L	H
CO3	H	H	L	L	L
CO4	H	M	L	L	L
CO5	M	H	L	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Earth planet	Different motions of the earth- gravity field of the earth- Clairaut's theorem- size and shape of earth- geochronology. Seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties of the earth.	11
II	Geomagnetism	Origin of earth's magnetism – elements of earth's magnetic field – inclination, declination and dib - earth's magnetic field – diurnal, annual and secular variations – magnetosphere.	11
III	Eismology basic principles of elasticity and wave motion	primary wave (P-waves) and elasticity wave (S-wave) – density within the earth – pressure distribution – variation of "g" and elastic constants - earth quakes – elementary ideas about Ritter's scale	10
IV	Geo-thermal effect	Fundamentals concept of thermal conductivity – heat flow measurement of on ground level and ocean – heat flow gravity variation – temperature of the primitive earth – inner core – melting point – adiabatic temperature gradient.	11
V	Gravimetry	Fundamental concepts of gravitational field – gravitational anomalies – use of gravitational anomalies in geophysical prospecting – petroleum and mineral survey – factors affecting gravitational field due to magnetic storms and cosmic ray showers Mammond and Faller method of absolute gravity measurement – principle and working.	11

Books for Study and Reference

1. Pedology – Concept and applications -J.Sehgal, Kalyani publishers, 2009.
2. Introduction to geophysics (mantle, core and crust) - George G. Garland, W.B. Saunder's company, 1979.
3. Physics and Geology - Jacobbs, Russel and Wilson, International Students Edition, Tata McGraw Hill, 1959.
4. Rock Magnetism - Nagata, McGraw Hill Publications, 1961.
5. Geology - Debrin, McGraw Hill Publications, 2016.
6. Physics and Geology - A.J. Aitken, Tata McGraw Hill Publications, 1990.
7. Biography of the earth (Its past, present and future) - George Gamove, Macmillon Company Ltd, 2017.

MOLECULAR BIOPHYSICS

COURSE CODE: 22PGPHYS03 **HOURS**

L	T	P	C
3	0	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the chemical binding of molecules
- To study the physics of biomolecules and Bioenergetics
- To study the memory system

COURSE OUTCOME: After completion of the course the students will be able to

CO1	Interpret the chemical binding
CO2	Explain the cells and their structures
CO3	Understand the physics of biomolecules
CO4	Acquire the knowledge of bioenergetics
CO5	Understand the memory system and its functions

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	H	M
CO2	L	H	M	L	M
CO3	L	L	M	L	H
CO4	L	H	L	H	M
CO5	H	M	M	L	H

Syllabus

Unit	Title	Intended Learning Chapter (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Chemical binding	Quantum mechanics-Pauli exclusion Principle – Ionisation energy – electron affinity – chemical binding – electro negativity – strong bonds – secondary bonds. Energies, Forces and Bonds: Interatomic potentials for strong bonds – weak bonds – non-central forces – bond energies – spring constants. Rates of reaction: Free energy – Internal energy – thermodynamics – statistical mechanics – reaction kinetics – water, acids, bases and aqueous reactions – radiation energy.	11
II	Cell: Its organells and molecules	Prokarytes and Eukaryotes molecular components of cell carbohydrates-lipids-proteins-nucleic acids-Macromolecular structure: Proteins: Amino acid and primary structure – peptide bond and secondary structure- α-helix and β- sheet - tertiary and quaternary structure of proteins-protein folding-Virus structure.	10
III	Physics of biomolecules	Molecular mechanism of Genetic information transfer- Genetic code – transfer of Genetic information – molecular mechanism of Protein synthesis - Principle of molecular recognition. Physics of Biological Membranes: Cell membrane –Structure of membranes-transport through membrane – Passive transport – diffusion – active transport-molecular reception	11
IV	Bioenergetics	Energy consumption - cellular respiration-photosynthesis – photosystem I & II ATP synthesis. Movement of Organisms: Bacterial motion – chemical memory in primitive organisms – muscular moment – Human performance. Excitable membranes: diffusion and mobility of Ion Resting potential . Nerve signals: Passive response – Nerve impulses (Auction Potentials) –the nervous system.	11
V	Memory	Hebbianlearing – Neural network – Auto-association. Control of movement: The Primacy of movement – Ballistic control in a simplified visual system – more sophistical modes of control – the Heterogeneous structures of muscle fibers – central pattern generators – conditional reflexes – volition and tree will – what purpose does consciousness serve – passive verses active in mental processing – the relevant anatomy and physiology – intelligence and creativity.	11

Books for Study and References

1. Biophysics :An Introduction -Rodney - M.J. Cotterill, John Wiley Publication, 2002.
2. Biophysics– Vasantha Pattabhi and N.Gautham, Alpha Science International, Second edition, 2009.
3. Biophysics - Roland Glacer, Springer Publications, 2012.
4. Elementary Biophysics An Introduction - P. K. Srivastava, Alpha Science International, 2005.
5. Biophysics - M. V. Volkenshtein, Mir Publications, 1983.
6. Biophysics: Principles and Techniques – M.A. Subramonian, MJP Publishers, 2005.

NON-LINEAR OPTICS

COURSE CODE: 22PGPHYS04 **HOURS**

L	T	P	C
3	0	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES

- To introduce the non-linear optics and basic level theoretical aspects.
- To get knowledge in non-linear optical instrumentation for the usage in research application.

COURSE OUTCOME: After completion of the course the student will be able to

CO1	Understand the physics phenomena behind the linear and nonlinear response of the electromagnetic radiation
CO2	Understand the various process of the generation of nonlinear waves
CO3	Get the knowledge in higher level nonlinearities
CO4	Get the knowledge of recent development in the non-linear materials for the applications of the optoelectronics
CO5	Get the knowledge of the instrumentation used to measure the higher harmonic waves

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	M	L
CO2	L	H	M	L	M
CO3	L	H	M	M	L
CO4	H	M	L	L	H
CO5	L	H	M	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Introduction	Introduction to non-linear Optics - Wave propagation- wave Propagation in Anisotropic Medium- Polarization response of materials to light – Generation of various harmonic waves.	11
II	Generation of second harmonics	Types of nonlinear wave generation - Nonlinear Frequency Mixing-Optical Response of Harmonic Oscillator- Second Harmonic Generation-Two wave process – Multi wave mixing-Up and down Conversion.	11
III	Higher non-linear wave generation	Three Wave Mixing – Third order nonlinear optical processes-Theory of third harmonic generation- Phase Matching - Frequency Conversion- Nonlinear Optical Susceptibilities – Applications of higher nonlinear waves.	11
IV	Non-linear materials	Nonlinear Optical Materials-Organic Nonlinear Optical Materials and their applications – KDP and ADP as nonlinear materials for optoelectronic application – Novel DAST materials and their applications.	10
V	Non-linear instrumentation	Kurt and Perry technique- Nonlinear Refraction And Absorption-Two-Photon Absorption And Doppler Free Spectroscopy-Kerr Lens -Third-Order Nonlinearity Measurement Techniques: Z-Scan-Pulse propagation through third order nonlinear optical medium.	11

Books for Study and References

1. Non-linear Optics - R.W.Boyd, Third edition, Academic, 2008.
2. Handbook of Non-linear Optics -R.L.Sutherland, 2nd Edition,Marcel Dekker, 2003.
3. Non-linear Optics and Quantum Electronics - M. Schubert and B. Wilhelmi, 1986.
4. Fundamentals of Nonlinear Optics - P.E.Powers, CRC Press, 2011.
5. Principles of Non-linear Optics - Y.R.Shen, Wiley, 1984.
6. Non-linear Fiber Optics - G.P.Agarwal, 4th Edition,Academic, 2007.
7. Non-linear Optics - N.Bloembergen,4thEdition,World Scientific, 1996.

LASER PHYSICS AND APPLICATIONS

COURSE CODE: 22PGPHYS05 **HOURS**

L	T	P	C
3	0	0	4

MAXIMUM MARKS:100

COURSE OBJECTIVES :

- To study the Einstein's theory of Lasers. To get knowledge about Lasers, its characteristics and applications
- To study the different type of Lasers such as, Ruby, Nd-Yag, Semiconductor, Diode Pumped solid state and dye Laser
- To study the differences between the Longitudinal and Transverse Modes of Laser cavity
- To learn the Optical Fibers communication, Qualitative treatment of medical and engineering applications of Lasers.

COURSE OUTCOME: After completion of the course, the student will be capable to

CO1	Understand and Interaction of radiation with matter
CO2	Understand the Characterization of Lasers and their applications
CO3	Understand the Laser systems involving high density media
CO4	Differentiate Longitudinal and Transverse Modes of Laser cavity
CO5	Get knowledge of Laser Raman scattering and their use in Pollution studies

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	L	M	M	L	L
CO2	M	M	M	L	M
CO3	L	M	L	L	M
CO4	M	M	L	L	M
CO5	M	M	L	L	H

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Basic Physics on the operation of Lasers	Einstein's theory – Interaction of radiation with matter – Theory of some simple processes.	10
II	Laser Characteristics Gaussian beam and its properties	Stable two mirror optical resonators, Longitudinal and Transverse Modes of Laser cavity – Mode selection - gain in a Regenerative Laser cavity – Threshold for 3 and 4 level laser systems – Q Switching Mode locking pulse shortening _ Pico second & femto second. operation – Spectral narrowing and stabilization.	11
III	Laser Systems	Laser systems involving low density gain media – Nitrogen Laser, Carbon dioxide Laser and Eximer laser. Laser systems involving high density gain media – Ruby Laser, Nd-Yag Laser, Semiconductor Laser, Diode Pumped solid state Laser, Dye Laser High power semiconductor diode Laser systems.	11
IV	Laser Spectroscopic Techniques and other Applications	Laser fluorescence and Raman scattering and their use in Pollution studies, Non-linear interaction of light with matter, Laser induced multi photon processes and their applications, Ultra high resolution spectroscopy with laser and its applications, Propagation of light in a medium with variable refractive index, Optical Fibres. Light wave communication. Qualitative treatment of medical and Engineering applications of Lasers.	11
V	Meteorological Application	Distance and range measurement – Lidar for range findings and tracking – pulsed laser sources – Configuration of a pulsed range finder – Range finding equation – Energy and power relation – signal detect ability – Switched lidars, Satellite and Lunar Range finders.	11

Books for Study and Reference

1. Principle of Lasers –Grazio Svelto, Plemum Press, Fifth Edition, 2008.
2. Laser Fundamentals - William Silfvast, Cambridge University Press, Second Edition, 2004.
3. Lasers and Non-linear Optics - B.B.Laud, Wiley Eastern Ltd, Third Edition, 2011.
4. Lasers - Lengyel, Wiley Inter Science, 1962.

ADD ON COURSES

VALUE ADDED COURSES

POWDER X-RAY DIFFRACTION AND ANALYSIS

COURSE CODE: 22PGVAC01 **HOURS : 30**

MAXIMUM MARKS: 100 **CREDITS: 2**

COURSE OBJECTIVES:

- To make understand X-rays, diffraction, crystal lattice and symmetry.
- To acquire background knowledge on X-ray diffraction from powder crystalline samples.

COURSE OUTCOME: After the completion of the course the student will be able to

CO1	Know the production of X-rays and diffraction from crystals and symmetry.
CO2	Record and Interpret the X-ray diffraction pattern of powder crystalline samples.

Mapping of course outcome with the programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	M	H	M	L
CO2	L	H	M	M	L

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	X-rays, diffraction, crystal lattices and symmetry	X-rays-Absorption and Filtering- Selection of Radiation- X-Ray tubes: Construction and Geometry-Crystals-Lattices, Planes and Indices-X-Ray Diffraction - Reciprocal Lattice- Bragg's Law- Crystal systems and symmetry- Non-primitive Lattices- Point Groups- Space groups symmetries.	15
II	Powder X-ray diffraction and analysis	Method of Recording X-Ray diffraction: X-ray Diffractometer: X-Ray source - Goniometer- Video camera and Microscope- X-ray detector system-Host computer. Principle of powder diffraction- powder diffraction pattern-Interpretation of powder photographs-Applications-Limitations.	15

Books for Study and Reference

1. Powder Diffraction: Theory and Practice –R. E. Dinnebier, S. J. L. Billinge, 2008.
2. Introduction to X-Ray Powder Diffractometry -Ron Jenkins, 1st Edition, Wiley-Interscience, 1996.

<u>**OPTICAL SYSTEM ANALYSIS AND DESIGN**</u>

COURSE CODE: 22PGVAC02 **HOURS**: **30**

MAXIMUM MARKS: 100 **CREDITS: 2**

COURSE OBJECTIVES:

- Understands Image defects (Aberrations) in the optical systems.
- Comprehend variety of lens design and its tolerance analysis.

COURSE OUTCOME: After completion of the course, the students will be able to

CO1	Acquire the knowledge of optical functions and energy through computation.
CO2	Acquire basics of non-paraxial propagation of light and mirror focusing.

Mapping of course outcome with the programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	M	L
CO2	L	H	M	M	L

<u>**Syllabus**</u>

Unit	Title	Intended learning chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Aberrations	Transverse ray and wave aberrations, chromatic aberration, Ray tracing: paraxial, finite and oblique rays, Image evaluation: transfer functions, point spread function, encircled energy and its computation and measurement, optimization techniques in lens design, merit function, Tolerance analysis; Double Gauss lens, Zoom lenses and aspheric lens.	15
II	GRIN optics	Focal shift, high and low N number focusing systems, focusing of light in stratified media, high numerical aperture focusing, basics of non-paraxial propagation of light. Classification of lens systems - Refractive systems - telephoto system, f-theta lens (fish eye lens); Reflective systems – single mirror telescope, two mirror telescope – three mirror aspheric system.	15

Books for Study and Reference

1. Principles of Computerized Tomographic Imaging, - A. C. Kak and Malcolm Slaney. IEEE Press, 1988.
2. Biomedical Optics: Principles and Imaging, - Lihong V. Wang and Hsin-i Wu. Wiley Interscience, 2007.

BIOMATERIALS

COURSE CODE: 22PGVAC03 **HOURS: 30**

MAXIMUM MARKS: 100 **CREDITS: 2**

COURSE OBJECTIVES:

Objective of this course is the students to understand the board spectrum of available biomaterials. And to provide a basic knowledge of engineering the materials that can be used as biomaterials and their applications.

COURSE OUTCOME: After completion of the course, the students will be able to

CO1	Understand how the basic engineering materials can be used as the biomaterials.
CO2	Apply and transfer interdisciplinary approaches in the biomedical field and other fields.

Mapping of course outcome with the program outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	L	M
CO2	H	M	L	M	H

Syllabus

Unit	Title	Intended learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Introduction to biomaterials	Biomaterials- historical development- impact of biomaterials-metals (stainless steels – cobalt-chromium alloys -titanium based alloys) – ceramics-surface reactive ceramic- resorbable ceramics (Calcium phosphate based ceramic materials)-synthetic polymers and its biomedical use-biodegradable synthetic polymers - Hydrogel - Polyurethanes - Polyamides –biopolymers-collagens- Gelatin - Chitin and chitosan - Alginate - Cellulose - composites.	15
II	Applications of biomaterials	Tissue grafts - tissue engineering – biosensors - drug delivery systems-orthopedic implants - knee joint repair - dental implants - oral implants, bio probes.	15

Books for Study and Reference

1. Biomaterials - Sujata V. Bhat, 2nd Edition, Narosa Publishing House, 2005.

2. Biomaterials: A Nano Approach - S. Ramakrishna, M. Ramalingam, T.S. SampathKumar,W.O. Soboyejo, CRC press, 2010.
3. Biomaterials for artificial organs - Michael Lvsaght and Thomas J.Webster, Woodhead publishing Limited, 2011.

SOLAR PHYSICS

COURSE CODE: 22PGVAC04 **HOURS: 30**

MAXIMUM MARKS: 100 **CREDITS: 2**

COURSE OBJECTIVES:

- Conceptualize Physics of the Sun and solar system. Students can be able to understand the photosphere, chromospheres, corona, and solar activity. Also they can get the knowledge on interpretation and the role of solar eruption towards the earth-space weather astrophysical phenomenon.

COURSE OUTCOME: After completion of the course the students will be able to

CO1	Understand the photosphere, chromospheres, corona and solar activity
CO2	Get the knowledge on interpretation and the role of solar eruption towards the earth-space

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	L	H	M	L	M
CO2	M	L	H	M	L

Syllabus

Unit	Title	Intended learning chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	The Sun	Anatomy of Sun-Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromospheres. Corona, -Basics of Solar Magneto-hydrodynamics. The solar family-Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model	15
II	Solar Eruptions	Solar Activity, Solar Cycle - Solar Storms - Solar flares - Solar Prominence - Corornal Mass Ejection- Types of CMEs - Earth and CMEs - Space Weather Change - Magnetic Belts - Satellites and CMEs.	15

Books for Study and Reference

1. Modern Astrophysics - B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co., 2007.
2. Introductory Astronomy and Astrophysics - M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing, 1998.
3. Textbook of Astronomy and Astrophysics with elements of cosmology - V.B. Bhatia, Narosa Publication, 2001.
4. Physics of Solar Flares and Coronal Mass Ejections - Dr. BojanVrnak, Create Space Independent Publishing Platform, 2015.

ANALYTICAL INSTRUMENTAL METHODS

COURSE CODE: 22PGVAC05 **HOURS: 30**

MAXIMUM MARKS: 100 **CREDITS: 2**

COURSE OBJECTIVES:

- To understand the operating principles, construction and working of various analytical instruments.
- To understand the accurate measurements and different types of errors.

COURSE OUTCOME: After completion of the course the students will be able to

CO1	Interpret the measurements and interpret the different types of errors.
CO2	Understand the operating principles, construction and working of various analytical instruments.

Mapping of the course outcomes with programme outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	L	M	H	L
CO2	M	H	L	L	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Errors and Analysis of Experimental Data	Types of errors – Mean, variance and standard deviation, standard deviation of standard deviation – sampling techniques. Thermal Analysis Thermo gravimetric analysis – instrumentation of weight loss and decomposition products – differential scanning calorimetric – instrumentation – specific heat capacity. Photoluminescence – light-matter interaction – fundamental transitions – excitons – instrumentation – electroluminescence - instrumentation.	15
II	Electron Microscopy and Electrical methods	Principles of SEM, TEM– Instrumentation – sample preparation – analysis of materials – study of dislocations– uses. Electrical Methods: Hall Effect – carrier density – resistivity – two probe and four probe methods – scattering mechanism – CV characteristics – Schottky barrier capacitance – impurity concentration – electrochemical CV profiling – limitations.	15

Books for Study and Reference

1. Instrumental Methods of Analysis - Willard. M, Steve. D, CBS Publishers, New Delhi, 1986.
2. Electron Microscopy and Microanalysis of Crystalline materials - Stradling, R.A, Applied Science Publishers, London, 1979.
3. Electron microscopy and Microanalysis of Crystalline Materials - Belk.J.A, Applied Science Publishers, London, 1979.

RADIATION PHYSICS

COURSE CODE: 22PGVAC06 **HOURS: 30**

MAXIMUM MARKS: 100 **CREDITS: 2**

COURSE OBJECTIVES:

- The objective of this course is to teach the basics of radiation physics and various radiation detectors.

COURSE OUTCOME: After completion of the course the students will be able to

CO1	Acquire knowledge on radiation and detection.
CO2	Determine the performance factors of various radiation detectors.

Mapping of the course outcomes with programme outcome

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	M	H	L	M
CO2	L	M	L	H	M

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Atomic Physics and Nuclear Transformation	Structure of matter - atom - nucleus -atomic mass and energy units - distribution of orbital electrons - atomic energy levels -nuclear forces -nuclear energy levels- particle radiation -Electromagnetic radiation- Binding energy - General properties of alpha, beta and gamma rays. Laws of equilibrium – modes of radioactive decay – nuclear isomerism -nuclear reactions - natural and artificial radioactivity - reactor and cyclotron produced isotopes - fission products – fusion.	15
II	Radiation Monitoring Instruments	Introduction – operational quantities for Radiation monitoring – Area survey meters –Ionization chambers – proportional counters – neutron area survey meters – GM survey meters – scintillation detectors – Personal monitoring – film badge – TLD –Properties of personal monitors – Radio photoluminescence glass dosimetry system -OSLD.	15

Books for Study and Reference

1. Radiation Oncology Physics: A Handbook for teachers and students. IAEA publications, 2005.
2. The Physics of Radiation Therapy - F.M. Khan, Third Edition, Lippincott Williams and Wilkins, U.S.A.,2003.

3. The Physics of Radiology - H. E. Jones, J. R. Cunningham and Charles C. Thomas, New York, 2002.

4. Fundamental Physics of Radiology - W. J. Meredith and J. B. Massey, John Wrightand Sons, U. K., 2000.

5. Medical Radiation Physics - W. R. Handee, Year Book Medical Publishers Inc.,London, 2003.

6. Principles of Radiological Physics - Donald T. Graham, Paul J. Cloke, Churchill Livingstone, 2003.

SKILL BASED COURSES

DESIGN AND FABRICATION OF ELECTRICAL ENERGY STORAGE DEVICES

COURSE CODE: 22PGSBC01 **HOURS:15**

MAXIMUM MARKS: 50 **CREDITS: 2**

COURSE OBJECTIVES:

- To explore the generation, operation and planning of the electricity systems including concepts. of electricity utility and competition in electricity generation and supply.
- To comprehend the different energy storage technologies which are currently available.

COURSE OUTCOME: After completion of this course, the students will be able to

CO1	Interpret the significance of electricity and renewable sources.
CO2	Determine the performance factors of various energy storage systems.

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	M	L	H	H	M
CO2	L	H	M	L	H

Syllabus

Unit	Title	Intended learning Chapters (K1, K2, K3, K4, K5, K6)	Hours ofInstruction
I	Electrical Energy Storage Technologies	Characteristics of electricity, Electricity and the roles of EES-More renewable energy, less fossil fuel, Smart Grid uses, the roles of electrical energy storage technologies, the roles from the viewpoint of a utility, the roles from the viewpoint of consumers, the roles from the viewpoint of generators of renewable energy.	7
II	Energy Storage Systems	Classification of EES systems, Mechanical storage systems, Pumped hydro storage (PHS), Flywheel energy storage (FES), electrochemical storage systems, Secondary batteries, Flow batteries, Conventional capacitors, Hydrogen (H2).	8

Books for Study and Reference

1. Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications – Detlef Stolten, Wiley, 2010.
2. Electrochemical Technologies for Energy Storage and Conversion - Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, John Wiley and Sons,2012.
3. Super capacitors - Francois Beguin and Elzbieta Frackowiak, Wiley, 2013.

PRACTICAL: DESIGN AND FABRICATION OF ELECTRICAL ENERGY STORAGE DEVICES

Hours: 15 **Maximum marks: 50**

Practical/Training: Practical training will be given on energy storage systems; after the completion of the practical training, students need to submit a brief report along with the data.

Marks will be awarded based on the performance of practical training, submission of report and knowledge gained.

C++ PROGRAMMING

COURSE CODE: 22PGSBC02 **HOURS: 15**

MAXIMUM MARKS: 50 **CREDITS: 2**

COURSE OBJECTIVES:

- To implement different functions for input and output, various data types, basic operators, files and functions.
- To demonstrate basic object oriented and structured programming concepts and Computational skill.

COURSE OUTCOME: After completion of this course, the students will be able to

CO1	Understand the Basic concepts of procedure-oriented and object oriented programming.
CO2	Know the function overloading, operator overloading, overloading of unary and binary operators, Rules for operator overloading.

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	L	M	L	H	L
CO2	M	H	L	M	L

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Basic concepts of procedure and object oriented programming	Procedure Oriented Programming (POP) verses Object Oriented Programming (OOP),Basic concepts of Object Oriented Programming, Object Oriented Languages, Applications of OOP. C verses C++, Structure of C++ program, Simple C++ Program. Tokens, keywords, variables, constants, basic data types, User defined data types, type casting, operators, expressions. Control structures: Decision making statements and Loops, Scope resolution operator, memory management operators. Arrays, Strings and Structures in C++.	8
II	Object oriented programming	Introduction to Inheritance, defining a derived class, visibility modes and effects. Types of Inheritance: Single, multilevel, multiple, hierarchical, hybrid Virtual base class, abstract class, constructors in derived class. Concepts of Pointer: Pointer	7

		declaration, Pointer operator, address operator, Pointer arithmetic. Pointer to Object: Pointer to Object, this pointer, Pointer to derived class. Introduction of Polymorphism, Types of Polymorphism. Compile time Polymorphism: Function overloading, operator overloading, overloading of unary and binary operators, Rules for operator overloading. Run time polymorphism: Virtual functions, rules for virtual functions, pure virtual function.	

Books for Study and References

1. Object Oriented Programming with C++ - E. Balagurusamy, Fifth edition, Tata McGraw Education Hill, 2011.
2. Object oriented Programming with ANSI &Turbo C++ - Ashok N. Kamthane, First Edition, Pearson India, 2006.
3. Object Oriented Programming in Turbo C++ - Robert Lafore, First Edition, Galgotia Publications, 1992.
4. Programming with C++ - D. Ravichandran, Second edition, Tata McGraw- Hill, 2017.

PRACTICAL: C++ Programming

Hours: 15 **Maximum marks: 50**

Practical: Computational C++ programming

1. To find the root of algebraic equation using the Newton-Raphson method.
2. To find the solution of first order differential equations using Runge-Kutta method.
3. Compute the C++ programming to find the solution for matrix inversion.

Marks will be awarded based on the performance of programming skill and submission of report.

JOB ORIENTED COURSES

SOLAR ENERGY SYSTEM DESIGN

COURSE CODE: 22PGJOC01 **HOURS:15**

MAXIMUM MARKS: 50 **CREDITS: 2**

COURSE OBJECTIVES:

- To study the basic concepts of Solar PV modules.
- To learn the techniques of assembling the solar cell arrays for power production**.**

COURSE OUTCOME: After completion of this course, the students will be able to

CO1	Understand the types of solar cells and their working principles.
CO2	Know-how to install the small scale solar PV system for power production.

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	**L**	**H**	**M**	**L**	**M**
CO2	**M**	**L**	**M**	**H**	**L**

Syllabus

Unit	Title	Intended learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Solar energy and Environment	World Energy Scenario and Indian Perspective, Renewable Energy Technologies, Role of Solar PV and policies in India, Basics of Electricity, Introduction to Instruments, Introduction to Solar Radiation, Optimum orientation of Solar PV modules, Solar related measuring devices, Solar PV Electricity, Introduction of Solar PV Modules, Interconnections of PV Modules, Impact of environmental parameters on module performance, Introduction to Battery technologies, Charge controller, MPPT, Solar PV inverters.	8
II	Solar PV systems	Types of Solar PV systems, Introduction to Solar PV system design, Grid Solar PV system design with DC load, Grid Solar PV system design with water pump, Example of Solar Power packs for homes/ industrial applications, Example of Solar Power packs for homes/ industrial applications, Design of Grid, Connected Solar PV systems, Wires and Cable sizing, Junction Boxes, Combiner Boxes, Fuses, etc, Solar PV system Installation, Monitoring and Trouble Shooting, Introduction to Solar lamps, Solar Products available in the market.	7

Books for Study and References

1. Photovoltaic Systems, 2nd Edition, by James P. Dunlop, ISBN 978-0-8269-1287-9. July 2009, National Joint Apprenticeship and Training Committee and American Technical Publishers: www.jimdunlopsolar.com
2. Study Guide for Photovoltaic System Installers, North American Board of Certified Energy Practitioners, Version 5.1.2, December 2011: www.nabcep.org
3. Photovoltaics Design and Installation Manual, ISBN 978-0-86571-520-2. ©2007 Solar Energy International, New Society Publishers (available in both English and Spanish): www.solarenergy.org

PRACTICAL: SOLAR ENERGY SYSTEM DESIGN

Hours: 15 **Maximum marks: 50**

Practical/Training: Practical **t**raining will be given for design, solar panel assembling, mounting and study the output. After the training, the students need to prepare a complete report on this practical training along with the data.

Marks will be awarded based on the performance of practical training, submission of report and knowledge gained.

MEDICAL INSTRUMENTATION

COURSE CODE: 22PGJOC02 **HOURS: 15**

MAXIMUM MARKS: 50 **CREDITS: 2**

COURSE OBJECTIVES:

- To make the student to understand the function of bio-electric signal recording physiological assist devices, nuclear, ultrasonic and other medical imaging systems.

COURSE OUTCOME: After completion of the course, the students will be able to

- Understand the function of bio potential based devices, physiological assist devices and medical imaging.
- Operate the medical equipment and do the measurements.

Mapping of course outcomes with programme outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5
CO1	L	H	M	L	M
CO2	M	L	H	M	L

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Bioelectric signal recording and physiological assist devices	Bioelectric Signal Recording: Fundamental biomedical instrumentation - characteristics of recording systems –electrocardiography (ECG) - Electroencephalograph (EEG)-Electromyograph (EMG) - recording units. Physiological Assist Devices: Cardiac pacemakers - natural and artificial pacemakers - pacemaker batteries - defibrillator - A. C./D. C. synchronized defibrillator - Various types of oxygenators.	8
II	Magnetic resonance and Ultrasonic image systems	Principles of NMR image systems – image reconstruction techniques – basic NMR components – biological effects of NMR imaging – advantages of NMR imaging system – diagnostic ultrasound – Physics of ultrasonic waves – medical ultrasound - basic pulse-echo apparatus – A-scan echocardiograph (M-mode) – B-scanner – real-time ultrasonic imaging systems.	7

Books for Study

1. Biomedical Instrumentation - M. Arumugam, Anuradha Publishing Co., Kumbakkonam, Tamilnadu, 2004.
2. Medicine and clinical Engineering - Jacobson and Webster, Prentice Hall of India, New Delhi, 1979.

Books for Reference

1. Handbook of Biomedical Instrumentation - R. S. Khandpur, Tata McGraw Hill, New Delhi, 1990.
2. Principles of Biomedical Instrumentation and measurement - Richad Aston, Merrill Publishing Co., London, 1990.
3. Biomedical instrumentation - Marvin D. Weiss, Chilton Book Co., 1973.
4. Biomedical Instrumentation and Measurements - Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Prentice-Hall, 1980.

PRACTICAL: MEDICAL INSTRUMENTATION

Hours: 15 **Maximum marks: 50**

Practical/Training: Students will be asked to visit the hospital for practical training to operate the medical instruments, specifically to operate the medical equipment like ECG, EEG, Ultrasound, CT-Scan and MRI. After completion of practical training the students need to submit a report on the data collected, analysis and results.

The marks will be awarded based on the report and experience gained to operate the medical equipment.

MODEL QUESTION PAPERS

Model Question Paper for Core Courses

18PGPHYC09

(For the candidates admitted from 2018-2019 onwards)

M.Sc. DEGREE EXAMINATION, DECEMBER 2020

Third Semester

Physics

QUANTUM MECHANICS-II

Time : Three hours Maximum: 75 marks

PART A - (20 x 1= 20 marks)
Answer ALL the questions

1. What is the unperturbed ground state energy (n=1) of normal helium atom?
   W_H = 13.6eV. [K2]
   (a) -26.6 eV
   (b) -54.4 eV
   (c) -74.8 eV
   (d) -27.2 eV
2. For the Anomalous Zeeman effect one of the following statements is true. [K1]
   (a) It does not include the spin
   (b) It includes spin
   (c) It is same as the normal Zeeman effect
   (d) It is applicable only for the particle has spin zero
3. The energy of unperturbed simple harmonic oscillator for the state n=1 is [K1]
   (a) $E = \frac{1}{2}\hbar\,\omega$
   (b) $E = \frac{1}{2}h\,\omega$
   (c) $E = \frac{3}{2}\hbar\,\omega$
   (d) $E = \frac{5}{2}\hbar\,\omega$
4. The variation principle states that the ground state energy for the normalized wave functions is
   (a) $< E > = E_0$ [K2]
   (b) $< E > \leq E_0$
   (c) $< E > \geq E_0$
   (d) $< E > \leq \frac{1}{2}\hbar\omega$

5. If the Hamiltonian of system is constant in time except for a very short time interval then the system may be described by [K1]
   (a) Sudden approximation
   (b) Adiabatic approximation
   (c) Time independent perturbation theory
   (d) Variation method
6. Semi-classical theory treats [K2]
   (a) The motions of the atoms are to be classical and electromagnetic field is quantized.
   (b) The motions of the atoms are quantized and electromagnetic field is classical.
   (c) Both motion of atom and electromagnetic field are quantized.
   (d) Both motions of atoms and electromagnetic field are classical.
7. The selection rules for the dipole transitions are [K1]
   (a) $\Delta m = 1, \Delta l = \pm 1$
   (b) $\Delta m = 0, \Delta l = \pm 1$
   (c) $\Delta m = 2, \Delta l = \pm 2$
   (d) $\Delta m = \pm 1, \Delta l = 1$
8. Fermi-Golden rule comprises that the transition probability is [K2]
   (a) Proportional to square of harmonic perturbing term and the density of final states.
   (b) Inversely proportional to square of harmonic perturbing term and the density of final states.
   (c) Proportional to square of harmonic perturbing term.
   (d) Equal to the $H'_{kn}\rho(E_k)$
9. Born approximation can be used in the problem of scattering where the [K2]
   (a) Potential of colliding particles are slowly varying
   (b) Scattered wave is strong in amplitudes
   (c) Scattered wave is weak in amplitudes
   (d) The potential V(r) = 0
10. The optical theorem states the relation of [K1]
    (a) $\sigma_{Total} = 4\pi\ I_m\ f(\theta)$
    (b) $\sigma_{Total} = \frac{4\pi}{k} I_m\ f(\theta)$
    (c) $\sigma_{Total} = \frac{4\pi}{\hbar k} I_m\ f(\theta)$
    (d) None of the above

11. If $\psi_k(r,\theta,\phi) = \overset{lim}{\underset{r\to\infty}{\longrightarrow}} e^{ik.r} + f(\omega)\frac{e^{ikr}}{r}$, the scattered function is [K2]

(a) $e^{ik.r}$

(b) $\frac{e^{ikr}}{r}$

(c) $f(\omega)\frac{e^{ikr}}{r}$

(d) $f(\omega)$

12. For partial wave analysis method, correct option (s) is/are [K1]

(a) Phase shift completely determine the scattering

(b) Scattering cross-section is zero when phase shift $\delta_l = 0°$

(c) Scattering cross-section is maximum when phase shift $\delta_l = 180°$

(d) Scattering cross-section is maximum when phase shift $\delta_l = 0°$

13. Klein-Gordan equation is considered not as a state equation but rather as the field equation of quanta associated with [K2]

(a) Spinless particles (b) Spin half particles

(c) Spin one particles (d) None of these

14. According to Dirac's theory, a position is [K1]

(a) an occupied state of negative energy

(b) an unoccupied state of negative energy

(c) an occupied state of positive energy

(d) an unoccupied state of negative energy

15. Which of the following is correct [K2]

(a) Trace α_i =Trace $\beta = 0$

(b) Trace $\alpha_i = 0$ but Trace $\beta \neq 0$

(c) Trace $\alpha_i \neq 0$ but Trace $\beta = 0$

(d) Trace α_i =Trace $\beta \neq 0$

16. Choose the correct option(s) for $\hat{\alpha}$and $\hat{\beta}$ matrices [K1]

(a) $\alpha_x^2 = \alpha_y^2 = \alpha_z^2 = 1$ but $\beta^2 \neq 1$

(b) $\alpha_x^2 = \alpha_y^2 = \alpha_z^2 = 1$ but $\beta^2 = 1$

(c) Eigenvalues of $\hat{\alpha}$and $\hat{\beta}$ are ± 1

(d) Trace α_i= Trace $\beta = 0$

17. Which one of the following statement is Hund's rule [K2]

(a) Electrons are described as clouds and probability

(b) Pairing of electrons in the orbitals belonging to the same subshell does not take place until each orbital belonging to that subshell has got one electron each.

(c) No two electrons can have the same quantum number

(d) In the ground state of an atom or ion, electrons fill atomic orbitals of the lowest available energy levels before occupying higher levels

18. For an atom, which one of the statement is true for Born-Oppenheimer approximation

(a) Both electrons and nuclei are stationary.

(b) Electrons are stationary and the nuclei in motion.

(c) Both electrons and nuclei are in motion.

(d) Nuclei as stationary while the electrons move around them.

19. Thomas – Fermi model assume that the [K1]

(a) atom is a statistical one in which the electrons are treated as a gas obeying Bose-Einstein statistics and the potential is slowly varying.

(b) atom is a statistical one in which the electrons are treated as a gas obeying Fermi-Dirac statistics and the potential is slowly varying.

(c) atom is not statistical one in which the electrons are treated as a gas obeying Fermi-Dirac statistics and the potential is rapidly varying.

(d) None of the above.

20. If ψ_a and ψ_b are the atomic orbitals centred on ***a*** and ***b*** respectively of hydrogen molecule ion H_2^+ and the Hamiltonian of the system is H. Their Coulomb integrals are [K2]

(a) $<\psi_a|\psi_a> = H_{aa}$ and $<\psi_b|\psi_b> = H_{bb}$

(b) $<\psi_a|H|\psi_b> = H_{ab}$ and $<\psi_b|H|\psi_a> = H_{ba}$

(c) $<\psi_a|H|\psi_a> = H_{aa}$ and $<\psi_b|H|\psi_b> = H_{bb}$

(d) $<\psi_a|\psi_b> = H_{ab}$ and $<\psi_b|\psi_a> = H_{ba}$

PART B – (3 x 5 = 15 marks)
Answer any THREE questions

21. Prove that for the ground state of hydrogen atom there is no first order Stark effect. [K3]

22. Calculate the electric dipole transition probability for an atom placed in a radiation field. [K4]

23. Using Born approximation determine the scattering cross-section for the weak scatterer and write the validity of this approximation. [K3]

24. If $\vec{\alpha}$ represents three Dirac matrices $\alpha_x, \alpha_y, \alpha_z$ and $\vec{B}$ and $\vec{C}$ are usual three dimensional vectors, then show that [K4]

$$(\vec{\alpha}.B)\ (\vec{\alpha}.C) = B.C + i\vec{\sigma}'.B \times C$$

where $\vec{\sigma}' = \begin{bmatrix} \vec{\sigma} & 0 \\ 0 & \vec{\sigma} \end{bmatrix}$ is a 4 x 4 matrix and $\vec{\sigma}$ being 2 x 2 Pauli's spin matries

25. What is LCAO approximation? List the conditions to be satisfied by the contributing atomic orbitals to generate an effective MO. [K3]

PART C – (5 x 8 = 40 marks)
Answer ALL the questions

26. (a) Give the time independent perturbation theory for the degenerate case. [K3]

Or

(b) Discuss the normal Zeeman effect and write how it differ from anomalous Zeeman effect. [K3]

27. (a) Explain the time development of states using time dependent perturbation theory and obtain the probability amplitude for the system with the perturbation in constant time. [K5]

Or

(b) Outline the semi-classical theory of radiation using time dependent perturbation and derive the expression for transition probability for absorption and emission. [K5]

28. (a) Evaluate the scattering amplitude in the Born approximation for scattering by the Yukawa potential [K4]

$$V(r) = V_0\, e^{-\alpha r}/r$$

where V_0 and α are constants. Also show that $\sigma(\theta)$ peaks in the forward direction ($\theta = 0$) except at zero energy and decreases monotonically as θ varies from 0 to π.

Or

(b) Discuss the scattering length and effective range theory for low energy scattering. [K4]

29. (a) Derive the Klein-Gordan equation and explain its significance. [K4]

Or

(b) Using Dirac's relativistic theory obtain the expression for the magnetic moment of electron. [K6]

30. (a) Discuss the Hartree-Fock method. [K4]

Or

(b) Using molecular orbital theory derive possible molecular orbital energies of the hydrogen molecule ion. [K6]

<u>Model Question Paper for Elective Courses</u>

18PGPHYE01

(For the candidates admitted from 2018-2019 onwards)

M.Sc. DEGREE EXAMINATION, MARCH 2021

First Semester

Physics

NANOSCIENCE

Time: Three hours | Maximum: 75 Marks

PART - A (20 x 1 = 20 marks)
Answer ALL questions

1. The limit of resolution of a microscope is given by [K2]
   (a) Wavelength of radiation (b) Magnifying power of eyepiece
   (c) Size of aperture (d) Polarization of radiation
2. Quantum confinement results in [K1]
   (a) Energy gap in semiconductor is proportional to the inverse of the square root of size
   (b) Energy gap in semiconductor is proportional to the inverse of the size
   (c) Energy gap in semiconductor is proportional to the square of size
   (d) Energy gap in semiconductor is proportional to the inverse of the square of size
3. Which ratio decides the efficiency of nanosubstances? [K2]
   (a) Weight/volume (b) Surface area/volume
   (c) Volume/weight (d) Pressure/volume
4. The density of states for a zero dimensional system shows the variation like that of a [K1]
   (a) δ-function (b) Exponential function
   (c) Step like behavior (d) Constant
5. Name the components in an amphiphile. [K2]
   (a) hydrophilic tail
   (b) hydrophobic head
   (c) hydrophilic tail and hydrophobic head
   (d) hydrophilic head and hydrophobic tail
6. Ceramics can conduct [K2]
   (a) heat (b) electricity (c) light (d) none of these
7. Reverse micelles are [K1]
   (a) Water-in-Oil (b) Oil-in-water (c) Oil+Polymer (d) None
8. What is the appropriate name of zero dimensional cadmium sulfide? [K1]
   (a) Ceramic (b) Nanomembrane (c) Quantum dot (d) Quantum well

9. Choose the type of nanomaterials that is easy to magnetize and demagnetize while exposed to external magnetic field? [K2]

(a) Hard magnet (b) Soft magnet

(c) Ferromagnets (d) All of the above

10. Which of the following magnetic material contains single domain particles? [K2]

(a) Superparamagnetic (b) Hard magnetic

(c) Diamagnetic (d) Ferrimagnetic

11. Coercivity of super paramagnetic material is [K1]

(a) ≥ 100 Oe (b) 0 Oe (c) < 10 Oe (d) $>$ 10 Oe

12. The nano particles from iron and palladium are used to produce [K2]

(a) Magnets (b) Magnetic lens

(c) Magnetometers (d) Magnetic storage devices

13. Which one of the following properties of nanoscale materials is suitable for catalytic applications? [K2]

(a) High surface to volume ratio (b) High mechanical strength

(c) Super plasticity (d) All of the above

14. The extensively used nanoparticles as catalyst is [K1]

(a) Silver (b) Copper (c) Gold (d) Cerium

15. According to _______ model specific heat of solids at low temperature is proportional to the third power of absolute temperature. [K1]

(a) Dulong-petit (b) Debye (c) Einstein (d) Sommerfield

16. The quantity of heat required to change the unit mass of a solid substance, from solid state to liquid state, while the temperature remains constant is known as [K1]

(a) Latent heat (b) Sublimation

(c) Hoar frost (d) Latent heat of fusion

17. Band gap engineered quantum devices are made-up of [K2]

(a) III-V semiconductors (b) II-VI semiconductors

(c) transition metals (d) magnetic nanoparticles

18. Molecular electronics operates in the quantum realm of distance [K2]

(a) ~100 nm (b) ~ 100 m (c) ~1000 nm (d) ~1 m

19. Select the correct name of electron-hole pair from the given list? [K1]

(a) Photon (b) Phonon (c) Exciton (d) Fermion

20. Carbon nanotube is a [K1]

(a) Conductor (b) Insulator

(c) Semiconductor (d) Impure metal

PART - B (3 x 5 = 15 marks)
Answer any THREE questions

21. What is single electron tunneling? Explain. [K3]
22. Explain the bonding and defects in ceramics. [K4]
23. Interpret the magnetic components inserted in semiconductor nanoscale solids. [K3]
24. Explain how the specific heat of a compound varies at nanoscale level. [K4]
25. Explain in detail about nanobots. [K3]

PART - C (5 x 8 = 40 marks)
Answer ALL questions

26. (a) How does the three dimensional (3D) density of states differs from the two dimensional (2D) and one dimensional (1D) density of states? Explain with the help of schematic and plots. [K5]

Or

(b) Explain in detail the electrical conductivity of palladium nanocluster. [K4]

27. (a) List out the physical, chemical and mechanical properties of ceramics. [K4]

Or

(b) Briefly explain the synthesis of cadmium telluride nano crystals. [K5]

28. (a) Give a detailed account of diluted magnetic semiconductor. [K6]

Or

(b) What are single domain particles? Give the salient features of single domain particles. [K5[

29. (a) Explain the melting temperature of nanomaterials in terms of thermodynamic predictions and atomic vibrations. [K5]

Or

(b) Discuss about the various nanostructured adsorbents. [K5]

30. (a) Discuss the applications of nanotechnology in photoelectrochemical cells. [K6]

Or

(b) Explain the various applications of nanomaterials as colorants and pigments. [K6]

Model Question Paper for Supportive Courses

18PGPHYS01

(For the candidates admitted from 2019-2020 onwards)

M.Sc. and M.Tech DEGREE EXAMINATION, DECEMBER 2020.

Third Semester

Physics

ELECTRONICS IN DAILY LIFE

Time: Three hours Maximum: 75 marks

PART A – (20 x 1= 20 marks)
Answer ALL the questions

1. Electricity is measured through a device called as [K1]
   (a) Ammeters (b) Voltmeters
   (c) Barometers (d) Anemometers
2. A suitable constant flow of electricity can be ensured through [K2]
   (a) an ammeter (b) a rheostat
   (c) a voltmeter (d) a galvanometer
3. Conventionally, negative terminals are shown as [K1]
   (a) a long thin line (b) a short fat line
   (c) a long wavy line (d) a short wavy line
4. A straight line symbol indicates the [K2]
   (a) Fuse (b) Diode
   (c) Connecting lead (d) Switch
5. Which of the following refrigerant is widely used in domestic refrigeration? [K2]
   (a) Oxygen (b) Ammonia (c) Neon (d) Alcohol
6. In a refrigerator, the lowest temperature occur at [K2]
   (a) Condenser (b) Compressor
   (c) Evaporator (d) Expansion valve
7. In a electric iron, the transfer of heat from coil to base plate is mainly through [K1]
   (a) Conduction (b) Convection (c) Radiation (d) Induction

8. The heating element in an electric iron is usually made of [K1]

(a) Brass (b)Iron (c) Nichrome (d) Platinum

9. Which material can be used upto a temperature of 130 °C? [K2]

(a) Mica (b) Cotton (c) Synthetic resin (d) Paper

10. Which alloy is used as electrical resistance alloy? [K1]

(a) Nickel alloys (b) Nickel chromium alloys

(b) Ferro nickel alloys (d) Zinc nickel alloys

11. Which among these is the application of universal motors? [K2]

(a) Vacuum cleaners (b) Fans

(c) Hair dryers (d) Washing machines

12. The different types of analog recorders are [K1]

(a) Graphic recorders (b) Oscillographic recorders

(c) Magnetic tape recorders (d) Compact disc recorders

13. In an optical fiber, the concept of numerical aperture is applicable in describing the ability of [K2]

(a) Light Collection (b) Light Scattering

(c) Light Dispersion (d) Light Polarization

14. In an optical fiber communication system, which among the following is not a typical transmitter function? [K2]

(a) Coding for error protection (b) Decoding of input data

(c) Electrical to optical conversion (d) Recoding to match output standard

15. The basic principle involved in light transmission through a fiber optic link is [K2]

(a) Total internal reflection (b) Polarization

(c) Diffraction (d) Refraction

16. The band of light wavelengths that are too long to be seen by the human eye [K1]

(a) Amber (b) Visible (c) Infrared (d) Ultraviolet

17. Probability of the event that might occur X Severity of the event if it occurs [K1]

(a) Accident (b) Hazard (c) Risk (d) Stroke

18. For household wiring and small units, the following should be used for safety measure [K1]

(a) MCB (b) ACB (c) OCB (d) MCCB

19. Which of the following colour is used for radiation hazard? [K2]

(a) Red (b) Orange (c) Green (d) Purple

20. Decibel (db) is a unit used to measure [K1]

(a) Light (b) Sound (c) Frequency (d) Heat

PART B – (3 x 5= 15 marks)
Answer any THREE questions

21. What is an integrated chip and give its advantages. [K3]

22. Draw a diagram of electrical switch board and describe its components. [K3]

23. Elucidate the function of transmitter and receiver in radios. [K4]

24. Illustrate and explain the basic principles of fibre-optic communication. [K4]

25. Describe potential accidents and hazards associated with the following equipment

(a) Portable generators (b) Battery charges [K3]

PART C – (5 x 8= 40 marks)
Answer ALL the questions

26. (a) What is resistor? Explain the circuit diagram with serial and parallel connections of resistors. [K3]

Or

(b) What is fuse wire? Discuss its types and significance in electrical appliances. [K3]

27. (a) Explain two phase and three phase electrical connections. [K4]

Or

(b) Elucidate the construction and working of electrical generators. [K4]

28. (a) With a neat diagram, explain the local area network and wide area network. [K5]

Or

(b) Write a brief account on input and output devices of computers. [K4]

29. (a) What a brief account of optical fibre? Explain the construction and working principle of optical communication. [K5]

Or

(b) Describe the single-mode and multi-mode fibre optical communication. [K4]

30. (a) Explain the function of electrical safety devices, fuse, circuit breakers and ground fault circuit interrupters. [K6]

Or

(b) Write the safety rules to be followed while handling the electrical appliances. [K3]

INSTRUCTION TO PREPARE THE QUESTION PAPERS

Instruction to Prepare the Question papers

Question Paper Pattern (Theory)

PART	Approaches	Mark Pattern	K Level
A	One word (Answer all questions)	(20 x 1 = 20 (Multiple choice questions)	K1 & K2
B	100 to 200 words (Answer any three out of five questions)	3 x 5 = 15 (Analytical type questions)	K3 & K4
B	500 to 1000 words	5 x 8 = 40 (Essay type questions)	K4, K5 & K6

Core courses

- PART A: Four questions from each unit and among all questions at least five questions must be problem.
- PART B: One question from each unit. In this section, among all questions at least two questions must be Problem and other questions are analytical type.
- PART C: Two questions from each unit. In this section, among all questions at least one question must be a problem, the remaining questions are descriptive.

Elective courses

- PART A: Four questions from each unit, all are objective type.
- PART B: One question from each unit, all are analytical type.
- PART C: Two questions from each unit, all are descriptive type.

Supportive courses

- PART A: Four questions from each unit, all are objective type.
- PART B: One question from each unit, all are analytical type questions.
- PART C: Two questions from each unit, all are descriptive type questions.