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 2021-2022 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 practical have 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: *Abilit* 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, formulate 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 Centres 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	60/Course	1200	48
Practical (4-Practicals)	4	48/Practical	400	16
Elective Courses (3-papers)	3	48/Course	300	12
Supportive Courses (2-papers)	2	36/Course	200	6
Research/Project (1)	1	72	200	8
Online Courses	-	-	-	-
Total	22	264	2300	90
Self-Learning Credit Courses				
Online Courses (MOOC courses: NPTEL/Coursera/ Swayam) [Mandatory]	1	Self-Learning	100	2
Elective Foundation Courses: Value added courses (Mandatory)	2	Self - Learning	100 (2x50)	4
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	5	-	400	10

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	21PGPHYC01	Core-1 : Mathematical Physics-I	4	6	25	75	100
	21PGPHYC02	Core-2 : Classical Mechanics	4	6	25	75	100
	21PGPHYC03	Core-3 : Electronics	4	6	25	75	100
	21PGPHYE__	Elective-I:	4	5	25	75	100
	21PGPHYC04	Core-4 : Practical-I : General Physics	4	6	40	60	100
		Total	**20**	**29**	**-**	**-**	**500**
II	21PGPHYC05	Core-5 : Mathematical Physics-II	4	5	25	75	100
	21PGPHYC06	Core-6 : Quantum Mechanics-I	4	6	25	75	100
	21PGPHYC07	Core-7 : Thermodynamics and Statistical Mechanics	4	5	25	75	100
	21PGPHYE__	Elective-II:	4	5	25	75	100
	21PGPHYC08	Core-8 : Practical-II : Electronics	4	6	40	60	100
	21PGPHYS__	Supportive course-I:	3	3	25	75	100
		Total	**23**	**30**	**-**	**-**	**600**
III	21PGPHYC09	Core-9 : Quantum Mechanics-II	4	6	25	75	100
	21PGPHYC10	Core-10: Spectroscopy	4	5	25	75	100
	21PGPHYC11	Core-11 : Numerical Methods and Fortran Programming	4	5	25	75	100
	21PGPHYE__	Elective-III:	4	5	25	75	100
	21PGPHYS__	Supportive course-II:	3	3	25	75	100
	21PGPHYC12	Core-12 : Practical-III : Microprocessors and Microcontroller	4	6	40	60	100
		Total	**23**	**30**	**-**	**-**	**600**
IV	21PGPHYC13	Core-13 : Electromagnetic Theory	4	5	25	75	100
	21PGPHYC14	Core-14 : Condensed Matter Physics	4	5	25	75	100
	21PGPHYC15	Core-15 : Nuclear and Elementary Particle Physics	4	5	25	75	100
	21PGPHYC16	Core-16 : Practical-IV: Computational Programming and Simulation	4	6	40	60	100
	21PGPHYC17	Core-17 : Project Work	8	9	-	-	200
		Total	**24**	**30**	**-**	**-**	**600**
		Seminar	**-**	**1**	**-**	**-**	**-**
		Total	**90**	**120**	-	-	**2300**

* Online course and Value Added courses are Mandatory.

Sem.	Add on Courses	Course Code	Credits	No. of Hours		Marks		Total Marks
				Theory	Practical	Theory	Practical	
I	Online ourses/Swayam/NPTL/ Coursera/MOOC		2	30	-	100	-	100
II	Value Added Course –I	21PGVAC01	2	30	-	50	-	50
III	Value Added Course –II	21PGVAC02	2	30	-	50	-	50
II	Skill Based Course	21PGSBC__	2	15	15	50	50	100
IV	Job Oriented Course	21PGJOC__	2	15	15	50	50	100
II	Internship (Students asked to take Internship offered by other Institution or Industry)	21PGINS01	-	15-20 days (During the Vacation only)		Training Report submission		
III	Field Visit	21PGFV01	-	Minimum one day		Field Visit Report Submission		

Elective Courses	
Course code	**Title of the course**
21PGPHYE01	Nanoscience
21PGPHYE02	Microprocessors sand Microcontroller
21PGPHYE03	Modern Optics
21PGPHYE04	X-ray Crystallography
21PGPHYE05	Biophysics
21PGPHYE06	Crystal Growth and Thin film Physics
21PGPHYE07	Energy Physics
21PGPHYE08	Communication Electronics
21PGPHYE09	Physics of Earth
21PGPHYE10	Photovoltaic Science

Supportive Courses	
Course code	**Title of the course**
21PGPHYS01	Electronics in Daily Life
21PGPHYS02	Geophysics
21PGPHYS03	Molecular Biophysics
21PGPHYS04	Non-linear Optics
21PGPHYS05	Laser Physics and Applications

Value Added Courses		
Course Code	**Title of the course**	**Credits**
21PGVAC01	Powder X-ray diffraction and Analysis	2
21PGVAC02	Optical system analysis and Design	2
21PGVAC03	Biomaterials	2
21PGVAC04	Solar Physics	2
21PGVAC05	Analytical instrumental Methods	2
21PGVAC06	Radiation Physics	2

Skill based Courses		
Course Code	**Title of the course**	**Credits**
21PGSBC01	Design and Fabrication of Electrical Energy Storage Devices	2
21PGSBC02	C++ programming	2
Job Oriented courses		
21PGJOC01	Solar energy system design	2
21PGJOC02	Medical Instrumentation	2

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	21PGPHYC01	Core-1 : Mathematical Physics – I	4	6	25	75	100
	21PGPHYC02	Core-2 : Classical Mechanics	4	6	25	75	100
	21PGPHYC03	Core-3 : Electronics	4	6	25	75	100
	21PGPHYE__	Elective-I:	4	5	25	75	100
	21PGPHYC04	Core-4 : Practical-I : General Physics	4	6	40	60	100
		Total	**20**	**29**	**-**	**-**	**500**
II	21PGPHYC05	Core-5 : Mathematical Physics –II	4	5	25	75	100
	21PGPHYC06	Core-6 : Quantum Mechanics-I	4	6	25	75	100
	21PGPHYC07	Core-7 : Thermodynamics and Statistical Mechanics	4	5	25	75	100
	21PGPHYE__	Elective-II:	4	5	25	75	100
	21PGPHYC08	Core-8 : Practical-II : Electronics	4	6	40	60	100
	21PGPHYS__	Supportive course-I:	3	3	25	75	100
		Total	**23**	**30**	**-**	**-**	**600**
III	21PGPHYC09	Core -9 : Quantum Mechanics-II	4	6	25	75	100
	21PGPHYC10	Core -10: Spectroscopy	4	5	25	75	100
	21PGPHYC11	Core -11 : Numerical Methods and Fortran Programming	4	5	25	75	100
	21PGPHYE__	Elective - III :	4	5	25	75	100
	21PGPHYS__	Supportive course : II	3	3	25	75	100
	21PGPHYC12	Core -12 : Practical-III : Microprocessors and Microcontroller	4	6	40	60	100
		Total	**23**	**30**	**-**	**-**	**600**
IV	21PGPHYC13	Core -13 : Electromagnetic Theory	4	5	25	75	100
	21PGPHYC14	Core -14 : Condensed Matter Physics	4	5	25	75	100
	21PGPHYC15	Core -15 : Nuclear and Elementary Particle Physics	4	5	25	75	100
	21PGPHYC16	Core -16 : Practical-IV: Computational Programming and Simulation	4	6	40	60	100
	21PGPHYC17	Core -17 : Project Work	8	9	-	-	200
		Total	**24**	**30**	**-**	**-**	**600**
		Seminar	**-**	**1**	**-**	**-**	**-**
		Total	**90**	**120**	-	-	**2300**

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 7^{th} week, the second valuation in the 11^{th} week, third valuation in the 16^{th} week and the end – semester examination in the 19^{th} week. 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 16^{th} week for the syllabi covered between 12^{th} week and 16^{th} week.

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 course:

- 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 course:

- 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 course:

- 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 90 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 Practicals

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: 21PGPHYC01 **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 and vector spaces	Concept of gradient, divergence and curl - Gauss's divergence theorem, Green's theorem and Stoke's theorem (statement and proof) - Orthogonal curvilinear coordinates - Expression for gradient, divergence, curl and Laplacian in cylindrical and spherical co-ordinates (Theory). Linearly dependent and independent sets of vectors - Inner product (problems)-Schmidt's orthogonalization process.	15
II	Matrices	Types of Matrices and their properties, Rank of a Matrix, Eigenvalue Equations and their solutions, Theorems on Matrices; Diagonalisation and Diagonalisation of different matrices; Cayley-Hamilton's theorem; Problems.	15
III	Tensor analysis	Definition of Tensors – Contravariant, covariant and mixed tensors – addition and subtraction of Tensors – Summation convention- Symmetry and Anti-symmetry Tensor – Contraction and direct product – Quotient rule- Pseudo tensors, Levi-Civita Symbol - Dual tensors, irreducible tensors-Metric tensors-Christoffel symbols – Geodesics.	15
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.	15
V	Group theory	Definition - 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).	15

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, Binomial, Poisson and Normal distributions

Books for Study

1. Mathematical Physics - Satya Prakash, Sultan Chand & Sons; Sixth Edition, 2014.
2. Mathematical methods for Physicists - George Arfken Hans, Weber Frank 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, 20^{th} 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., 3^{rd} 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, 3^{rd} Edition, 1995.

CLASSICAL MECHANICS

COURSE CODE: 21PGPHYC02 **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 to have the knowledge of small oscillations.
- To understand rigid body dynamics and to study the Euler equations.
- To obtain the knowledge about central force field and the theory of relativity.

COURSE OUTCOME: After completion of the course the student will be 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 using Euler equation
CO5	Understand and solve the central force field problems and the 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	L	L
CO3	H	H	L	L	L
CO4	H	M	L	L	L
CO5	H	M	L	L	L

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Lagrangian Formulation	Lagrangian formulation: System of particles-constraints an degrees of freedom -generalized coordinates, force and energy-conservation laws-conservations of linear and angular- momenta-symmetric properties-homogeneity and isotropy-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.	17
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-Legendre transformation and Hamilton's equation of motion. Cyclic coordinates and conservation theorem-Canonical transformations-Hamilton's canonical equations - Generating functions-Examples-Poisson brackets and its properties.	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. Eigen value equation-Normal coordinates-Normal frequencies of vibration-vibrations of linear triatomic molecule.	15
IV	Kinematics of Rigid Body	Independent coordinates of rigid body-orthogonal transformation-properties of transformation matrix-Euler angle and Euler's theorem-infinitesimal rotation-Coriolis force-angular momentum and kinetic energy of motion about a point-moment of inertia tensor-Non-inertial frames and pseudo forces-Euler's equations of motion-torque free motion of a rigid body-heavy symmetrical top.	15
V	Central Force Problem and Theory of Relativity	Reduction to the equivalent one body problem-Centre of mass-Equation of motion and first integral-classification of orbits - Kepler problem: Inverse-Square law of force-Scattering in a central force field - transformation of scattering to laboratory coordinates. Orbits of artificial satellites, Virial theorem – Lorentz transformation, Relativistic Mechanics, Relativistic Lagrangian and Hamiltonian for a particle, Space time and energy – Momentum vectors.	17

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. Poole and 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. ISBN: 9781292026558

Books for Reference

1. Classical Mechanics - S. L. Gutpa, V. Kumar and 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 McGraw Hill, New Delhi, 2015.
4. Classical Mechanics - J. C. Upadhaya, Himalaya Publishing House Pvt. Ltd, Bangalore, Second edition, 2017.
5. Classical Mechanics - B.D.Gupta and Satya Prakash, Keder Nath Publishers, Meerut, Revised Edition, 2015.
6. Introduction to Classical Mechanics - R.G.Takwale and P.S.Puranik, Tata Mc Graw Hill, New Delhi, 1989.

ELECTRONICS

COURSE CODE: 21PGPHYC03 **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 of

CO1	Gets an insight about the diode characteristic with linear models.
CO2	Understands 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, analyse and evaluate physical operation of operational amplifier and learns its real world application.
CO4	Demonstrates the ability to understand semiconductor fundamentals and its corresponding application as memory elements.
CO5	Develops an ability to analyse and design 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	Introduction to Semiconductor- PN Junction diode – Zener diode- Varactor Diodes- Tunnel diode- Photo diode - schottky diode – Impatt diode- LED- Photodiodes-Characteristics and Applications.	15
II	Transistor biasing and optoelectronic devices	Transistor Characteristics- Its configuration- PNP-NPN transistors - Transistor biasing and Thermal stabilization- Need for biasing- operating point- Bias stability - Hybrid model – h parameters - JFET – UJT- SCR.	15
III	Operational amplifier applications	Operational Amplifier- Performance parameters- Types of Op-Amp- General purpose Op-Amp- Instrumentation Op-Amp- Sample and Hold circuits. Applications of Op-Amp: Inverting, Non- inverting Amplifiers-circuits – Adder- Subtractor- Differentiator- Integrator-–Clipper circuits- clamper circuits- Comparator- Active filters: Low, High and Band pass	15
IV	Semiconductor memories	Classification of memories and sequential memory – Static Shift Register and Dynamic Shift Register, ROM, PROM and EPROM principle and operation Read & Write memory - Static RAM, dynamic RAM. Charge Couple Device (CCD) - Principle, Construction, Working.	15
V	Converter	Sampling theorem– DAC- Weighted resistor method – Binary Ladder network –successive approximation, A/D Conversion-types- Dual slope and Counter method – Voltage to current conversion and Current to Voltage conversion	15

Tutorial

1. Problems in Diode, Transistor, Amplifier and Optoelectronics.
2. Depletion width calculation
3. Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting,

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, 7^{th} Edition, McGraw Hill, 2007.
5. Principles of Electronics - V.K.Mehta, 6 th Revised Edition, S.Chand and Company, 2001.
6. Electronic Devices and Circuits - David A. Bell, 4^{th} Edition, Prentice Hall. 2007.

PRACTICAL-I: GENERAL PHYSICS

COURSE CODE: 21PGPHYC04 **HOURS**

L	T	P	C
0	0	6	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 to handle scientific equipment, measure and analyze the data and compare with the standard data and understand the theoretically studied concepts.
- To learn analytical techniques like XRD and FT-IR.
- To learn Zeeman effect and hydrogen spectra.

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	L	L	H
CO3	H	H	L	L	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.
5. (i) Measurement of He-Ne Laser wavelength using meter scale (ii) Diffraction and Interference experiments using Laser.
6. Measurement of numerical aperture of an optical fiber and its characteristics using optical fibers.
7. Rydburg's constant using constant deviation spectrometer.
8. Determination of refractive index of given liquid using hollow prism.
9. 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.
10. Determination of velocity of ultrasonic waves in the given liquid for a different frequency using Aqua grating method.
11. Determination of Hall coefficients and carrier type of given semiconducting material using Four-probe method.
12. Four-Probe Method - Determination of resistivity of semiconductor at different temperatures.
13. Determination of dielectric constant of given solid leachir wire method.
14. Microwave dielectric measurement of Liquids by using Waveguide Plunger Technique.
15. Study the Zeeman effect and determination the e/m of electron.
16. Determination of specific charge of electron (e/m) by Thomson's method.
17. Determination of specific charge of electron (e/m) by Millikan's oil drop method.
18. G.M Counter - Verification of inverse square law, dead time, Poisson and Gaussian distributions.

19. Susceptibility measurement by Quincke's - Paramagnetic susceptibility of specimen.
20. Susceptibility determination of solid sample by Gouy's method
21. Determination of Stefan's constant.
22. Determination of energy loss in a magnetic material of B-H Curve using Anchor ring
23. I-V Characteristics and efficiency calculation using Solar cell and determine its maximum efficiency.
24. LVDT - Characteristics curve and displacement measurement.
25. Determination of self-inductance of ac coil by Anderson's method.
26. Study temperature characteristics and determine the band gap of given thermistor.
27. Study the photoelectric effect and determination Planck's constant.
28. Study the spectrum of hydrogen atom.
29. Determination of lattice parameters and crystallite size calculation from Powder X-ray diffraction patterns of NaCl crystal.
30. Polarization analysis and identification of crystal defects using polarization microscope.
31. Solar Cell: Determination of efficiency of given solar cell using solar simulator.
32. 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; Little hampton. 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: 21PGPHYC05 **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 it's 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.	15
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.	15
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.	15
IV	Partial Differential Equations	Solution of Laplace Differential Equation - Two dimensional flow of heat in cartesian and cylindrical co-ordinates. Solution of heat flow equation in one dimension - Solution of wave equation – Transverse vibrations of a stretched string (Theory).	15
V	Integral Transforms	Fourier transforms - cosine and sine transforms - Linearity theorem - Parseval's theorem - solution of differential equation. Laplace transforms - Definition - Linearity, shifting and change of scale properties. Inverse Laplace transforms – Definition - Problems - Solution of differential equation (problems using the above methods).	15

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, Qualitative idea of Green's functions in 2- and 3- dimensions, 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, Pragati Prakashan, 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: 21PGPHYC06 **HOURS**

L	T	P	C
4	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.
- To understand the scattering theory.

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

CO1	To demonstrate 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	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	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 tunnelling- 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 eigenvalue problems	One dimensional linear harmonic oscillator-properties of stationary states-abstract operator method - Angular momentum operators- commutation relation- 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.	15
IV	Matrix formulation of quantum theory, equation of motion and Angular momentum	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. 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.	15
V	Scattering theory	Kinematics of scattering process - wave mechanical picture-Green's functions – Born approximation and its validity –Born series – screend 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 – low energy scattering – resonant scattering – non-resonant scattering-scattering length and effective range– Ramsauer-Townsend effect – scattering by square well potential.	15

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 , JohnWiley 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: 21PGPHYC07 **HOURS**

L	T	P	C
4	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	15
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.	15
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	15

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-partician 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, 20^{th} Edition, Pragati Prakashan, Meerut, 2003.
7. Statistical Mechanics - B.K.Agarwal and M.Eisner, Second Edition, New Age International Private Limited, Delhi, 2016.

PRACTICAL – II: ELECTRONICS

COURSE CODE: 21PGPHYC08 **HOURS**

L	T	P	C
0	0	6	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. JFET – Characteristics and Design of amplifier.
2. UJT- Characteristics & Design of Relaxation Oscillator
3. Design of square wave generator (Astable) using IC741 and 555 timers
4. Design of monostable multivibrator using IC 741 and 555 timers
5. Design of Schmidt's trigger using IC 741 and 555 timers
6. Phase locked loop using IC556.
7. Design and Study of Phase shift Oscillator
8. Photo Transistor characteristic
9. Photo Diode characteristic
10. Binary addition and subtraction (4 bits)- 7483 IC
11. Study of multiplexer and Demultiplexer
12. Study of Encoders and Decoders
13. Study of Flip Flops using IC 7400
14. Design of Counters and shift Registers using 7476/7473 IC
15. BCD Counters – Seven Segment display
16. Design of R/2R ladder and Binary weighted method of DAC using 741 IC
17. Construction of ADC using DAC Comparator.
18. Study of Modulation and Demodulation.
19. Arithmetic Operations using Op- amp IC 741 (Addition, Subtraction, Multiplication & Division)
20. Printed Circuit Board – Designing and testing.
21. Study of TV trainer Kit – Demonstration.
22. Design of Active filters (Low pass, High pass and Band pass filters)
23. Solving Simultaneous equations using Op- amp.
24. Analog Computer circuit design – solving simultaneous equation.
25. Computer assembling and testing

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: 21PGPHYC09 **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	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	Approximation methods for time independent problems	Time independent perturbation theory – stationary theory- Non-degenerate case: first and second order-Normal Helium atom– Zeeman effect without electron spin – Stark effect in hydrogen molecule - Degenerate case: Energy correction- Stark effect in hydrogen atom.	15
II	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: Application of the time dependent perturbation theory to semi-classical theory of radiation – Einstein's coefficients – absorption - induced emission- spontaneous emission – Einstein's transition probabilities- dipole transition - selection rules – forbidden transitions	15
III	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 for penetration barrier – Bohr-Summer field quantization condition- tunnelling through a potential barrier.	15
IV	Relativistic quantum mechanics and quantization of the field	Schrodinger relativistic equation- Klein-Gordan equation-charge and current densities – interaction with electromagnetic field- Hydrogen like atom – nonrelativistic limit- Dirac relativistic equation: Dirac relativistic Hamiltonian – probability density- Dirac matrices-plane wave solution – eigen spectrum – spin of Dirac particle – significance of negative eigen states – electron in a magnetic field – spin magnetic moment. Quantization of the Field : Quantization of wave fields- Classical Lagrangian equation- Classical Hamiltonian equation- Field quantization of the non-relativistics Schrodinger equation- Creation, destruction and number operators- Anti-commutation relations- Quantization of Electromagnetic field energy and momentum.	15
V	Quantum theory of atomic and molecular systems	Central field approximation: Residual electrostatic interaction-spin-orbit interaction- Determination of central field: Thomas Fermi statistical method-Hartree and Hartree-Fock approximations (self consistent fields) – Atomic structure and Hund's rule. Molecules: Born-Oppenheimer approximation – An application: the hydrogen molecule Ion (H_2^+)-Molecular orbital theory: LCAO- hydrogen molecule.	15

Books for Study

1. A Text book of Quantum Mechanics - P. M. Mathews and K. Venkatesan, Tata McGraw – 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: 21PGPHYC10 **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 spectroscopy.

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

CO1	Gets an insight about the basic quantum description of electronic 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

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Electronic Spectroscopy	Quantum states of an atom - electronic wave functions – shape of atomic orbitals - atomic quantum numbers – hydrogen atom spectrum – relativistic corrections of energy levels - spectrum of lithium and helium atoms – LS and JJ couplings – selection rules - hyperfine structure – isotopic shift – width of spectral lines - Zeeman effect – Paschen-Back effect – Stark effect - Electronic spectra of diatomic molecules – Born- Oppenheimer approximation – vibrational course structure – Frank- Condon principle	15
II	Infrared Spectroscopy	Vibrational energy of a diatomic molecule- Infrared selection rules-Vibrating diatomic molecule-Diatomic vibrating rotator-Vibrations of polyatomic molecules-Fermi resonance-Rotation vibration spectra of polyatomic molecules-Normal modes of vibration in crystal-Interpretation of vibrational spectra-Group frequencies-IR spectrophotometer-Instrumentation-Sample handling techniques-Fourier Transform Infrared spectroscopy-Applications	15
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-Raman investigation of phase transitions-Resonance Raman scattering-Nonlinear Raman phenomena-Preliminaries-Hyper Raman effect-Stimulated Raman scattering-Inverse Raman effect-Coherent Anti-Stokes Raman scattering.	15
IV	Nuclear Magnetic and Electron Spin Resonance Spectroscopy	Basic principles – Quantum theory of NMR - magnetic resonance – relaxation processes – chemical shifts – spin-spin coupling - Spectra and molecular structure – Fourier Transform NMR –Instrumentation – Applications. Basic principles – Quantum theory - g-factor – Nuclear Interaction and Hyperfine structure – Relaxation effects - Hyperfine interaction – line widths – ESR spectrometer – Instrumentation – applications.	15
V	Nuclear Quadrupole Resonance and Mossbauer Spectroscopy	Basic theory - Nuclear Electric quadrupole interaction – Energy levels – Transition frequency – Excitation and Detection – Effect of magnetic field – Instrumentation – applications. Mossbauer effect - recoilless emission and absorption - hyperfine interaction - chemical isomer shift - magnetic hyperfine and electric quadruple interactions – ` Instrumentation – applications.	15

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, 32nd 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.

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.
4. Elements of Spectroscopy: Atomic, Molecular and Laser - S.L.Gupta, V.Kumar and R.C.Sharma, Pragati Prakashan Educational Publishers, 2016.
5. Molecular Spectroscopy- J.D. Graybeal - McGraw-Hill, New York, 1988.
6. Modern Spectroscopy - Hollas, Michael, (Fourth Edition) John Wiley, New York, 2004.

NUMERICAL METHODS AND FORTRAN PROGRAMMING

COURSE CODE: 21PGPHYC11 **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	Errors and Root of Algebraic Equations	Errors – Different Types of Errors- Errors of observation and measurement -Empirical formula -Graphical method – Method of averages – Least square fitting – curve fitting - parabola, exponential- Errors and their Computation. 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.	15
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- Boole's rule, Waddle's rule.	15
III	Interpolation	Linear interpolation - Lagrange interpolation Gregory - Newton forward and backward interpolation formula - Central difference interpolation formula - Gauss forward and backward interpolation formula -Divided differences - Properties - Newton's interpolation formula for unequal intervals- Hermite's Interpolation. Extrapolation: Richardson's extrapolation, solving numerical problem	15
IV	Numerical Solutions Of Ordinary Differential Equations	Nth order ordinary differential equations – Power series approximation – Pointwise method – 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- Predictor Corrector Methods.	15
V	Fortran Programming	Flow charts, Algorithms, Integer and floating point arithmetic, Precision, Variable types, Arithmetic statements, Input and output statements, Control statements, Executable and non-executable statements, Arrays, Repetitive and logical structures, Subroutines and functions, Operation with files, Operating systems, Creation of executable programs.	15

Tutorial

General formula for errors, Least square fitting, curve fitting, parabola, exponential, The method of false position, Newton-Raphson method, Convergence and rate of convergence, Gauss elimination method, Jordon's modification, Gauss-Seidel method, Interpolation, 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.

PRACTICAL III: Microprocessors and Microcontroller

COURSE CODE: 21PGPHYC12 **HOURS**

L	T	P	C
0	**0**	**6**	**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.
- 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 an 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. Decimal counter with specified time interval (n to 0 and 0 to n).
7. Display and roll of a message.
8. Solving simple expressions.
9. Square and square root of the given number.
10. Sum of the “n” numbers.
11. Stepper motor interfacing.
12. Temperature controller measurements (Digital thermometer).
13. ADC and DAC interfacing (analogue to digital and vice versa).
14. Traffic light Controller.
15. Arithmetic operations using 8086 microprocessors.
16. Find the number of occurrence of a character in the sentence.
17. Wave generation using interface of 8255A.

Microcontroller 8051

18. Arithmetic operations- 8 bit.
19. Solving simple expressions.
20. Array operations (Biggest and Smallest number).
21. Square and square root of the given number.
22. Stepper motor interfacing.
23. Seven segment display interfacing.
24. Seven segment display interfacing.
25. ADC interfacing.

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

COURSE CODE: 21PGPHYC13 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

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 understand the application of electromagnetic waves.

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

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 application of electromagnetic waves.

Mapping of the course outcomes with programme outcome:

Course outcome	PO1	PO2	PO3	PO4	PO5
CO1	H	H	L	L	H
CO2	M	H	L	L	H
CO3	H	M	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	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.	15
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.	15
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	Boundary conditions at the surface of discontinuity – Reflection and refraction of E.M waves at the interface of non – Conducting media – Kinematic and dynamic properties – Fresnel's equation – Electric field vector 'E' parallel to the plane of incidence and perpendicular to the plane of incidence – Reflection and transmission co-efficients at the interface between two non–Conducting media – Brewster's law and degree of polarization – Total internal reflection.	15

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, 4^{th} Edition, Pearson.
2. Electromagnetic Theory and Electrodynamics - SathyaPrakash, KedarNath RamNath 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.
4. Electromagnetics , B.B Laud, Wiley Eastern Company, 2000.

CONDENSED MATTER PHYSICS

COURSE CODE: 21PGPHYC14 **HOURS**

L	T	P	C
4	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 will be 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

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Crystal Structure	Elementary concepts of crystals- Bonding of solids- 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- Laue, Powder, Rotation methods.	14
II	Lattice dynamics and Thermal properties	Theory of vibrations of monoatomic and diatomic lattices- -acoustical, optical, transverse and longitudinal modes- Phonon-Dispersion relation-Phonon quantization – Anharmonic effects-Thermal conductivity-Umklapp process-Specific heat capacity of solids-Einstein, Debye model-Drude model of thermal conductivity- -specific heat response and relaxation phenomena- Debye model.	14
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. Hall effect-construction of Fermi surfaces – Van-Alphen effect	13
IV	Dielectric and magnetic properties	Classification of polarization- macroscopic electric field- local electric field at an atom- Lorentz field- Dielectric constant and polarizability- Clausius-Mossotti relation- Ferro electric crystals- Ferro electric domains- Polarization catastrophe- Landau theory of phase transition. Langevin theory of Diamagnetism-paramagnetism-Quantum theory of paramagnetism- Curie law- Ferromagnetism-Weiss molecular field theory- Domain theory- Neel temperature- Ferrimagnetism- Ferrites- Spin waves.	17
V	Superconductivity	Occurrence of superconductivity- destruction of superconductivity by magnetic fields- Meissner effects- Type I and Type II superconductors-Heat capacity- electron-phonon interaction- Cooper pairs and BCS theory- London equation- Coherence length-penetration depth- Flux quantization in superconducting ring- duration of persistent currents- Quantum interference- Josephson effect and applications SQUIDS- High temperature superconductivity.	17

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. Introduction to Superconductivity - M. Tinkham, Tata Mcgraw Hill, New Delhi, 1996.
4. Introduction to Nanoscience and Nanotechnolog - K.K.Chattopadhyay and A.N.Banerjee, PHI Learning private Ltd., Delhi 2014.
5. Electrical Engineering Materials - A. J. Dekker, Prentice Hall of India, 1975.
6. Problems and Solutions in Solid State Physics - S.O. Pillai, New Age international Publishers, New Delhi, 1994.
7. Ferroelectrics - A.K. Bain, P. Chand, Wiley, 2017.
8. Dielectric phenomena in solids with emphasis on physical concepts of electronic processes - Kwan Chi Kao, Elsevier Academic Press, 2004
9. Intermediate Quantum Theory of Crystalline solids - Alexander O. E. Animalu, Prentice Hall of India, New Delhi, 1978.
10. The Physics of Solids – Essentials and Beyond - Eleftherios N. Economou, Springer, 2010.

NUCLEAR AND ELEMENTARY PARTICLE PHYSICS

COURSE CODE: 21PGPHYC15 **HOURS**

L	T	P	C
4	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 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	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.	15
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 – Breit -Wigner one level formula – Resonance scattering – Absorption cross section at high energy.	15
IV	Radioactive decays	Alpha decay - Beta decay –Energy release in 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 radiation – Angular momentum and parity selection rules – Internal conversion – Nuclear isomerism.	15
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 - Universal Fermi interaction – Elementary concepts of weak interactions.	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.
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. Elements of Nuclear Physics - M.L. Pandya and P.R.S Yadav, Kedar Nath Ram Nath publications, Meerut, 2016.

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 - H. Enge, Addision-Wesley Reading MA. 1975
4. Nuclear Physics - R. R. Roy and B. P. Nigam, Wiley Eastern, Madras, 1993.
5. Nuclear Physics - D.C. Tayal
6. Nuclear Structure - A. Bohr and B. R. Mottelson, Benjamin Reading, Vol. I (1969) and Vol.II (1975).

PRACTICAL IV: COMPUTATIONAL PROGRAMMING AND SIMULATION

COURSE CODE: 21PGPHYC16 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
0	0	6	4

COURSE OBJECTIVES:

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

COURSE OUTCOME: After completion of the course, the students will be 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 course outcomes with programme outcomes:

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 find 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 for matrix inversion and diagonalization.
7. Program to solve simultaneous linear algebraic equation - Gauss elimination method.
8. Program to solve simultaneous linear algebraic equation - Gauss-Seidel iteration method.
9. Program to integrate any function or tabulated data using trapezoidal rule.
10. Program to integrate any function or tabulated data using Simpson‟s rule.
11. Program to compute the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method.
12. Least-Square curve fitting - Straight line fit.
13. Least-Square curve fitting - Exponential fit.
14. Roots of algebraic equations – Newton-Raphson method.
15. Program to find the sum of the series for a given small „x‟ correct to four decimal places
16. Interpolation – Lagrange method.
17. Numerical differentiation – Euler method.
18. Evaluation of definite integrals – Monte Carlo method.
19. Uniform random number generation – Park and Miller method.
20. Uniform random number generation – Box and Muller method.
21. Numerical simulation of wave functions of simple harmonic oscillator.
22. Computer simulation of Kroning-Penney model.
23. Computer simulation of Leneard-Jones potential, binding parameters, elastic constants.
24. Computation of wave functions and their interpretation for various potentials.
25. Simulation of a wave functions for a particle in a critical box.

26. Write a program to solve heat equation – finite difference method.
27. Monte Carlo of 2D Ising model on a square lattice.

Books for Study

1. Programming and Computing with FORTRAN 77/90 - P .S. Grover, Allied Publishers, 1992.
2. Programmers's Guide to Fortran90 - Brainerd and Walter S, Springer publication, 1996.

Book 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

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 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: 21PGPHYE01 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
3	1	0	4

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 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	Interpret 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	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 – Bound states and density of states: 3D,2D, 1D and 0D – Quantum confinement - Quantum wells, wires and dots - size dependent properties-Mossbauer effect – surface Plasmon resonance – single electron tunnelling.	15
II	Synthesis of Nanomaterials	Synthesis of nano materials: Physical vapour deposition - Chemical vapour deposition plasma arching - Sol gel - Ball milling technique - Reverse miceller technique - Electro deposition. Synthesis of Semiconductors: Nanostructures fabrication by physical techniques – Nano lithography – Nanomanipulator.	15
III	Nanoparticles and Magnetism	Magnetism in particles of reduced size and dimensions – Single domain particles and super paramagnetism – magnetism in clusters of nonmagnetic solids – magnetic behavior of small particles – diluted magnetic semiconductors (DMS) – Fe – DMS and II-VI Mn DMS and their applications – intermetallic compounds – binary and ternaries and their magnetic properties. Importance of nanoscale magnetism.	10
IV	Chemical and Catalytic Aspects of Nanocrystals	Nanomaterials in Catalysis – Nanostructured Adsorbents – Nanoparticles as new Chemical reagents – Specific Heat and Melting Points of Nanocrystalline Materials: Specific Heat of Nanocrystalline materials – melting points of Nanoparticle materials.	10
V	Application of Nanomaterials	Molecular Electronics and nano electronics, nanoboats, Biological applications, band gap engineered quantum devices – nanomechanics – carbon nanotube emitters, photoelectrochemical cells – photonic crystal and Plasmon wave guides - Structural and Mechanical materials – Colorants and Pigments.	10

Books for Study

1. Nanoscale Materials in Chemistry - Kenneth J. Klabunde, A John Wiley & Sons Publication, 2009.
2. Nanoscience and Nanotechnology: Fundamentals to Frontiers - M.S.Ramachandra Rao, Shubra Singh, Wiley, First Edition, 2013.

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 - 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: 21PGPHYE02 **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 and applies it to write an assembly language programme for various real-world problems.

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 8085. Instruction classification: number of bytes, nature of operations- Instruction format. Vectored and non-vectored interrupts	15
II	8085 Assembly Language Programming	Instruction set: Data transfer operations - Arithmetic operations Logical operations – Branching and machine control operations. Addressing modes. Writing assembly language programs: Sum of N numbers, Arithmatic opearation.	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. Interrupts: Hardware interrupts – Software interrupts. Simple programs	15
IV	Microcontroller 8051 Architecture And Programming	Introduction to microcontroller. Difference between microprocessor and microcontroller. 8051 microcontroller: Pin configuration, Architecture and Key features. 8051. 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 - 8255 Programmable Peripheral Interface (PPI) – 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.	15

Tutorials

Basic programs from Microprocessor and Microcontroller.

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, II Edition, 2018.

Books for Reference

1. Microprocessor Architecture, Programming and Applications with 8085/8080 - Ramesh S. Gaonkar, New Age International 6^{th} 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: 21PGPHYE03 **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 OUTCOME: After completion of the course, the student will be capable 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	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 - Harmonic waves - phase velocity - group velocity - energy flow - Wave motion - equation - superposition of waves - interference - diffraction - basics of coherence theory - Dispersion, Optical anisotropy, birefringence - Scattering and polarization. Polaritons and polarons	18
II	Excitons	Basic concept, free excitons in external electric and magnetic fields, Free Excitions at light densities, frenkel excitons. Luminescence: Light emission in solids, Interband luminescence, Direct and indirect gap materials, photoluminescence: Excitation and relaxation, degeneracy, Electroluminescence: General Principles of electroluminescence.	16
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- Raman scattering.	15
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.	15
V	Optical microscopy and 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.	16

Tutorial

Phase and group velocity – interference – diffraction – Birefringence - aplanatic points - numerical aperture increasing lens -Thickness function - Fourier transform - second order non-linear optics - phase matching - frequency conversion - parametric oscillator - Spatial frequency filtering.

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 China - 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 V Papoyan; Erevani Petakan Hamalsaran, World Scientific Pub. Co., 2010.
4. A text book of Optics - N.Subramaniyam, Brijlal and M.N.Avadhanulu, S.Chand & Co., New Delhi, 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

X-RAY CRYSTALLOGRAPHY

COURSE CODE: 21PGPHYE04 **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 analyse 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.	15
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.	15
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.	15

Books for Study and Reference

1. X-ray Structure Determination – G.H. Stout and L.H.Jensen, John Wiley Publications, Second Edition, 1989.

2. Fundamentals of Crystallography - C. Giacovazzo, Oxford Press, Second Edition, 2011.
3. Structure Determination by X-ray Crystallography - Ladd and Palmer, Plenum Publishing Corporation, Second Edition, 2013.
4. X-ray Crystallography - Woolfson, Cambridge University Press Publications. Second Edition, 1997.
5. Elements of X-ray Crystallography - Leonid V. Azaroff, , McGraw Hill Publications, 1968.
6. Crystal Structure analysis for Chemist and Biologist – J.P. Glusker, M. Lewis and M. Rossi, VCH Publishers Inc, 1994.
7. Crystal, X-ray and Proteins – D. Sherwood, and J. Cooper, Oxford University Press, 2010.
8. An Introduction to Crystallography – F.C. Phillips, John Wiley Publications, 1971.
9. International table for Crystallography.

BIOPHYSICS

COURSE CODE: 21PGPHYE05 **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.	15
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.	15
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.	15
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.

CRYSTAL GROWTH AND THIN FILM PHYSICS

COURSE CODE: 21PGPHYE06 **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, FTIR 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 – Energy of formation of a spherical nucleus – Statistical theory on nucleation: Equilibrium concentration of critical nuclei, Free energy of formation. Classification of crystal growth methods	16
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 – Constant temperature bath as a crystallizer.	15
III	Gel, melt and vapor growth techniques	Principle of gel technique – Structure and importance of gel – Methods of gel growth and advantages -- Melt technique – Czochralski growth – Floating zone – Bridgeman method – Flux growth – Hydrothermal growth – Vapor-phase growth – Physical vapor deposition – Chemical vapor deposition.	15
IV	Thin film deposition techniques	Vacuum evaporation - Evaporation from a source and film thickness uniformity -- E-beam, pulsed laser and ion beam evaporations - Mechanisms and yield of sputtering processes – DC, rf, magnetically enhanced, reactive sputtering – Spray pyrolysis – Electro deposition – Sol-gel technique.	15
V	Characterization Techniques	X–ray diffraction – Powder and single crystal – Fourier transform infrared analysis – Transmission– UV-Vis-NIR spectrometer – Vickers micro hardness – Basic principles and operations of AFM and STM - X-ray photoelectron spectroscopy for chemical analysis – Photoluminescence	16

Tutorial

Gibbs Thomson equations for vapour and solution – Solubility- Miers TC diagram- Physical vapor deposition- UV-vis-NIR spectrometer – Vickers micro hardness

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 - A. 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 Films - M. Ohring, Academic Press, Boston, 2002, 2nd edition.
3. Characterization of Materials - E. N. Kaufmann, Volume-I, John Wiley, New Jersey, 2012.

ENERGY PHYSICS

COURSE CODE: 21PGPHYE07 **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	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	Energy Source	Introduction to energy source - Energy sources and their availability - Types of energy - Prospects of renewable energy - Extraterrestrial solar radiation - Effect of earth's atmosphere - Measurement and estimation of solar radiation.	10
II	Renewable Energy	Environmental consequences of oil fuel use- Importance of renewable sources of energy- Sustainable Design and development- Types of renewable energy sources- Limitations of renewable energy sources sources- Present Indian and international energy scenario of conventional and renewable energy sources.	12
III	Energy From Biomass	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.	12
IV	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.	12
V	Additional Alternate Energy Sources	Introduction and principles of Magneto hydro dynamic(MHD) – open and closed cycle systems – materials for MHD generators – MHD design problems and developments – electrical conditions – advantages of MHD systems. Hydrogen Production and Storage- Fuel cel :Principle of working- various types – construction and aplications. Energy Storage System- Hybrid Energy Systems.	12

Books for Study and Reference

1. Renewable Energy Resources - John Twidell & Tony Weir, Taylor & Francis Group, 2006.
2. Principles of Solar Engineering - Kreith and Kreider, McGraw Hill Pub, 1978.
3. Applied Solar Energy - A.B.Meinel and A.P.Meinal, 1976.
4. Solar Energy - M.P.Agarwal, S.Chand & Co, 1983.
5. Solar Energy - S.P.Sukhatme, TMH, 1996.
6. Non-conventional Energy sources - G.D.Rai, Khauna Publication, 2004.

COMMUNICATION ELECTRONICS

COURSE CODE: 21PGPHYE08 **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.

Syllabus

Unit	Title	Intended Learning Chapters (K1, K2, K3, K4, K5, K6)	Hours of Instruction
I	Antennas and Wave propagation	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- Eccles & Larmor Theory-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	15
III	Radar and Television	Elements of a Radar System-Radar Equation-Radar Performance Factors-Radar Transmitting Systems- Radar Antennas-Duplexers-Radar Receivers and Indicators- Pulsed Systems-Other Radar Systems- Colour TV Transmission and Reception.	15
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 - Mathematical representation of FM - Frequency spectrum of the FM wave - Effects of noise on carrier.	15
V	Optical Fibres	Propagation of Light in an Optical Fibre-Acceptance Angle-Numerical Aperture- Step and Graded Index Fibres-Optical Fibre as a Cylindrical Wave Guide-Fibre Losses and Dispersion-Applications.	15

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, edition, 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.

PHYSICS OF EARTH

COURSE CODE: 21PGPHYE09 **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 Palaeomagnetism.

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 palaeomagnetism

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.	15
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.	15
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	15
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 palaeomagnetism	Geomagnetism and palaeomagnetism-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 palaeomagnetism - 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

COURSE CODE: 21PGPHYE10 **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.	12
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.	12
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	12
IV	Cadmium telluride solar cells	Introduction - CdTe Properties and Thin-film Fabrication Methods - Condensation/Reaction of Cd and Te_2 Vapors on a Surface- Galvanic Reduction of Cd and Te Ions at a Surface- Precursor Reaction at a Surface-Window Layers - CdTe Absorber Layer and $CdCl_2$ Treatment - CdS/CdTe Intermixing - Back Contact - Solar Cell Characterization - CdTe modules.	12
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_2 electrode - Redox Electrolyte - Counter electrode - Assembling the cell and cell performance.	12

Tutorial

Efficiency- Short circuit current, Open circuit voltage, Fill factor, Series resistance, resistance due to Ohmic contacts-Photovoltaic energy conversion - Spectral distribution of solar radiation Constants

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.

SUPPORTIVE COURSES

ELECTRONICS IN DAILY LIFE

COURSE CODE: 21PGPHYS01 **HOURS**

L	T	P	C
3	0	0	3

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 Resistors – Capacitors – Resistance wale – Capacitor wale – Electrical quantities – Electrical formulas – Magnetism – Meters – Fuse wire Transistors – Integrated chips.	7
II	Electrical appliances	Switch board – Main box – Metal circuit breakers (MCB) – AC – DC currents – Two Phase – Three Phase electrical connections – generators – un intrepid power supply (UPS)- stabilizer – voltage regulators – Electrical devices – Iron box – Fan – Electrical Oven – water Heaters Air conditioners – Refrigerators – washing machines.	8
III	Electronic home appliances	Radio – Audio taper veaulem, speaker- televisions – VCR – CD Players – DVD – calculators – Computers – scanner – Printer – Digital Camera – LCD Projectors – Display devices.	7
IV	Communication electronics	Principles of optical fiber Cables (OFC) – Telephone – Mobile phones – wireless phone - Antenna - Internet - Intranet.	7
V	Safety mechanism	Handling Electrical appliances - Power saving methods – Hazards Prevention Methods - Protection of Hi–Fi electronic devices.	7

Books for Study and Reference

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

GEOPHYSICS

COURSE CODE: 21PGPHYS02 **HOURS**

L	T	P	C
3	0	0	3

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	Origin of earth	Petrology – evolution and composition of earth – Major subdivisions of earth's Sphere – atmosphere – hydrosphere – lithosphere – Interior of earth – composition of earth crust - relative abundance of earth's crust,	7
II	Geomagnetism	Origin of earth's magnetism – elements of earth's magnetic field – inclination, declanation and dib - earth's magnetic field – diurnal, annual and secular variations – magnetosphere.	7
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	7
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.	7
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.	8

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: 21PGPHYS03 **HOURS**

L	T	P	C
3	0	0	3

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 the structure
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.	8
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.	7
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	7
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.	7
V	Memory	Hebbian learing – 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.	7

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: 21PGPHYS04 **HOURS**

L	T	P	C
3	0	0	3

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.	7
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.	7
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.	7
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.	7
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.	8

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, 4th Edition,World Scientific, 1996.

LASER PHYSICS AND APPLICATIONS

COURSE CODE: 21PGPHYS05 **HOURS**

L	T	P	C
3	0	0	3

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.	5
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.	8
III	Laser Systems	Laser systems involving low density gain media – Nitrogen Laser, Carbondioxide 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.	8
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.	8
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 detectability – Switched lidars, Satellite and Lunar Range finders.	7

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.

VALUE ADDED COURSES

POWDER X-RAY DIFFRACTION AND ANALYSIS

COURSE CODE: 21PGVAC01 **HOURSE: 30**

MAXIMUM MARKS: 50 **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-The 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 or 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.

OPTICAL SYSTEM ANALYSIS AND DESIGN

COURSE CODE: 21PGVAC02 **HOURS : 30**

MAXIMUM MARKS: 50 **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

Syllabus

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: 21PGVAC03 **HOURS: 30**

MAXIMUM MARKS: 50 **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, bioprobes.	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. Sampath Kumar,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: 21PGVAC04 **HOURS: 30**

MAXIMUM MARKS: 50 **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. Bojan Vrnak, Create Space Independent Publishing Platform, 2015.

ANALYTICAL INSTRUMENTAL METHODS

COURSE CODE: 21PGVAC05 **HOURS: 30**

MAXIMUM MARKS: 50 **CREDITS: 2**

COURSE OBJECTIVES:

- To give a basic knowledge on different errors and the methods of thermal analysis.
- To understand the operating principles, construction and working of various analytical instruments

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

CO1	Interpret the different errors and the methods of thermal analysis.
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 Experiment al 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, 1**9**86.
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: 21PGVAC06 **HOURS: 30**

MAXIMUM MARKS: 50 **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 - Radiophtoluminesce 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, Charles C. Thomas, New York, 2002.
4. Fundamental Physics of Radiology - W. J. Meredith and J. B. Massey, John Wright and 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: 21PGSBC01 **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 of Instruction
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 (H_2).	8

Books for Study and References

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: 21PGSBC02 **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	7

		Virtual base class, abstract class, constructors in derived class. Concepts of Pointer: Pointer 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. Compute the C++ programming to find the solution for matrix inversion.
2. To find the root of algebraic equation using the Newton-Raphson method.
3. To find the solution of first order differential equations using Runge-Kutta method.

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

JOB ORIENTED COURSES

SOLAR ENERGY SYSTEM DESIGN

COURSE CODE: 21PGJOC01 **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: 21PGJOC02 **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 biopotential based devices, physiological assist devices and medical imaging.
- Operate the medical equipments 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 - characterstics of recording systems - lectrodcardiography (ECG) - Electroencephalograph (EEG)- Electromyograph (EMG) - recoring 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 equipments 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 equipments.