PERIYAR UNIVERSITY

PERIYARPALKALAI NAGAR

SALEM-636 011

M.Sc. DEGREE

Branch-III (B)-PHYSICS

[Choice Based Credit System (CBCS)]

REGULATIONS AND SYLLABUS

(Effective from the academic year 2018-2019 and thereafter)

M.Sc. BRANCH III (B) - PHYSICS

OBE REGULATIONS AND SYLLABUS

1. Preamble

Department of Physics

This department 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 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 the 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 subjects intact in the curriculum. Experiments for the advanced level Electronic and General physics practical have designed to enrich the stakeholders to attain experimental understanding and computer simulation.

Creation of new knowledge by doing cutting edge research is 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 ones 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

S.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 energy physics and molecular dynamics simulation.

5. Programme Objectives and Outcomes

Programme Educational Objectives (PEOs)

PEO1: The main aim of the M.Sc (Physics) course is to have enriched syllabus prepare 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 program 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) Practical (4-Practicals)	 12 4	 60/course 48/practical	 1200 300	 48 12
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	25		2300	90
Part B (Self – Learning Credit Courses)				
Online Courses (MOOC courses: NPTEL/Coursera/ Swayam)	2	Self-Learning	200	4
Elective Foundation Courses (Value added courses/Skill based courses)	2	Self-Learning	200	4
Total	4	-	400	8

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

Sem.	Course Code	Name of the Course	Credits	Hrs/ Week	Marks		Total
					Int.	Ext.	
I	18PGPHYC01	Core -1 : Mathematical Physics – I	4	6	25	75	100
	18PGPHYC02	Core -2 : Classical Mechanics	4	6	25	75	100
	18PGPHYC03	Core-3 : Electronics	4	6	25	75	100
	18PGPHYE01	Elective -I: Nanoscience	4	5	25	75	100
	18PGPHYC04	Core-4 : Practical – I : General Physics	4	6	40	60	100
		Total	**20**	**29**	**-**	**-**	**500**
II	18PGPHYC05	Core-5 : Mathematical Physics –II	4	5	25	75	100
	18PGPHYC06	Core-6 : Quantum Mechanics-I	4	6	25	75	100
	18PGPHYC07	Core-7 : Thermodynamics and Statistical Mechanics	4	5	25	75	100
	18PGPHYE02	Elective -II : Microprocessors and Microcontroller	4	5	25	75	100
	18PGPHYC08	Core-8 : Practical-II : Electronics	4	6	40	60	100
	18PGPHYS01	Supportive : I	3	3	25	75	100
		Total	**23**	**30**	**-**	**-**	**600**
III	18PGPHYC09	Core-9 : Quantum Mechanics-II	4	6	25	75	100
	18PGPHYC10	Core-10: Spectroscopy	4	5	25	75	100
	18PGPHYC11	Core-11 : Numerical Methods and Fortran Programming	4	5	25	75	100
	18PGPHYE03	Elective -III : Modern Optics	4	5	25	75	100
	18PGPHYS02	Supportive : II	3	3	25	75	100
	18PGPHYC12	Core-12 : Practical-III :Microprocessors and Microcontroller	4	6	40	60	100
		Total	**23**	**30**	**-**	**-**	**600**
IV	18PGPHYC13	Core-13 : Electromagnetic Theory	4	5	25	75	100
	18PGPHYC14	Core-14 : Solid State Physics	4	5	25	75	100
	18PGPHYC15	Core-15 : Nuclear and Particle Physics	4	5	25	75	100
	18PGPHYC16	Core-16 : Practical-IV: Computational Programming and Simulation	4	6	40	60	100
	18PGPHYC17	Core-17 : Project Work	8	9	-	-	200
		Total	**24**	**30**	**-**	**-**	**600**
General Seminar			**-**	**1**	**-**	**-**	**-**
Total			**90**	**120**	-	-	**2300**
Online courses/Swayam/NPTL/Coursera			2	-	-	100	100
Value Added course / Skill based courses			2	-	-	100	100

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	Examination Scheme			
				Max. Marks		Total Marks	Min. Passing Marks
				Int.	Ext.		
I	18PGPHYC01	Core -1 : Mathematical Physics – I	4	25	75	100	50
	18PGPHYC02	Core -2 : Classical Mechanics	4	25	75	100	50
	18PGPHYC03	Core-3 : Electronics	4	25	75	100	50
	18PGPHYE01	Elective -I: Nanoscience	4	25	75	100	50
	18PGPHYC04	Core-4 : Practical – I : General Physics	4	40	60	100	50
		Total	**20**	**-**	**-**	**500**	**-**
II	18PGPHYC05	Core-5 : Mathematical Physics –II	4	25	75	100	50
	18PGPHYC06	Core-6 : Quantum Mechanics-I	4	25	75	100	50
	18PGPHYC07	Core-7 : Thermodynamics and Statistical Mechanics	4	25	75	100	50
	18PGPHYE02	Elective -II : Microprocessors and Microcontroller	4	25	75	100	50
	18PGPHYC08	Core-8 : Practical-II : Electronics	4	40	60	100	50
	18PGPHYS01	Supportive : I	3	25	75	100	50
		Total	**23**	**-**	**-**	**600**	**-**
III	18PGPHYC09	Core-9 : Quantum Mechanics-II	4	25	75	100	50
	18PGPHYC10	Core-10: Spectroscopy	4	25	75	100	50
	18PGPHYC11	Core-11 : Numerical Methods and Fortran Programming	4	25	75	100	50
	18PGPHYE03	Elective -III : Modern Optics	4	25	75	100	50
	18PGPHYS02	Supportive : II	3	25	75	100	50
	18PGPHYC12	Core-12 : Practical-III : Microprocessors and Microcontroller	4	40	60	100	50
		Total	**23**	**-**	**-**	**600**	**-**
IV	18PGPHYC13	Core-13 : Electromagnetic Theory	4	25	75	100	50
	18PGPHYC14	Core-14 : Solid State Physics	4	25	75	100	50

	18PGPHYC15	Core-15 : Nuclear and Particle Physics	4	25	75	100	50
	18PGPHYC16	Core-16 : Practical-IV: Computational Programming and Simulation	4	40	60	100	50
	18PGPHYC17	Core-17 : Project Work	8	-	-	200	100
		Total	**24**	**-**	**-**	**600**	**-**
General Seminar			**-**	**-**	**-**	**-**	
Total			**90**	**-**	**-**	**2300**	
Online courses/Swayam/NPTL/Coursera			2	-	100	100	50
Value Added course / Skill based courses			2	-	100	100	50

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

(a) Sessional Test I will be held during seventh week for the syllabi covered till then.

(b) Sessional Test II will be held during eleventh week for the syllabi covered between eighth and eleventh week.

(c) Sessional Test III will be held during 16th week for the syllabi covered between 12th week and 16th 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) 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)

Section	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%
C	500 to 1000 words	5 x 8 = 40 (Essay type questions)	K3 & K4	53.3%

<u>Note:</u>

Core course:

- Section-A: Four questions from each unit and among all questions at least five questions must be problem.
- Section-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.
- Section-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:

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

Supportive course:

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

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**
90-100	9.0-10.0	O	Outstanding
80-90	8.0-8.9	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

MATHEMATICAL PHYSICS-I

COURSE CODE: 18PGPHYC01 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study about Gram-Schmidt orthogonalisation procedure in vector space.
- To learn to use the Christoffel symbols in tensor.
- To provide application of Cauchy's residue theorem in evaluation of definite integrals.
- To learn and prepare the character tables for simple molecules.
- To understand the central limit theorem in probability distribution.

COURSE OUTCOMES: After completion of this course, student able to

CO1	Solve problems in orthogonality of vectors and eigen values and Eigen vectors.
CO2	Understand the algebraic operation and calculus in tensor.
CO3	Solve the analytical function in complex variable and use complex variable for solving the definite integrals.
CO4	Use the representation of group in Crystallography and Molecular symmetry.
CO5	Understand different probability distribution in probability theory.

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	Unit Title	Intended learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	Hours of Instruction
I	Linear Vector Space and Matrices Theory	Linear vector spaces- subspaces-Bases and dimension- Linear independence and orthogonality of vectors-Gram-Schmidt orthogonalisation procedure-Matrices Inverse - Orthogonal and Unitary matrices- Independent elements of matrix-Eigen values and Eigen vectors- Caley-HemiltonTherorem - diagonalization - complete orthonormal set of functions.	15
II	Tensors analysis	Notations and conventions in tensor analysis-Einsteins summation convention covariant and contravariant and mixed tensors-algebraic operations in tensors symmetric and skew symmetric tensors-tensor calulus- Christoffel symbols-kinematics in Riemann space-Riemann-Christoffel tensor.	15
III	Functions of a complex variable	Functions of complex variable-Analytic functions-Cauchy-Riemann equations- integration in the Complex plane- Cauichy'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
IV	Group Theory	Definitions of a group-elementary properties-sub groups-homomorphism and isomorphism of groups-representation of groups-reducible and irreducible representations-simple applications in crystallography and molecular symmetry-Lie groups-SU(2) groups and their representations.	15
V	Probability theory	Fundamental laws of probability- Random variables-Probability distributions-Moments of the distributions- Binomial- Poisson and Normal distributions- Conditional probability distribution-joint probability distribution- Characteristic functions- Central limit theorem- Random walks (1D, 2D and 3D) and their applications to physical processes (diffusion, paramagnetism)	15

Tutorial

Eigen values and Eigen vectors, Caley-HemiltonTherorem, 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. MathematicalPhysics- H.K.Dass and R.Verma. S. Chand & Co Pvt Ltd; First Edition, 1997.
2. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern, New Delhi; Second Edition,2002.
3. Applied Mathematics for Engineering and Physicists - L.A. Pipes and L.R. Harvill, McGraw Hill, Singapore; Third Edition, 1967.
4. Mathematical Physics - B.D. Gupta, Vikas, Publishing House Pvt Ltd., New Delhi; Fourth Edition, 2003.
5. Mathematical Physics- A.K.Ghatak, I.C.Goyalamd, S.T.Chua, Macmillan India Limited, 2003.

CLASSICAL MECHANICS

COURSE CODE: 19PGPHYC02 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

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

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

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

Mapping of the course outcomes with programme outcome:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	Hours of Instruction
I	Lagrangian formulation	System of particles- constraints and degrees of freedom-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 Transformati on	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-Hamilton's equation of motion. Canonical transformations-Hamilton's canonical equations.	18
III	Hamilton – Jacobi theory and small oscillation	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-Vibrations of linear triatomic molecule	15
IV	Kinematics of rigid body	Independent coordinates of rigid body-Euler angle and Euler's theorem-infinitesimal rotation-Coriolis force-angular momentum and kinetic energy of motion about a point-moment of inertia tensor –Euler equation of motion-torque free motion of a rigid body-heavy symmetrical top.	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-Kepler problem: Inverse-Square law of force-Scattering in a central force field-transformation of scattering to laboratory coordinates. Special theory of relativity- Lorentz transformations - Relativistic kinematics- mass–energy equivalence.	17

Tutorial

Contraints, Degrees of freedom, Lagrange's equation of motion - Hamilton`s function-Lagrange's equation from Hamilton's principle-Hamilton's principle for nonholonomic system-variational principle- Hamilton's equations from variational principle -Jacobi method-frequencies of free vibrations - angular momentum and kinetic energy of motion about a point-top- Centre of mass - Relativistic kinematic, Special theory of relativity, Lorentz transformations, Relativistic Kinematics, Mass-energy equivalence.

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.

Books for Reference

1. Classical Mechanics -S. L. Gutpa, V. Kumar and H.V. Sharma, PragatiPrakashan, Meerat, 2016.
2. Classical Mechanics of Particles and Rigid Bodies -K.C. Gupta, New Age International Publishers,New Delhi, Thirdedition,2018.
3. Classical Mechanics -N.C. Rana and P.J. Joag, Tata McGraw Hill, New Delhi, 25th Reprint. 2015.
4. Classical Mechanics -J. C. Upadhaya, Himalaya Publishing House Pvt. Ltd, Bangalore, Second edition, 2017.

ELECTRONICS

COURSE CODE: 18PGPHYC03 **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 learn the fundamentals and applications Optoelectronic devices.
- To interpret characteristics of Digital systems.

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

CO1	Obtain 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	Demonstration ability and to understand semiconductor fundamentals and its corresponding application for optoelectronic devices.
CO5	Develops an ability to analyse and design different Digital systems.

Mapping of course outcome with the program outcome

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	Hours of Instruction
I	Diode Characteristics	Junction- Diode characteristics-The open circuited P-N junction- The P-N junction as rectifier- The current components in a P-N diode – The Volt – Ampere characteristic- The temperature dependence of the V/I characteristic - Diode resistance - The load- line concept- Clipping at two Independent levels- Comparators- Sampling gates.	15
II	Transistor	Transistor characteristics –Transistor constructions- transistor at low frequencies- hybrid model – h-parameters - Transistor as an amplifier - Field effect transistor – Uni-Junction Transistor - Homo and hetero Junction devices - Device characteristics, frequency response and its applications	15
III	Amplifier	Multistage amplifier – classification – distortion - Frequency response of Op-amp – Feedback amplifier - Transfer gain with feedback - Negative feedback -method of analysis – voltage series. Application: Sample and hold circuit - Schmidt trigger - Active filters (low pass - high pass - band pass filter)	15
IV	Optoelectronic Devices	PN junction solar cell working principle and construction - Photo transistor and Photo diode construction and working principle - Light Emitting Diode (working principle and applications)–Laser diodes – semiconductor laser device structure and operation – quantum well lasers - Impedance matching.	15
V	Digital Systems	Differential DC amplifier - Stable AC amplifier - AD/DA Converters - Logarithmic amplifier - Wave form generators - Flip Flops – Registers – Counters - Comparators and its applications. Signal: conditioning –measurement- control and recovery. Noise: reduction - shielding and grounding- Signal modulations.	15

Tutorial

Semiconductor devices, Device structure, device characteristics, frequency dependence and applications, Opto-electronic devices, Operational amplifiers and their applications, Digital techniques and applications (registers, counters, comparators and similar circuit).A/D and D/A converters. Measurement and control, signal conditioning and recovery, amplification, filtering and noise reduction.

Books for Study

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

Books for Reference

1. Electronic principles - Malvino, TMH, eighth edition, 2015.
2. Basic Electronics Engineering - Vijay Baru, RajendraKaduskar, Sunil T. Gaikwad, Wiley Publications, 2011.
3. Text Book of Electronics - S. Chattopadhyay, New Central Book Agency P.Ltd, First Edition, 2012.
4. Electronic Devices and Circuts - Anil K. Maini and VarshaAgarwal, Wiley Publications, First Edition, 2009.
5. Digital Integrated Electronics - Herbert Taut and Donald Schilling, McGraw Hill International Edition, 2004.

PRACTICAL –I: GENERAL PHYSICS

COURSE CODE: 19PGPHYC04

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 analyse 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 equipment.
CO2	Understand and apply the physical phenomena 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 analyse 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	Analyse 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 a 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. GM 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. Spectrum of hydrogen atom
29. Lattice parameters and crystallite size calculation from Powder X-ray diffraction patterns of NaCl crystal.
30. 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; Eighth Edition, 2007.
2. A Textbook of Advanced Practical Physics - S. K. Ghosh; New Central; Fourth Edition, 2000.

Books for Reference

1. Advanced Practical Physics for students - B. L. Worsnop and H. T. Flint; Littlehampton. Book Services Ltd; Ninth Revised 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: 18PGPHYC05 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To provide the Recurrence relation of Legendre's differential equation and Bessel's differential equation.
- To derive the Heat Equations in two and three dimensions.
- To apply the Fourier transforms to evaluate the solution of differential equations.
- To study inverse Laplace transform to solution of differential equation.
- To attain the knowledge on the relation between beta and gamma functions.

COURSE OUTCOMES: On successful completion of this course the student will be able to

CO1	Construct the Recurrence relation of Legendre's differential equation and Bessel's differential equation.
CO2	Apply the partial differential equation in the solution of Wave and Heat Equations.
CO3	Represent the Fourier cosine and Sin series in the periodic function.
CO4	Prove the Fourier Mellin theorem in inverse Laplace transform.
CO5	(1) Evaluate the gamma function and (2) Obtain the orthogonal relation of delta function.

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	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	Hours of Instruction
I	Differential Equations	First and Second order differential equation-Solution of First and Second order differential equation, Legendre's differential equation: Legendre polynomials - Generating functions - Recurrence Formula, Rodrigue's formula–orthogonality of Legendre's polynomial, Laguerre's differential equation: polynomial–generating functions–Recurrence Formulae–orthogonal properties of Laguerre's polynomials, Bessel's differential equation: Bessel's polynomial–generating functions–Recurrence Formulae–orthogonal properties of Bessel's polynomial, Hermite differential equation: Hermite polynomials – generating functions – recurrence relation.	15
II	Partial Differential Equation Green's Functions	Introduction to partial differential equations – Introduction to curvilinear coordinates – Cylindrical polar and spherical polar systems - Laplace, Wave and Heat Equations in two and three dimensions. One-dimensional problems- Qualitative idea of Green's functions in 2- and 3-dimentions	15
III	Fourier series and Transform	Properties of Fourier transforms - Fourier sine and cosine transforms-Power in Fourier series - Modulation theorem, Fourier transform of impulse function, Constants, Unit step function and Periodic (square wave, triangular wave & sawtooth wave) functions.	15
IV	Laplace Transforms	Laplace Transform: Properties-Derivative function- Laplace transforms of Dirac delta function-Laplace transforms integral-applications to solution of simple differential equations- Inverse Laplace transform: Fourier Mellin Theorem-properties of inverse Laplace transform	15
V	Delta and gamma functions	Dirac delta function-delta sequences for one-dimensional function-properties of delta function-orthogonal function and integral representation of delta function-gamma function-Weierstrass form-factorial notation and applications-beta function- relation with gamma function.	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-dimentions, 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, Weber Frank E. Harris, Elsevier publications, Seventh Edition, 2012.

Books for Reference

1. Mathematical Physics- H.K.Dass and R.Verma. S. Chand & Co Pvt Ltd; First Edition, 1997.
2. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern, New Delhi; Second Edition, 2002.
3. Applied Mathematics for Engineering and Physicists - L.A. Pipes and L.R. Harvill, McGraw Hill, Singapore; Third Edition, 1967.
4. Mathematical Physics - B.D. Gupta, Vikas, Publishing House Pvt Ltd., New Delhi; Fourth Edition, 2003.
5. Mathematical Physics- A.K.Ghatak, I.C.Goyalamd, S.T.Chua, Macmillan India Limited, 2003.
6. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern, New Delhi, 2002.

QUANTUM MECHANICS-I

COURSE CODE: 19PGPHYC06 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
4	1	0	4

COURSE OBJECTIVES

- To study the fundamentals of wave mechanics.
- To study the stationary state and eigen spectrum of systems using time dependent Schrodinger equation.
- To understand the exactly soluble eigenvalue problems.
- To know the matrix formulation of quantum theory and how it can be used to understand the equation of motion at different representations.
- To understand the commutation rules and addition of angular momentum.

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

CO1	Understand the fundamental principles of quantum mechanics and the formulation of Schrodinger equation.
CO2	Solve time-independent stationary state problems for the square well, finite and multiple potential wells.
CO3	Solve linear harmonic oscillator and the hydrogen atom problems.
CO4	(1) Understand the matrix formulation of Schrodinger, Heisenberg and Interaction representations and derive the equation of motion. (2) Understand Symmetry and Anti-symmetry wave functions of identical particles.
CO5	Solve the eigenvalue problems using commutation rules and Addition of angular momenta.

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	Hours of Instruction
I	Foundations of Wave Mechanics	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. Postulates of wave mechanics -adjoint and self-adjoint operators-degeneracy-eigen value, eigen functions-observables - Physical interpretation-expansion coefficients-momentum eigen functions-Uncertainty principle-states with minimum value-commuting observables - constant of motion-Interacting and Non-interacting systems.	15
II	Stationary State and Eigen Spectrum	Time independent Schrodinger equation - Particle in a square well potential – Bound states –eigen values, eigen functions –Potential barrier – quantum mechanical tunnelling-infinite potential-finite potential – multiple potential well –alpha emission.	15
III	Exactly Soluble Eigenvalue Problems	One dimensional linear harmonic oscillator – properties of stationary states- abstract operator method - Angular momentum operators- commutation relation-Parity- 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 and Equation of Motion	Quantum state vectors and functions- Hilbert space-Dirac's Bra-Ket notation-matrix theory of Harmonic oscillator – Schrodinger, Heisenberg and Interaction representation – coordinates and momentum representations – Projection operator **Identical Particles and Spin** Identical Particles – symmetry and antisymmetric wave functions – exchange degeneracy – Spin and statistics: Pauli's exclusion principle-Slater determinant- collision of identical particles-spin and Pauli's matrices- density operator and density matrix.	15
V	Angular Momentum	Angular momentum -commutation rules - eigen value spectrum -matrix representation of J in the |jm> basis – spin angular momentum – spin ½ , spin-1- addition of angular momenta-Clebsch-Gordan coefficients-spin wave functions for a system of two spin- ½ particles.	15

Tutorial

Wave-particle duality, Schrodiger equation (Time-dependent and time independent), Eigenvalue problems (particle in a box, harmonic oscillator, etc), Tunneling through barrier, Wave function in coordinate and momentum representations, Commutators and Heissenberg uncertainty principle, Dirac notation for state vectors, Motion in Central potential: Orbital angular momentum, angular momentum algebra, spin, addition of angular momenta.

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 - SatyaPrakash, KedarNath Ram Nath and Co. Publications, 2018.

Books for Reference

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

THERMODYNAMICS AND STATISTICAL MECHANICS

COURSE CODE: 18PGPHYC07 **HOURS**

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study fundamentals of Thermodynamics and Statistical Physics.
- To provide the knowledge of different ensembles and Free energy.
- To obtain the concept of quantum statistics and to know the solutions of using Model.
- To understand the equation of state and phase transition.
- To evaluate the specific heat from lattice vibration.

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

CO1	Explain the basic concepts of statistical mechanics fundamentals and Laws of Thermodynamics.
CO2	Apply knowledge and demonstrates the various types of Ensembles.
CO3	To understand 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	To understand fluctuations of macroscopic properties of thermodynamic systems about their equilibrium values.
CO5	To understand 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 course outcome with the program 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	H

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3,K4)	Hours of Instruction
I	Thermodynamics and fundamentals of statistical Physics	Objective of statistical mechanics:Laws of thermodynamics – Thermodynamic potentials- Maxwell relations-macrostates, microstates, phase equilibria - phase space and ensembles- Density of states- Density distribution in phase space- Ergodic hypothesis- Postulate of equal a priori probability and equality of ensemble average and time average- Boltzmann postulate of entropy- Classical ideal gas- Entropy of ideal gas: Gibbs paradox- Liouvilles theorem.	15
II	Theory of Ensembles	Classification of ensembles- Micro canonical, Canonical and Grand canonical ensembles- Partition function of canonical ensemble- Thermo dynamical quantities by partition function- expression of entropy- Helmholtz free energy- fluctuation of internal energy- chemical potential of ideal gas.	15
III	Quantum Statistics	Introduction- Postulates of quantum statistical mechanics- Density matrix- Ensembles in Quantum statistical mechanics- Quantum Liouville theorem- Maxwell law of distribution of velocities- Ideal quantum gases- Bosons- Fermions- BE, FD, MB distributions using GCE partition functions. Black body radiation and Plank's distribution law.	15
IV	Approximate Methods	Classical Cluster expansion- Quantum Cluster expansion- Virial equations of states, Ising model in one, two, three dimensions- exact solutions. Fluctuations: Fluctuations in energy and enthalpy-Random walk -Brownian motion – Introduction in non-equlibrium process	15
V	Phase Transitions	Photon gas- Equation of state- Bose-Einstein condensation- Diffusion equation-Equation of state of ideal gas- Specific heat from lattice vibration- phase transitions- first and second order phase transitions- critical points-Diamagnetism, Paramagnetism and Ferromagnetism-Ising model- Landau's theory- Phonon gas- Theory of Super fluidity- Liquid helium.	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, Black body radiation and Planks distribution law.

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.

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.

PRACTICAL–II: ELECTRONICS

COURSE CODE: 19PGPHYC08 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
0	0	6	4

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 Optoelectronic devices.
- To interpret characteristics of Digital systems.

COURSE OUTCOMES: At the end of the course the student will be 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	Learning 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	Capable of performing 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	PO4
CO1	H	M	L	L	M
CO2	H	H	M	L	H
CO3	H	M	H	L	M
CO4	H	M	H	L	M
CO5	H	H	M	L	H

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 IC 741 and 555 timers
4. Design of monostablemultivibrator using IC 741 and 555 timers
5. Design of Schmidt's trigger using IC 741 and 555 timers
6. Phase locked loop using IC 556.
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, Pragati Prakasan Educational publishers, Seventeenth Edition, 2011.
2. Practical Physics and Electronics – C.C. Ouseph, U.J. Rao, V. Vijayendran S. Viswanathan (Printers & Publishers), Pvt., Ltd., First Edition, 2007.

QUANTUM MECHANICS-II

COURSE CODE: 19PGPHYC09 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the approximation methods using in stationary time independent perturbation theory.
- The study the approximation methods using in stationary time dependent perturbation theory.
- The understand the kinematics of scattering process and partial wave analysis
- The study the formulation of relativistic quantum mechanics and quantization of field.
- The study quantum theory of atomic and molecular structures.

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

CO1	(1) Apply perturbation theory in Non-degenerate and degenerate case problems in systems under magnetic and electric fields. (2) Solve chemical problems using Variation methods.
CO2	Solve the problems in time dependent perturbation and Semi-classical theory of radiation.
CO3	Understand how Born approximation to be used to explore the scattering with screened potential and different scattering cross sections at various potentials.
CO4	(1) Solve the relativistic problems using Klein-Gordan and Dirac equations. (2) Understand the theory of field quantization.
CO5	Explore the theory of Centre field approximation and Molecular orbital theory.

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	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 –Degenerate case: Energy correction- stark effect in hydrogen atom. Variation method: Variation Principle – upper bound states- ground state of Helium atom –Hydrogen molecule-WKB approximation -Schrodinger equation-Asymtotic solution-validity of WKB approximation-solution near a turning point – connection formula for penetration barrier – Bohr-Summer field quantization condition-tunneling through a potential barrier.	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	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 behavior – 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
IV	Relativistic Quantum Mechanics and Quantisation 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. **Quantisation of the Field** Electromagnetic wave as harmonic oscillators – quantisation: classical e.m.wave –quantisation of fields oscillators- Photons- number operator – creation and annihilation operators of photons	15

V	Quantum Theory of Atomic and Molecular Structure	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 (H2+) – Molecular orbital theory: LCAO- Hydrogen molecule.	15

Tutorial

Spin-orbit coupling, fine structure, Variation method, WKB approximation, Relativistic quantum mechanics: Klein-Gordon and Dirac equations, Semi-Classical theory of radiation.

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), 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: 19PGPHYC10 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study about electronic spectroscopy.
- To study the vibrational spectroscopy of molecules.
- To understand the physics of spin resonance spectroscopy.
- To understand the nuclear quadrapole and Mossbauer spectroscopy.
- To study about laser spectroscopy.

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

CO1	Understand the basic quantum description of electronic spectroscopy.
CO2	Understand the vibrational spectroscopy methods and will have basic knowledge on IR and Raman spectra analysis.
CO3	Acquire knowledge on spin resonance spectroscopy.
CO4	Acquire knowledge on quadrupole interaction and its application to spectroscopy.
CO5	Understand the basics of laser and its higher level applications.

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	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	Vibrational spectroscopy	Vibrational study of diatomic molecules – IR rotation – Vibrational spectra of gaseous diatomic and polyatomic molecules – Vibrational frequencies qualitative and quantitative analysis – determination of bond length and bond moment – determination of interstellar atoms and molecules – IR spectrometer – Raman effect – Classical and quantum theory of Raman effect –vibrational Raman spectra – structure determination from Raman and IR spectroscopy – Raman spectrometer.	15
III	NMR & ESR Spectroscopy	Interaction of spin and applied magnetic field – Quantum mechanical description – Relaxation times – spin-spin and spin lattice – Chemical shift – Spin-spin coupling between two and more nuclei – NMR spectrometer – quantum mechanical theory of ESR – Hyperfine structure study – Triplets study of ESR – application of ESR to solid state physics (Crystal defects and Biological studies) - design of ESR spectrometer.	10
IV	NQR & Mossbauer Spectroscopy	General principles of NQR – energy levels of quadrupole transitions of half integral spins – design of NQR spectrometer – Application of NQR (Molecular Structure) - Principle of Mossbauer effect – Schematic arrangement of Mossbauer spectrometer – Isomer shift – Quadrupole interaction – magnetic hyperfine interactions – applications of Mossbauer spectroscopy (Biological applications)	10
V	Laser Spectroscopy	Basic Principles of Laser – Spontaneous and stimulated emission - Einstein coefficients (A and B) of radiation – Population inversion - optical pumping – rate equation – resonators and coherence (spatial and temporal) - Nd:YAG laser, He-Ne Laser – CO_2 Laser – Applications of Laser – Holography – Q Switching	10

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.

NUMERICAL METHODS AND FORTRAN PROGRAMMING

COURSE CODE: 18PGPHYC11 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To study the numerical error analysis in physical measurements.
- To learn suitable numerical method for solution the solution of algebraic equation.
- To study the Newton's interpolation formula in unequal intervals for numerical problem.
- To understand the Euler's Runge-Kutta method for solving ordinary differential equation.
- To study the basic about FORTRAN program language.

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

CO1	Develop a comprehensive understanding on numerical error analysis in physical measurements.
CO2	Demonstrate the accurate numerical methods to solve algebraic equation.
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	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3,K4)	Hours of Instruction
I	Errors and the measurements Numerical Differentiation and Integration	General formula for errors – Errors of observation and measurement -Empirical formula -Graphical method – Method of averages – Least square fitting – curve fitting - parabola, exponential. Newton's forward and backward difference formula to compute derivatives – Numerical integration: the trapezoidal rule, Simpson's rule – Extended Simpson's rule.	15
II	Numerical solution of algebraic equations	The iteration method - The method of false position – Newton – Raphson method – Convergence and rate of convergence - Simultaneous linear algebraic equations: Gauss elimination method – Jordon's modification –Gauss-Seidel method of iteration	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. Extrapolation: Richardson‟s extrapolation, solving numerical problems.	15
IV	Numerical solutions of ordinary differential equations	N^{th} 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	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.

Book for study

1. Introductory Methods of Numerical Analysis, S.S.Sastry, Prentice Hall of India, NewDelhi, Third Edition, 2005.
2. Brainerd and Walter S, Programmer's Guide to Fortran90, 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, NewDelhi, Third Edition, 2003.
3. Numerical Methods in Science and Engineering- The National Publishing Co. Madras, Third Edition, 2001.

PRACTICAL III: Microprocessor and Microcontroller

COURSE CODE: 18PGPHYC12 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
0	0	6	4

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 microcontrollers.

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

CO1	To write simple ALP for 8 and 16 bit arithmetic operations using 8085 and 8051.
CO2	To learn the ALP program of microprocessors/microcontrollers-based systems such as code conversion, arranging numbers in ascending and descending orders
CO3	To develop an capability to handle analog signals in digital devices.
CO4	Gain knowledge on interfacing various I/O devices.
CO5	To 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 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: 18PGPHYC13

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 learn the plasma behavior in magnetic field.

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

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

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	Hours of Instruction
I	Electrostatics	Coulomb's law- Electric field-Gauss' law - Differential form of Gauss' law- its applications surface distributions of charges and dipoles- Poisson and Laplace equations- Green's theorem- Solution of boundary value problem with green's function- Electrostatic potential energy and capacitance.	15
II	Boundary Value Problems in Electrostatics	Method of Images- point charge in the presence of a – grounded conducting sphere-charged, insulated, conducting sphere- point charge near a conducting sphere at fixed potential- conducting sphere in a uniform electric field by method of Images- Laplace equations in spherical co-ordinates- multipole expansion- boundary value problems with dielectrics- molecular polarizability and electric susceptibility- electrostatic energy in dielectric media.	15
III	Magnetostatics	Biot and Savart law- Differential equations of magneto statics and Ampere's law- vector potential- magnetic fields of localized current distribution and magnetic moment- force, torque and energy of a localized current distribution- macroscopic equations and boundary conditions of B and H- methods of solving boundary value problems in magneto statics- uniformly magnetized sphere.	15
IV	Electromagnetics	Faraday's law of induction-Maxwell's equations in free space – linear and isotropic media- vector and scalar potentials- gauge transformation- Lorentz gauge- Coulomb gauge- Poynting's theorem and conservation of energy and momentum- electromagnetic waves in free space- plane electromagnetic waves in a dielectrics- conductors - non-conducting medium- linear and circular polarization- reflection- and refraction, polarzation of EM waves- Fresnel's law, interference, coherence, diffraction-plane interface between dielectrics- cylindrical cavities and transmission lines and wave guides.	15
V	Dynamics of charge particles and radiation of E.M. waves Applications of E.M. waves in Plasma	Dynamics of charged particles in static and uniform electromagnetic fields- Radiation from moving charges and dipoles and retarded potentials. Introduction to plasma-dispersion relations in plasma. Plasma behavior in magnetic field-Plasma as a conducting field-Pinch effect- Instabilities in Plasma-hydromagnetic waves-Alfen waves.	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.

Books for Study

1. Classical Electrodynamics, J.D. Jackson, John Wiley, Third Edition, 1999.

Books for Reference

1. Introduction to Electrodynamics - David J. Griffiths, Prentice-Hall of India. Fourth Edition, 2015.
2. Electromagnetic waves and radiating system - E.C. Jordan and K.G. Balmin, Prentice Hall of India, Second Edition, 1995.
3. Foundation of Electromagnetic Theory - John R. Reits, Fredrick, J. Milford and Robert W. Christy, Addison-Wesley, Fourth edition, 2008.
4. Electromagentic theory - K.K.Chopra and G. C Agrawal, K Nath& Co, 2006.

SOLID STATE PHYSICS

COURSE CODE: 19PGPHYC14 **HOURS**

L	T	P	C
4	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

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

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

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

Mapping of the course outcomes with programme outcome:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attribute K1, K2, K3, K4)	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.	18
II	Lattice dynamics and Thermal properties	Vibrations of monoatomic and diatomic basis-harmonic approximation-acoustical, optical, transverse and longitudinal modes-Phonon quantization - Thermal conductivity-Umklapp process-Specific heat capacity of solids-Einstein, Debye model-Drude model of thermal conductivity-Density of states in one and three dimensional-specific heat response and relaxation phenomena.	16
III	Metals and Semiconductors	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-Limitations. Semiconductors- Band theory of pure and doped semiconductors- Carrier concentrations- intrinsic carrier- Hall effect.	15
IV	Electric 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.	18
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.	18

Tutorial

Reciprocal lattice, Bragg's law- Ewald's sphere construction- Laue, Powder, Rotation methods, Drude model of thermal conductivity, Nearly free electron model, Semiconductors- Band theory of pure and doped semiconductors- Carrier concentrations- intrinsic carrier- Hall effect, Type I and Type II superconductors.

Books for Study

1. Introduction to Solid State Physics - C. Kittel, Wiley Eastern, New Delhi, Eighth Edition, 2014.
2. Solid State Physics - S.O. Pillai, A.J. Dekker, New Age International Publishers, New Delhi, Seventh Edition, 2015.

Books for Reference

1. Solid State Physics - A.J. Dekker, Macmillan, 1965.
2. Solid State Physics - Rita John,McGraw Hill,New Delhi, 2014.
3. Solid State Physics - B.S.Saxena, R.C. Gupta and P.N. Saxena,PragatiPrakashan, Uttar Pradesh,Eighteenth Edition,2015.
4. Crystallography for Solid State Physics- A.R.Verma and O.N.Srivastava, Wiley, Marshall, Second Edition, 1991.
5. Elements of X-ray Crystallography, L.V. Azaroff, McGraw-Hill, New Delhi, 1968.

NUCLEAR AND PARTICLE PHYSICS

COURSE CODE: 19PGPHYC15 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
4	1	0	4

COURSE OBJECTIVES:

- To learn about the nuclear forces in detail.
- To understand about various nuclear models.
- To calculate the kinematics of various reactions and decay processes.
- To explain the different forms of radioactivity and account for their occurrence.
- To learn the types of interactions and the elementary particles and their quantum numbers.

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

CO1	Understand of nuclear forces, interactions, models and factors affecting the stability of the nucleus.
CO2	Explain the different forms of radioactivity and account for their occurrence. Explain the interaction of radioactivity with matter and particle detectors.
CO3	Account for the fission and fusion processes and explain the basic properties of nuclear reactors. Also, assess a range of applications of nuclear technology.
CO4	Calculate the kinematics of various reactions and decay processes.
CO5	The four fundamental interactions in nature and classify the elementary particles and nuclear states in terms of their quantum numbers.

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attribute K1, K2, K3, K4)	Hours of Instruction
I	Nuclear structure and nuclear forces	Nuclear size, shape, charge distribution, spin, parity and magnetic moment – binding energy – semi empirical mass formula – Mass parabolas – Nuclear models – liquid drop model, evidence of shell model, single particle shell model, its validity and limitations, collective model– Nuclear forces – nature of nuclear forces – charge independence – deuteron – forms of nuclear potentials - Charge symmetry - non-central (tensor) forces – ground state of deuteron – exchange forces –Yukawa meson theory	15
II	Radioactive decays	Alpha decay – Gamow's theory – Geiger Nuttall law – Neutrino hypothesis – Fermi's theory of beta decay – Selection rules – Non conservation of parity in beta decay – Gamma decay - Selection rules – Internal Conversion – Nuclear isomerism - Interaction of nuclear radiation with matter – stopping power, range and straggling - Nuclear radiation detectors – Solid state detectors - Geiger-Muller counter.	15
III	Nuclear fission and fusion	Nuclear fission – types - Mass and energy distribution of nuclear fragments – Bohr Wheeler's theory of nuclear fission - Fission reactors – Power and breeder type reactors - Nuclear chain reactions – Four factor formula – Nuclear Fusion – Solar fusion – Controlled thermonuclear reactors – Pinched discharge, stellarator, magnetic mirror system, beam injection.	10
IV	Nuclear Reactions	Nuclear reactions – types – conservation laws – Q-equation – Nuclear reaction cross sections – Partial wave analysis – Compound nucleus model – Resonance scattering – Breit Wigner one level formula – Direct reactions – Stripping and pick up reactions. Scattering Process The scattering cross section – scattering amplitude – Expression in terms of Green's function – Born approximation and its validity – Screened Coulomb potential – Alpha particle scattering – Rutherford's formula.	10
V	Elementary particles	Four types of interactions and classifications of elementary particles – Isospin – Isospin quantum numbers – Strangeness and hyper charge – Hadrons – Baryons – Leptons – Invariance principles and symmetries – Invariance under charge-parity (CP), time (T) and CPT – CP violation in neutral K-meson decay – Quark model – SU(3) symmetry – Gell-Mann Nishijma formula – Gauge theory of weak and strong interactions – Charm, bottom and top quarks.	10

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. Nuclear Physics - D.C.Tayal, Himalaya Publishing House, 2017.
2. Concepts of Nuclear Physics - B.L.Cohen, Tata McGraw Hill, New Delhi, 1983.

Books for Reference

1. Nuclear Physics - R.R.Roy and B.P.Nigam, Wiley Eastern Ltd., New Delhi, 1986.
2. Introduction to Nuclear Physics - H.A.Enge, Addision Wesley, New York, 1971.
3. Introduction to Atomic and Nuclear Physics -H.Semat, Chapman and Hall, New Delhi, 1983.
4. Introduction to Elementary particles - D.Griffiths, Wiley International Edition, New York, 1987.
5. Nuclear and Particle Physics - W.S.C.Williams, Clarendon Press, London, 1981.
6. Introductory Nuclear Physics - K.S.Krane, John Wiley, New York, 1987.

PRACTICAL– IV: COMPUTATIONAL PROGRAMMING AND SIMULATION

COURSE CODE: 18PGPHYC16

MAXIMUM MARKS: 100

HOURS

L	T	P	C
2	0	4	6

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 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.

Books for Reference

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

NANOSCIENCE

COURSE CODE: 19PGPHYE01 **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To understand the theoretical back ground of nanosciences.
- To learn the fabrication methods of metal, semiconductor and ceramic nanoparticles.
- To study the magnetic properties of nanoparticles.
- To understand the thermal behavior of nanoparticles.
- To learn the various applications of nanoparticles.

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

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

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme Specific qualification attribute K1, K2, K3, K4)	Hours of Instruction
I	Introduction to 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 tunneling.	15
II	Metals, semiconductors and ceramic nanocrystals	Reduction of size – Synthesis of metal nanoparticles and structures – Routes to arrangements – Background on Quantum Dot semiconductors - background on reverse Micellar solution – Synthesis of Semiconductors – Cadmium Telluride Nanocrystals – Cadmium sulfide Nanocrystals – Alloy Semiconductors – 2D and 3D Superlattices of Silver Sulfide Nanocrystals– Synthesis of Ceramics – Bondings and defects - Chemical, Physical and Mechanical properties of Ceramics.	15
III	Nanoparticles and magnetism	Magnetism in particles of reduced size and dimensions – variations of magnetic moment with size – magnetism in clusters of nonmagnetic solids – magnetic behavior of small particles – diluted magnetic semiconductors (DMS) – Fe – DMS and IV-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 – Nanocrystal Superlattices - Specific Heat and Melting Points of Nanocrystalline Materials: Specific Heat of Nanocrystalline materials – melting points of Nanoparticle materials.	10
V	Applications 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

Tutorial

Quantum mechanics of 0D, 1D, 2D and 3D systems, calculation of energy level separation in low dimensional systems, probability of finding a particle in a particular level. Synthesis of nanomaterials using micelles and reverse micelles. Superparamagnetic and dilute magnetic semiconductors. Medical, catalytic and structural applications of nanomaterials.

Books for Study

1. Nanoscale Materials in Chemistry - Kenneth J.Klabunde, A John Wiley & Sons, Inc.,Publication, 2009.
2. Nanoscience and Nanotechnology: Fundamentals to Frontiers - M.S.RamachandraRao, 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 - GuozhongGao, Imperial College Press, London, 2004.
3. Metal Oxides - V. Henrich, P.A.Cox, Cambridge University Press, New York, 1994.
4. NATO ASI Series, Science and Technology of Nanostructured Magnetic Materials - Ed. George C. Hadjipanyis and Gary A.Prinz, , Plenum Press, New York, 1991.
5. Introduction to Magnetism and Magnetic Materials - D.Jiles, Chapman and Hall, London, 1991.
6. Physics and Chemistry of Metal Cluster Compounds - J.deJongh, Kluwer Academic Publishers, Dordrecht, 1994.

MICROPROCESSOR & MICROCONTROLLER

COURSE CODE: 18PGPHYE02
MAXIMUM MARKS: 100

HOURS

L	T	P	C
3	1	0	4

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 microcontrollers.

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

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

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme Specific qualification attribute K1, K2, K3, K4)	Hours of Instruction
I	Architecture of 8085	Architecture of 8085 – Organization of 8085: Control, data and address buses – registers in 8085 – Addressing modes of 8085 – Instruction set of 8085-Timing and sequencing: Instruction cycle, machine cycle– Timing diagram for opcode fetch, memory read and write cycles. Interrupts: maskable and non-maskable.	15
II	Architecture of 8086	Memory organization, Register organization: General purpose, index, pointer, segment registers and flags – Bus structure: data bus, address bus, effective & physical address and pipelining. Addressing modes of 8086: Register, immediate, direct and indirect addressing.	15
III	Applications of Microprocessors	Microprocessor based temperature monitoring systems – limit setting – operator panel – block diagram. Assembly language programming, Simple programs using arithmetic and logical operations. Analog to digital conversion using ADC 0809 interfacing through PPI 8255 – Block diagram.	15
IV	Architecture of Microcontroller 8051	Introduction – Comparison between microcontroller and microprocessors - Architecture of 8051 – Key features of 8051 – Memory organization – Data memory and program memory – internal RAM organization – Special function registers – Control registers – Counters and timers – Interrupt structure.	15
V	Programming The Microcontroller 8051	Instruction set of 8051 – Arithmetic, Logical, Data move, jump and call instructions, Addressing modes: Immediate, register, direct and indirect addressing modes– Simple programs to illustrate arithmetic and logical operations (Sum of numbers, biggest and smallest in an array) – Softwaretime delay.	15

Tutorial

Basic programs from Microprocessor 8085 & 8086 and Microcontroller 8051.

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Books for Study

1. Microprocessors and its applications - A. P. Godse and D. A. Godse Technical Publications, Pune, 2009.
2. The 8051 Microcontroller – Kenneta J. Ayala, Penram International publications, India, Third Edition, 2005.

Books for Reference

1. Introduction to Microprocessors – Aditya P.Mathur, Tata McGraw Hill Company, Second Edition, 2006.
2. Microprocessor Architecture, Programming and Application with 8085 - Ramesh S.Gaonkar, Wiley Eastern Publications, 2013.
3. Introduction to Microprocessors Software, Hardware Programming - Lance A. Leventhal. Praentice Hall of India, Edition, 2011.
4. Microprocessors and programmed logic - Kenneth L. Short, Prentice Hall of India, Second Edition, 2009.
5. The 8051 Microcontroller and Embedded systems using Assembly and C - Muhammad Ali Maizidi, Pearson Education India, Second Edition, 2009.

MODERN OPTICS

COURSE CODE: 19PGPHYE03

HOURS

L	T	P	C
3	1	0	4

MAXIMUM MARKS: 100

COURSE OBJECTIVES:

- To understand quantum nature of light promote from the Maxwell theories and to study the propagation of light.
- To understand and study the optical devices to manipulate of light waves and Fourier transformation of light.
- To learn the basics of nonlinear optics and to study their effects.
- To study the image of processing techniques (Holography) and understand phase and amplitude problems.
- To understand and study the various types of microscopic instrumentation techniques.

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

CO1	Explain the basic concepts applied in Optics. Understands the basic phenomenon such as Dispersion, Optical anisotropy, birefringence and polarization.
CO2	Understand the optical devices to manipulate light and Fourier transformation.
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 microscopy imaging for practical application.

The Mapping of the course outcomes with programme outcome:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3,K4)	Hours of Instruction
I	Wave nature and Light Propagation	Electromagnetic wave propagation - Harmonic waves - phase velocity - group velocity - energy flow - Poynting vector - Wave motion - equation - superposition of waves - interference - diffraction - basics of coherence theory - Michelson and Fabry-Perot interferometer - Scattering and polarization - types - Birefringence.	18
II	Optical engineering and Fourier Optics	Image formation (first-order optics) - aberrations - prisms and mirrors - stops and apertures - basic optical devices - the design of optical systems: general, aplanatic points, solid immersion lens, numerical aperture increasing lens. Fourier optics - Thin lens as phase transformation -Thickness function - Various types of lenses.	16
III	Non-Linear Optics	Non-linear optics – principle - nonlinear wave equation - second order non-linear optics - second harmonic generation - phase matching -frequency conversion - electro optic effect - three wave mixing. Third order non-linear optics -third harmonics generation - optical Kerr effect.	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 & imaging techniques	Basics of optical microscopy - bright field and dark field microscopy - polarizing microscopy - phase contrast 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. Fundamental Optics - Francis Jerkins and Harvey White, McGraw Hill Inc., New Delhi, Fourth Edition, 2011
2. A text book of Optics - N.Subramaniyam, Brijlal and M.N.Avadhanulu, S.Chand&Co, NewDelhi, Twenty Fifth Edition, 2012.

Books for Reference

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

X-RAY CRYSTALLOGRAPHY

COURSE CODE: 19PGPHYC **HOURS**

MAXIMUM MARKS: 100

L	T	P	C
3	1	0	4

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.
- To know the Data reduction, structure factor and Fourier syntheses.
- To understand the Phase problem when solving the complete structure.
- To know the refinement, error and derived results.

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

CO1	Understand the basic concepts of crystals and their properties.
CO2	Apply principles of data collections various intensity methods.
CO3	Interepretation of intensity data to correlate structure factor and Fourier syntheses.
CO4	Find the crystal structure of an unknown material.
CO5	Identification of molecular geometry and errors.

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attribute K1, K2, K3, K4)	Hours of Instruction
I	X-rays	X-rays sources – conventional generators-construction and geometry-sealed tube–rotating anode generators–choice of radiation-Synchrotron radiation – X-ray optics: filters–monochromators–collimators-mirrors- 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 – limiting sphere. Symmetry of crystals: Crystal systems and symmetry – unit cell – space lattices- nonprimitive lattices – point groups–space groups–screw axes–glide planes-equivalent positions–matrix representation of symmetry-intensity weighted reciprocal lattice – analysis of space group symbols. Crystals and their properties**:** Crystallization – growing crystals – choosing a crystal –mosaic structure-absorption- crystal mounting–alignment – measurement of crystal properties.	15
II	Data collection techniques for single crystals	Laue method–single crystal diffraction cameras: rotation and oscillation method – Ewald construction – Weissenberg method – Precession method. Single crystal diffractometers and data collection strategy: Instrument geometry–crystal in a diffracting position–determination of unit cell–orientation matrix–Intensity Data collection–Unique data–equivalent reflections – selection of data–Intensity measurement methods: Film methods–counter methods: Point detector–Area detectors–CCD's–Image plates–Low temperature single crystal diffractometry.	15
III	Data Reduction	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 – Fourier synthesis –Fast Fourier transform – Anomalous scattering and its effect– Calculation of structure factors and Fourier syntheses.	15
IV	Phase Problem	Methods of solving Phase Problem: Direct methods – Patterson methods – Heavy atom methods – molecular replacement- search methods – completing the structure.	15
V	Refinement of crystal structures	Weighting – Refinement by Fourier syntheses – Locating Hydrogen atoms- identification of atom types – Least squares – goodness of fit– Least square and matrices-correlation coefficients–Relationship between Fourier and Least squares – Practical consideration in least squares methods.	15

		Errors and Derived results : Random and systematic errors –derived results – molecular geometry – absolute configuration –thermal motion.	

Tutorial

Lattice-Crystal planes-Miller indices-symmetry and space groups-Bragg's Law-Calculation of structure factors.

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, VCHPublishers 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.

ENERGY PHYSICS

COURSE CODE: 18PGPHYE05

MAXIMUM MARKS: 100

HOURS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To know and study about 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 OUTCOMES: After the completion of the course, Students will be able to

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

The 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	Unit Title	Intended learning Chapters (Programme specific qualification attribute K1, K2, K3,K4)	Hours of Instruction
I	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.	15
II	Renewable energy	Wind energy – basic principle and components of wind energy conversion system - types of wind machines – scheme of electric generation – application of wind energy – Hydrogen energy – hydrogen production – storage – utilization of hydrogen gas – hydrogen as an alternative fuel for motor vehicles – safety and management.	15
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.	15
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.	15
V	Additional alternate energysources	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.	15

Tutorial

Hydrogen production, Biomass conversion Technologies, Utilization of biogas, Solar cell electrical characteristics, Magneto hydro dynamic

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, McGrew 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.

PHOTOVOLTAIC SCIENCE

COURSE CODE: 18PGPHYE06 **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 students able to

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.

The 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	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3, K4)	Hours of Instruction
I	Introduction to Photovoltaics	Introduction - History of photovoltaics - Silicon P-N junction – Types and adaptations of photovoltaics - Photovoltaic circuit properties - Applications. 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.	17
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.	18
III	Amorphous Silicon Solar cell	Amorphous silicon: The first bipolar amorphous semiconductor- designs for amorphous silicon solar cells - Staebler-Wronski Effect - Atomic and Electronic Structure of Hydrogenated Amorphous silicon: Atomic structure - defects and metastability - electronic density of states -bandtails, bandedges, and band gaps-defects and gap states-doping - alloying and optical properties - Depositing Amorphous Silicon: Deposition Techiniques - RF glow discharge deposition - Glow discharge deposition at different frequencies - Hot wire chemical vapor deposition.	15
IV	Cadmium Telluride Solar Cells	Introduction - CdTe Properties and Thin-film Fabrication Methods -Condensation/Reaction of Cd and Te_2Vapors on a Surface- Galvanic Reduction of Cd and Te Ions at a Surface-Precursor Reaction at a Surface-Window Layers - CdTe Absorber Layer and $CdCl_2$ Treatment - CdS/CdTe Intermixing - Back Contact - Solar Cell Characterization - CdTe modules.	15
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 TiO2 electrode - Redox Electrolyte - Counter electrode - Assembling the cell and cell performance.	17

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.

INSTRUMENTAL METHODS OF ANALYSES

COURSE CODE: 19PGPHYE07 **HOURS**
MAXIMUM MARKS: 100

L	T	P	C
3	1	0	4

COURSE OBJECTIVE

- To provide the basic principle, working and instrumentation of various analytical tools.
- To study the electronic, electrical, optical, thermal properties of materials.
- To provide the knowledge on the types of errors in analysis and their evaluation.

COURSE OUTCOME

After completion of the course the students will be able to

CO1	Explain the types of errors in experimental methods of analysis.
CO2	Understand the principle and working of thermal methods of analysis such as thermogravimetric analysis and differential scanning calorimetric analysis and apply for material analysis.
CO3	Understand and apply x-ray diffraction method for analysing crystalline materials.
CO4	Utilize luminescence methods and electron microscopy methods for material analysis and their application.
CO5	Apply various analytical methods for electrical property measurement.

Mapping of course outcomes with programme outcomes:

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

Syllabus

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3,K4)	Hours of Instruction
I	Errors and Analysis of Experimental Data	Types of errors – Mean, variance and standard deviation, standard deviation of standard deviation – sampling techniques – Chi square test. Experimental Stress Analysis: Stress analysis by strain gauging- high temperature strain gauge techniques – photoelasticity and holography.	15
II	Thermal Analysis	Introduction – thermo gravimetric analysis – instrumentation of weight loss and decomposition products – differential scanning calorimetric – instrumentation – specific heat capacity measurements – determination of thermo chemical parameters – differential thermal analysis – basic principles – melting point determination and analysis.	15
III	III X-ray Analysis	Single Crystal and powder diffraction – Diffractometer – interpretation of diffraction patterns – indexing – unknown and phase identification – double and four crystal Diffractometer for epitaxial characterization – lattice mismatch – tetragonal distortion – thin film characterization – X-ray fluorescence spectroscopy – uses.	15
IV	Optical Methods and Electron Microscopy	Photoluminescence – light-matter interaction – fundamental transitions – excitons – instrumentation – electroluminescence – instrumentation – photo reflectance-electronic transitions – behavior of electronic transitions as a function of electric field. Principles of SEM, TEM, EDAX, AFM, EPMA – Instrumentation – sample preparation – analysis of materials – study of dislocations – ion implantation – uses – Nanolithogrphy.	15
V	Electrical Methods	Hall Effect – carrier density – resistivity – two probe and four probe methods – scattering mechanism – van der pauw method – CV characteristics – Schottky barrier capacitance – impurity concentration – electrochemical CV profiling – limitations.	15

Books for Study and Reference

1. Instrumental Methods of Analysis - Willard.M, Steve.D, CBS Publishers, New Delhi, 1986.
2. Electron Microscopy and Microanalysis of Crystalline materials - Stradling, R.A, Applied Science Publishers, London, 1979.
3. Electron microscopy and Microanalysis of Crystalline Materials - Belk.J.A, Applied Science Publishers, London, 1979.
4. Modern Metallographic Techniques and their Applications - Philips V.A, Wiley Interscience, 1971.

ELECTRONICS IN DAILY LIFE

COURSE CODE: 18PHYS01
MAXIMUM MARKS: 100

HOURS

L	T	P	C
3	0	0	3

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

CO1	To identify the function of different components of electronic circuit.
CO2	To learn and acquire a basic knowledge on the various components such as iron box, Fan, Electric oven etc., used in day to day life.
CO3	To study various display system and its application.
CO4	To 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 Hi-Fi devices.

Mapping of course outcome with the program outcome

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

<u>Syllabus</u>

Unit	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3,K4)	Hours of Instruction
I	Fundamentals of Electronic component	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	Communications 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: 19PGPHYS02
MAXIMUM MARKS: 100

HOURS

L	T	P	C
3	0	0	3

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 this course the students will be able to

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	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3,K4)	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.

LASER PHYSICS AND ITS APPLICATIONS

COURSE CODE: 18PGPHYS03
MAXIMUM MARKS: 100

HOURS

L	T	P	C
3	1	0	4

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 students able 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.

The 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	Unit Title	Intended Learning Chapters (Programme specific qualification attributes K1, K2, K3,K4)	Hours of Instruction
I	Basic Physics on the Operation of Lasers	Einstein's theory – Interaction of radiation with matter – Theory of some simple processes.	7
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.	7
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.	7
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

Tutorial

Lasing action Role of feedback - blackbody radiation.-Caussian beam in spherical mirror cavity - Longitudinal and transverse modes - Losses and Q-factor.-Single mode laser theory- line widths.

Books for Study and Reference

1. Principle of Lasers - GrazioSvelto, 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.
5. Lasers - Ghatak and Thyagarajan, Second Edition, 2011.

ONLINE COURSES

(Swayam/NPTL/Coursera)

There are two Swayam courses introduced for this PG course, of which, each course carry maximum 2 credits. The title and the syllabus of the course is available in the Swayam website; as per instruction PG student has to choose one course every year (either even or odd semester) with the help of Department.

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2. Molecular Modelling
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4. Crystal growth Techniques
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6. Yoga
7. Fabrication of Solar cell
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9. Non-linear Optics