Holy Cross College (Autonomous), Nagercoil

Kanyakumari District, Tamil Nadu.

Accredited with A$^+$ by NAAC - IV Cycle – CGPA 3.35

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

Semester I - IV

Guidelines & Syllabus

DEPARTMENT OF PHYSICS

2023-2026

(With effect from the academic year 2024-2025)

Issued from

THE DEANS' OFFICE

Vision

Envisions training students for quality Physics education and holistic development empowered to meet challenges and embark on luxuriant careers.

Mission

- To produce competent graduates infused with professionalism, ethical values and social responsibility.
- To prepare students to accentuate learning for life.
- To foster a research environment, to keep up with global development in Science.
- To evolve strategies for the growth of the department towards excellence.

Graduate Attributes

Graduates of our College develop the following attributes during the course of their studies.

- **Creative thinking:**

  Equipping students with hands-on-training through skill based courses and promote startup.
- **Personality development:**

  Coping with increasing pace and change of modern life through value education, awareness on human rights, gender issues and giving counselling for the needful.
- **Environmental consciousness and social understanding:**

  Reflecting upon green initiatives and understanding the responsibility to contribute to the society; promoting social and cultural diversity through student training and service learning programmes.
- **Communicative competence:**

  Offering effective communication skills in both professional and social contexts through bridge courses and activities of clubs and committees.
- **Aesthetic skills:**

  Engaging mind, body and emotions for transformation through fine arts, meditation and exercise; enriching skills through certificate courses offered by Holy Cross Academy.
- **Research and knowledge enrichment:**

  Getting in-depth knowledge in the specific area of study through relevant core papers; ability to create new understanding through the process of critical analysis and problem solving.
- **Professional ethics:**

  Valuing honesty, fairness, respect, compassion and professional ethics among students. The students of social work adhere to the *National Association of Social Workers Code of Ethics*
- **Student engagement in the learning process:**

  Obtaining extensive and varied opportunities to utilize and build upon the theoretical and empirical knowledge gained through workshops, seminars, conferences, industrial visits and summer internship programmes.
- **Employability:**

  Enhancing students in their professional life through Entrepreneur development, Placement & Career guidance Cell.
- **Women empowerment and leadership:**

  Developing the capacity of self-management, team work, leadership and decision making through gender sensitization programmes.

Programme Educational Objectives (PEOs)

PEOs	Upon completion of M. Sc. Physics Programme, the graduates will be able to:	Mapping with Mission
PEO1	apply scientific and computational technology to solve social and ecological issues and pursue research.	**M1, M2**
PEO2	continue to learn and advance their career in industry both in private and public sectors.	**M4 & M5**
PEO3	develop leadership, teamwork, and professional abilities to become a more cultured and civilized person and to tackle the challenges in serving the country.	**M2, M5 & M6**

Programme Outcomes (POs)

POs	Upon completion of M.Sc. Physics Degree Programme, the graduates will be able to:	Mapping with PEOs
PO1	apply their knowledge, analyze complex problems, think independently, formulate and perform quality research.	**PEO1 & PEO2**
PO2	carry out internship programmes and research projects to develop scientific and innovative ideas through effective communication.	**PEO1, PEO2 &PEO3**
PO3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe.	**PEO2**
PO4	develop innovative initiatives to sustain ecofriendly environment	**PEO1, PEO2**
PO5	through active career, team work and using managerial skills guide people to the right destination in a smooth and efficient way.	**PEO2**
PO6	employ appropriate analysis tools and ICT in a range of learning scenarios, demonstrating the capacity to find, assess, and apply relevant information sources.	**PEO1, PEO2 &PEO3**
PO7	learn independently for lifelong executing professional, socialand ethical responsibilities leading to sustainable development.	**PEO3**

Programme Specific Outcomes (PSOS)

PSOs	Upon completion of M.Sc. Physics Degree Programme, the graduates of Physics will be able to:	Mapping with POs
PSO1	have well– defined knowledge on theoretical concepts and experimental methods of advanced physics.	**PO1 & PO2**
PSO2	acquire skills in performing advanced physics experiments and projects using modern technology and numerical simulations.	**PO3, PO4 &PO5**
PSO3	develop and communicate analytical skills ranging from nuclear to cosmology to progress in the expanding frontiers of physics.	**PO6**
PSO4	apply and interpret physics principles in various physical observations. Demonstrate proficiency in analyzing, applying and solving Scientific problems.	**PO1, PO7**
PSO5	use the techniques, skills, and modern technology necessary to communicate effectively with professional and ethical responsibility. Understand the impact of Physics in a global, economic, environmental, and societal context.	**PO7**

Mapping of POs and PSOs

POs	PSO1	PSO2	PSO3	PSO4	PSO5
PO1	**S**	**S**	**M**	**S**	**M**
PO2	**S**	**S**	**S**	**S**	**M**
PO3	**S**	**S**	**S**	**M**	**S**
PO4	**M**	**M**	**M**	**M**	**S**
PO5	**S**	**S**	**M**	**M**	**S**
PO6	**M**	**M**	**M**	**M**	**M**
PO7	**S**	**S**	**M**	**M**	**S**

Strong -S (3), Medium – M (2), Low – L (1)

Eligibility Norms for Admission

A pass in the B.Sc Physics as major with the minimum of 50% in major and major related courses or equivalent examination as per the norms of Manonmaniam Sundaranar University, Tirunelveli. For SC / ST candidates a pass in B.Sc. Physics is sufficient.

Duration of the Programme: 2 years

Medium of Instruction: English

Passing minimum

A minimum of 50% in the external examination and an aggregate of 50% is required. There is no minimum pass mark for the continuous internal assessment.

Components

Courses	No of Courses	Total Marks
Core Courses	9x100	900
Core Lab Course	4x100	400
Core Research Project	1x100	100
Elective courses	6x100	600
Total	**20x100**	**2000**

Course Structure

Distribution of Hours and Credits

(i) Curricular Courses:

Course	Sem.I	Sem.II	Sem.III	Sem.IV	Total	
					Hours	Credits
Core– Theory	7 (5) + 6 (5) + 6 (4)	6 (5)+ 6 (5)	6 (5) + 6 (5)	6 (5) + 6 (5)	79	61
Core Lab Course	6 (3)	6 (4)	6 (5)	6 (5)		
Elective Course	5 (3)	4 (3) 4 (3)	4(3)	4 (3) + 4(3)	25	18
Core Research Project			5 (4)		5	4
Skill Enhancement Course		4 (2)	3 (2)	4 (2)	11	6
Internship/ Industrial Activity			(2)		-	2
Extension Activity					-	
Total	**30 (20)**	**30 (22)**	**30 (26)**	**30 (23)**	**120**	**91**

(ii) Co-curricular Courses

Course	Semester				Total
	I	II	III	IV	Credits
Life Skill Training –I	-	(1)	-	-	1
Life Skill Training –II	-	-	-	(1)	1
Field Project	(1)		-		1
Specific Value-Added Courses	(1)		(1)		2
Generic Value-Added Courses		(1)		(1)	2
MOOC		(1)		(1)	2
Community Engagement Activity (UBA)		(1)			1

Total Number of Hours = 120
Total Number of Credits = 91 + 10

Non- academic courses are mandatory and conducted outside the regular working hours.

Courses Offered

SEMESTER I

Course Code	Title of the Course	Credits	Hours / Week
PP231CC1	Core Course I: Mathematical Physics	5	7
PP231CC2	Core Course II: Classical Mechanics and Relativity	5	6
PP231CC3	Core Course III: Linear and Digital ICs and applications	4	6
PP231CP1	Core Lab Course I- Advanced Physics Lab-I	3	6
PP231EC1	Elective Course I: a) Energy Physics	3	5
PP231EC2	Elective Course I: b) Crystal Growth and Thin Film Materials		
PP231EC3	Elective Course I: c) Material Science		
	Total	**20**	**30**

SEMESTER II

Course Code	Title of the Course	Credits	Hours / Week
PP232CC1	Core Course IV: Statistical Mechanics	5	6
PP232CC2	Core Course V: Quantum Mechanics	5	6
PP232CP1	Core Lab Course II- Advanced Physics Lab-II	4	6
PP232EC1	Elective Course II: a) Advanced Optics	3	4
PP232EC2	Elective Course II: b) Non-Linear Dynamics		
PP232EC3	Elective Course II: c) Quantum Field Theory		
PP232EC4	Elective Course III: a) Medical Physics	3	4
PP232EC5	Elective Course III: b) Advanced Spectroscopy		
PP232EC6	Elective Course III: c) Characterization of Materials		
PP232SE1	Skill Enhancement Course I: NME I Solar Energy Utilization	2	4
	Total	**22**	**30**

SEMESTER III

Course Code	Title of the Course	Credits	Hours / Week
PP233CC1	Core Course VI: Condensed Matter Physics	5	6
PP233CC2	Core Course VII: Electromagnetic Theory	5	6
PP233CP1	Core Lab Course III- Advanced Physics Lab-III Programming in Microprocessor and Microcontroller	5	6
PP233RP1	Core Research Project	4	5
PP233EC1	Elective Course IV: a) Communication Electronics	3	4
PP233EC2	Elective Course IV: b) Microprocessor and Microcontroller		
PP233EC3	Elective Course IV: c) Advanced Mathematical Physics		
PP233SE1	Skill Enhancement Course II Sewage and Waste Water Treatment and Reuse	2	3
PP233IS1	Internship	2	-
	Total	**26**	**30**

SEMESTER IV

Course Code	Title of the Course	Credits	Hours / Week
PP234CC1	Core Course VIII: Nuclear and Particle Physics	5	6
PP234CC2	Core Course IX: Spectroscopy	5	6
PP234CP1	Core Lab Course IV- Advanced Physics Lab-IV Numerical Methods and Computer Programming C++	5	6
PP234EC1	Elective Course V: a) Numerical Methods and Computer Algorithms	3	4
PP234EC2	Elective Course V: b) Analysis of Crystal Structures		
PP234EC3	Elective Course V: c) Plasma Physics		
PP234EC4	Elective Course VI: a) Physics of Nanoscience and Technology	3	4
PP234EC5	Elective Course VI: b) Bio Physics		
PP234EC6	Elective Course VI: c) General Relativity and Cosmology		
PP234SE1	Skill Enhancement Course III Solid Waste Management	2	4
	Total	**23**	**30**

Co-curricular Courses

Semester	Code	Title of the Course	Credit
I & II	PG23LST1	Life Skill Training	1
II & IV	-	MOOC	1+1
II	PG232CE1	Community Engagement Activity	1
III & IV	PG23LST2	Life Skill Training	1
I	PP231FP1	Field Project	1
I & III	PP231V01 / PP233V01	Specific Value-added Course	1+1
II & IV	GVAC2401-	Generic Value-added Course	1+1
Total			**10**

Specific Value added Course

Semester	Title of the Course	Course Code
I	Computer Maintenance	PP231V01
I	Fundamentals of Communication	PP231V02
III	Sensor based Appliances	PP233V01
III	Recent Advances in Astrophysics	PP233V02

Self-Learning Course

Semester	Title of the Course	Course Code
III	National Eligibility Test : Physics- I	PP233SL1
IV	National Eligibility Test : Physics- II	PP234SL1

Examination Pattern

Curricular Courses:

i) Core Course / Elective Course

Internal: External–25:75

Continuous Internal Assessment (CIA)

Internal Components and Distribution of Marks

Components	Marks
Internal test (2) (40 marks)	10
Quiz (2) (20 marks)	5
Seminar (10 marks)	5
Assignment: (Model Making, Exhibition, Role Play, Group Discussion, Problem Solving, Class Test, Open Book Test (Minimum three items per course) (30 marks)	5
Total	**25**

Question Pattern

Internal Test	Marks	External Exam	Marks
Part A 4 x 1 (No choice)	4	Part A 10 x 1 (No choice)	10
Part B 2 x 6 (Internal choice)	12	Part B 5 x 6 (Internal choice)	30
Part C 2 x 12 (Internal choice)	24	Part C 5 x 12 (Internal choice)	60
Total	**40**	**Total**	**100**

ii) Core Lab Course:

Ratio of Internal and External= 25:75

Total: 100 marks

Internal Components and Distribution of Marks

Internal Components	Marks
Performance of the Experiments	10
Regularity in attending practical and submission of records	5
Record	5
Model exam	5
Total	**25**

Question pattern

External Exam	Marks
Major Practical	75
Minor Practical / Spotters /Record	
Total	**75**

iii) Core Research Project:

Ratio of Internal and External **25: 75**

Internal (Supervisor)	**Marks**
I Review	5
II Review	5
Report	15
External (External Examiner)	
Report	40
Viva-voce (individual, open viva-voce)	35
Total	**100**

iv) Skill Enhancement Course

Ratio of Internal and External = 2**5: 75**

Internal Components and Distribution of Marks

Components	**Marks**
Internal test (2) – (40 marks)	10
Quiz (2) – (20 marks)	5
Assignment: (Model Making, Exhibition, Role Play, Album, Group Activity (Mime, Skit, Song) (Minimum three items per course)	10
Total	**25**

Question Pattern

Internal Test	**Marks**	**External Exam**	**Marks**
Part A 2 x 2 (No Choice)	4	Part A 5 x 2 (No Choice)	10
Part B 3 x 4 (Open choice **Three** out of **Five**)	12	Part B 5 x 4 (Open choice any **Five** out **of Eight**)	20
Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 9 (Open choice any **Five** out **of Eight**)	45
Total	**25**	**Total**	**75**

(v)Internship

Components	**Marks**
Industry Contribution	50
Report & Viva-voce	50
Total	**100**

Co-Curricular Courses:

(i) Life Skill Training

Internal Component

Components		**Marks**
Life Skill Training -I	Album (20 pages)	30
	Group Activity (Group of 5 students)	20
	Total	**50**
Life Skill Training -II	Case Study (30 pages)	50
	Total	**50**

External Component

Written Test	Five out of Seven (5 x 10)	50
	Total	**50**

(ii) Field Project:

Components	**Marks**
Field Work	50
Field Project Report & Viva-voce	50
Total	**100**

(iii) Specific Value-Added Courses & Generic Value-Added Courses:

Components	Marks
Internal	25
External	75
Total	**100**

(iv) Community Engagement Activity-UBA

Internal Component	
Component	**Marks**
Attendance (Field Work)	30
Participation	20
Total	**50**

External Component

Component	Marks
Group Project Report/ Case Study (10-15 pages in print)	50
Total	**50**

(v) Self Learning Course

Ratio of Internal and External = 25: 75

Internal Test	Marks	External Exam	Marks
Part A 7 x 1 (No Choice)	7	Part A 15 x 1(No Choice)	15
Part B 3 x 2 (No Choice)	6	Part B 10 x 2 (No Choice)	20
Part C 3 x 4 (No Choice)	12	Part C 10x 4 (No Choice)	40
Total	**25**	**Total**	**75**

Outcome Based Education (OBE)

(i) Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S. No.	Level	Parameter	Description
1	KI	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analysing	The learner distinguishes among different parts
5	K5	Evaluation/Evaluating	The learner justifies a stand or decision
6	K6	Synthesis /Creating	The learner creates a new product or point of view

(ii) Weightage of K – levels in Question Paper

Number of questions for each cognitive level:

Assessment	Cognitive Level	KI			K2			K3			K4, K5, K6			Total
Internal Test	Part	A	B	C	A	B	C	A	B	C	A	B	C	
	No. of Questions	1	1	-	-	-	-	1	-	1	2	1	1	**8**
External Examination	Part	A	B	C	A	B	C	A	B	C	A	B	C	
	No. of Questions	3	-	1	3	1	1	1	2	1	3	2	2	**20**

The levels of assessment are flexible and it should assess the cognitive levels and outcome attainment.

Evaluation

i. The performance of a student in each Course is evaluated in terms of percentage of marks with a provision for conversion to grade points.
ii. Evaluation for each Course shall be done by a Continuous Internal Assessment (CIA) by the Course teacher as well as by an end semester examination and will be consolidated at the end of the semester.
iii. There shall be examinations at the end of each semester, for odd semesters in October / November; for even semesters in April / May.
iv. A candidate who does not pass the examination in any course (s) shall be permitted to re-appear in such failed course (s) in the subsequent examination to be held in October / November or April / May. However, candidates who have arrears in Practical Examination(s) shall be permitted to re-appear for their arrears only along with Regular Practical examinations in the respective semester.
v. Viva- voce: Each candidate shall be required to appear for Viva-voce Examination in defense of the Project.
vi. The results of all the examinations will be published in the College website.

Conferment of the Master's Degree

A candidate shall be eligible for the conferment of the Degree of Master of Arts / Science/ Commerce only if the minimum required credits for the programme thereof (91 +10 credits) is earned.

Grading System

For a semester examination:

Calculation of Grade Point Average for End Semester Examination:

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the course}}{\text{Sum of the credits of the courses (passed) in a semester}}$$

For the entire programme:

Cumulative Grade Point Average (CGPA) $\Sigma_n\Sigma_i C_{ni}G_{ni} / \Sigma_{ni}\Sigma_i C_{ni}$

$$CGPA = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

where

C_i - Credits earned for course i in any semester

G_i - Grade point obtained for course i in any semester

n - semester in which such courses were credited

Final Result

Conversion of Marks to Grade Points and Letter Grade

Range of Marks	Grade Points	Letter Grade	Description
90-100	9.0-10.0	O	Outstanding
80-89	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
00-49	0.0	U	Re-Appear
ABSENT	0.0	AAA	ABSENT

Overall Performance

CGPA	Grade	Classification of Final Results
9.5-10.0	O+	First Class – Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction*

8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0and above but below 6.5	A	
5.5and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-appear

*The candidates who have passed in the first appearance and within the prescribed semester are eligible.

SEMESTER I

CORE COURSE I: MATHEMATICAL PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231CC1	7	-	-	-	5	7	105	25	75	100

Pre-requisite:

Students should know the basic knowledge in matrices, vectors, differentiation, integration, and differential equations.

Learning Objectives:

1. To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program.
2. To extend their manipulative skills to apply mathematical techniques in their fields.
3. To help students apply Mathematics in solving problems of Physics.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them.	**K1, K2**
2	able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	**K2, K3**
3	analyze characteristics of matrices and its different types, and the process of diagonalization.	**K4**
4	solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	**K4 , K5**
5	to find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	**K2, K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**Linear Vector Space:** Basic concepts – Definitions- examples of vector space – Linear independence - Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure –linear operators – Dual space- ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator –Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation.	**21**
II	**Complex analysis:** Review of Complex Numbers -de Moivre's theorem- Functions of a Complex Variable- Differentiability -Analytic functions - Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem. Probability – Introduction – Addition rule of probability – Multiplication law of probability – Problems – Introduction to statistics – Mean, median, mode and standard deviations.	**21**
III	**Matrices:** Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices -Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem –Diagonalization.	**21**

IV	**Fourier Transforms and Laplace Transforms:** Definitions -Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function -Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Wave equation: Vibration of an infinite string and of a semi - infinite string. Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions- Application - Laplace equation: Potential problem in a semi - infinite strip.	**21**
V	**Differential Equations:** Second order differential equation- Sturm-Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function- One dimensional Green's function and Reciprocity theorem -Sturm-Liouville's type equation in one dimension & their Green's function	**21**
TOTAL		**105**

Self -Study	Isomorphism of vector space, Harmonic Functions, Rank of a Matrix Vibration of an infinite string, One dimensional Green's function

Textbooks:

1. George Arfken, Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
2. Chattopadhyay, P.K, 2013,Mathematical Physics (2nd edition), New Age, New Delhi
3. Gupta,B.D,2009, Mathematical Physics (4thedition), Vikas Publishing House, New Delhi.
4. Dass, H. K, Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.

Reference Books:

1. Zill, D. G, and Cullen,M.R, 2006, Advanced Engineering Mathematics,3rd Ed.Narosa, New Delhi.
2. Satya Prakash. (2005). Mathematical Physics. (4th ed.) New Delhi:S. Chand & Company Pvt. Ltd.

Web Resources:

1. www.khanacademy.org
2. https://youtu.be/LZnRlOA1_2I
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ
5. https://archive.nptel.ac.in/courses/115/106/115106086/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1	2	1	3	3	1	3	1
CO2	3	2	1	1	1	2	1	3	2	1	2	1
CO3	2	2	1	1	1	2	1	3	2	1	2	1
CO4	3	2	1	1	1	2	1	3	3	1	3	1
CO5	3	2	1	1	1	2	1	3	3	1	3	1
TOTAL	**14**	**10**	**5**	**5**	**5**	**10**	**5**	**15**	**13**	**5**	**13**	**5**
AVERAGE	**2.8**	**2**	**1**	**1**	**1**	**2**	**1**	**3**	**2.6**	**1**	**2.6**	**1**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

CORE COURSE II: CLASSICAL MECHANICS AND RELATIVITY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231CC2	6	-	-	-	5	6	90	25	75	100

Pre requisites:

Fundamentals of mechanics, Foundation in mathematical methods.

Learning Objectives:

1. To understand fundamentals of classical mechanics.
2. To understand Lagrangian and Hamiltonian formulation of mechanics and apply it to solve equation of motion.

Course Outcomes

Upon completion of this course the students will be able to:		
1	understand the fundamentals of classical mechanics.	**K2**
2	apply the principles of Lagrangian mechanics to solve the equations of motion of physical systems.	**K3**
3	apply the principles of Hamiltonian mechanics to solve the equations of motion of physical systems.	**K3**
4	analyze the small oscillations in systems and determine their normal modes of oscillations.	**K2, K4**
5	understand and apply the principles of relativistic kinematics to the mechanical systems.	**K2, K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**Principles of Classical Mechanics:** Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic &non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.	**18**
II	**Lagrangian Formulation:** D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.	**18**
III	**Hamiltonian Formulation:** Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.	**18**
IV	**Small Oscillations:** Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.	**18**
V	**Relativity**: Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations.	**18**
	TOTAL	**90**

Self-study	Principle of virtual work, Simple pendulum, One dimensional simple harmonic oscillator, Linear triatomic molecule Einstein's mass-energy relation

Textbooks:

1. H. Goldstein (2002), Classical Mechanics, 3rd Edition, Pearson Edu.
2. J. C. Upadhyaya (2014), Classical Mechanics, New Delhi: Himalaya Publishing. Co.
3. R. Resnick (1968), Introduction to Special Theory of Relativity, New Delhi: Wiley Eastern
4. R. G. Takwala and P.S. Puranik (1980), Introduction to Classical Mechanics, New Delhi: Tata – McGraw Hill
5. N. C. Rana and P.S. Joag (2001), Classical Mechanics, New Delhi: Tata – McGraw Hill

Reference Books:

1. K. R. Symon (1971), *Mechanics*, London: Addison Wesley.
2. S. N. Biswas (1999), *Classical Mechanics*, Kolkata: Books & Allied Ltd,
3. S.L. Gupta, V. Kumar and H.V. Sharma (1998), *Classical Mechanics*, Meerut: Pragati Prakashan Publications
4. Tom W.B. Kibble Frank and H. Berkshire (2004), *Classical Mechanics*, London: Imperial College press
5. Donald T. Greenwood (1997), *Classical Dynamics*, New Delhi: Dover Publication, New York.

Web Resources:

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html
3. https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
5. https://www.britannica.com/science/relativistic-mechanics

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO2	3	3	3	3	2.6	2.4	2.6	2	3	3	3	3
CO3	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO4	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO5	3	3	3	3	2.6	2.4	2.6	3	2	3	3	3
TOTAL	**15**	**15**	**15**	**15**	**13**	**12**	**13**	**14**	**14**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**3**	**2.6**	**2.4**	**2.6**	**2.8**	**2.8**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

CORE COURSE III: LINEAR AND DIGITAL ICS AND APPLICATIONS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231CC3	6	-	-	-	4	6	90	25	75	100

Pre-requisite: Knowledge of semiconductor devices, basic concepts of digital and analog electronics

Learning Objectives:

1. To introduce the basic building blocks of linear integrated circuits.
2. To introduce the concepts of waveform generation and introduce one special function ICs.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	remember the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	**K1 & K2**
2	develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	**K2 & K3**
3	apply knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	**K2& K5**
4	analyze about various techniques to develop A/D and D/A converters.	**K4 & K5**
5	evaluate and to create the knowledge about the CMOS logic, combinational and sequential circuits	**K3& K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**Integrated Circuits and Operational Amplifier:** Introduction; Classification of IC's, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit and Op-Amp; Characteristics.	**18**
II	**Applications of OP-AMP**: **Linear applications of OP-AMP:** Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters. **Non-linear applications of OP-AMP:** Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.	**18**
III	**Active filters, Timer and Phase locked loops:** **Active filters:** Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. **Timer and Phase locked loops:** Introduction to IC 555 timer, description of functional diagram, monostable and a stable operations and applications, Schmitt trigger, PLL - introduction, basic principle, phase detector/comparator, voltage-controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL	**18**
IV	**Voltage regulator: D to A and A to D converters:** **Voltage regulator:** Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator.	**18**

	D to A and A to D converters: Introduction, basic DAC techniques - weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.	
V	**CMOS logic, combinational circuits using TTL 74XX ICs and Sequential circuits using TTL 74XX ICs:** **Combinational circuits using TTL 74XX ICs:** Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154). Sequential circuits using TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).	**18**
TOTAL		**90**

Self-study	Basic information of Op-Amp 741, Square waveform generators Schmitt trigger, Counter type ADC, Universal Shift Register

Textbooks:

1. Roy Choudhury, D., Shail Jain, B.2012. Linear Integrated Circuit, (Fourth Edition). New Age International Pvt. Ltd., New Delhi, India.
2. Sergio Franco,. 1997, Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi, India.
3. Vijayendran,V. 2008. Introduction to Integrated electronics (Digital & Analog), S. Viswanathan Printers & Publishers Private Ltd, New Delhi, India.

Reference Books:

1. Floyd,.Jain, A.2009. Digital Fundamentals, 8th edition, Pearson Education, New Delhi, India.
2. Ramakant, A.,Gayakwad. 2012. OP-AMP and Linear Integrated Circuits, ForthEdition).Prentice Hall / Pearson Education, New Delhi, India.

Web Resources:

1. https://nptel.ac.in/course.html/digital circuits/
2. https://nptel.ac.in/course.html/electronics/operational amplifier/
3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effect-controlled-thyristors/
4. https://www.electrical4u.com/applications-of-op-amp/
5. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	3	2	2	3	2	3
CO2	3	2	3	3	3	2	2	2	3	2	2
CO3	3	2	2	3	3	2	2	2	3	3	2
CO4	3	2	3	3	2	2	2	2	3	2	3
CO5	2	2	3	3	2	2	2	3	2	2	2
TOTAL	**14**	**10**	**14**	**15**	**12**	**11**	**10**	**11**	**14**	**11**	**12**
AVERAGE	**2.8**	**2**	**2.8**	**3**	**2.4**	**2.2**	**2**	**2.2**	**2.8**	**2.2**	**2.4**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

CORE LAB COURSE I: ADVANCED PHYSICS LAB I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231CP1	-	-	6	-	3	6	90	25	75	100

Prerequisites:

Knowledge and hands on experience of basic general and electronics experiments of Physics.

Learning Objectives:

1. To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
2. To calculate the thermodynamic quantities and physical properties of materials.
3. To analyze the optical and electrical properties of materials.

Course Outcomes

On the successful completion of the course, students will able to:		
1	understand the strength of material using Young's modulus.	**K2**
2	acquire knowledge of thermal behaviour of the matetials.	**K1**
3	understand theoretical principles of magnetism through the experiments.	**K2**
4	acquire knowledge about the applications of laser	**K1**
5	improve the analytical and observation ability in Physics experiments	**K4**

K1 - Remember; **K2** – Understand; **K3** - Apply; **K4** - Analyze

Contents

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of Compressibility of a liquid using Ultrasonics
3. Measurement of Conductivity - Four probe method.
4. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
5. Measurement of Susceptibility of liquid - Quincke's method
6. Determine the slit width of a Fraunhofer single, double slit grating.
7. Construction of Schmidt trigger circuit using IC 741
8. Construction of sine wave Triangular wave generator using IC 741
9. Study of Binary to Gray and Gray to Binary code conversion.
10. Study of R-S, clocked R-S and D-Flip flop using NAND gates
11. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
12. Study of Modulus Counter
13. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
14. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
15. Measurement of Coefficient of linear expansion- Air wedge Method
16. Measurement of Band gap energy- Thermistor
17. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
18. Study of J-K, D and T flip flops using IC 7476/7473
19. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
20. Study of Arithmetic logic unit using IC 74181.

21. Construction of Encoder and Decoder circuits using ICs.

Textbooks:

1. Singh, S.P, 2019, Advanced Practical Physics, Pragati Prakasan, India.
2. Anavas, K,2008, Electronic lab manual, Vol I, Rajath Publishing Kochi.
3. Kuriachan T.D and Syam Mohan,2010, Electronic lab manual Vol II, Ayodhya Publishing, India.

Reference Books:

1. Ramakanth A Gaykwad,Op-Amp and linear integrated circuit, Eastern Economy Edition.
2. Sirohi, R.S,1985, A course on experiment with He-Ne Laser, John Wiley & Sons Pvt. Ltd, Asia.
3. Chattopadhayay, D and Rakshit, C.R,1990, An advanced course in Practical Physics, New Central Book Agency Pvt. Ltd, Calcutta.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	2	1	3	1	3	3	1	3	1
CO2	2	3	3	2	1	3	1	3	3	1	3	1
CO3	2	3	3	2	1	3	1	3	3	1	3	1
CO4	2	3	3	2	1	3	1	3	3	1	3	1
CO5	2	3	3	2	1	3	1	3	3	1	3	1
TOTAL	**10**	**15**	**15**	**10**	**5**	**15**	**5**	**15**	**15**	**5**	**15**	**5**
AVERAGE	**2**	**3**	**3**	**2**	**1**	**3**	**1**	**3**	**3**	**1**	**3**	**1**

SEMESTER I

ELECTIVE COURSE I: a) ENERGY PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231EC1	5	-	-	-	3	5	75	25	75	100

Prerequisites:

Knowledge of conventional energy resources

Learning Objectives:

1. To learn about various renewable energy sources.
2. To know the ways of effectively utilizing the oceanic energy
3. To study the method of harnessing wind energy and its advantages
4. To learn the techniques useful for the conversion of biomass into useful energy.
5. To know about utilization of solar energy

Course Outcomes

On the successful completion of the course, students will able to:		
1	to identify and understand the various forms of renewable and non-renewable energy sources	K1 & K2
2	understand the principle of utilizing the oceanic energy and apply it for practical applications	K2 & K3
3	discuss the working of a windmill and analyze the advantages of wind energy.	K4
4	evaluate the aerobic digestion process from anaerobic digestion.	K5
5	understand the components of solar radiation, their measurement and apply them to utilize solar energy	K2 & K3

K1 - Remember; **K2** – Understand; **K3** - Apply; **K4** - Analyze; **K5** – Evaluate

Unit	Contents	No. of Hours
I	**INTRODUCTION TO ENERGY SOURCES** Conventional and non-conventional energy sources and their availability– prospects of Renewable energy sources– Energy from other sources– chemical energy–Nuclear energy– Energy storage and distribution.	15
II	**ENERGY FROM THE OCEANS** Energy utilization–Energy from tides–Basic principle of tidal power– utilization of tidal energy – Principle of ocean thermal energy conversion systems.	15
III	**WIND ENERGY SOURCES** Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy.	15
IV	**ENERGY FROM BIOMASS** Biomass conversion Technologies– wet and dry process– Photosynthesis - Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion–factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas-utilization of biogas.	15
V	**SOLAR ENERGY SOURCES** Solar radiation and its measurements–solar cells: Solar cells for direct	15

	conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.	
TOTAL		**75**

Self Study	Nuclear energy, Energy conversion systems, Applications of wind energy, Generation of gas- bio gas from waste fuel, Solar cooking

Textbooks:

1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi.
2. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983).
3. Solar energy, principles of thermal collection and storage by S. P. Sukhatme, 2nd edition, Tata McGraw-Hill Publishing Co. Lt., New Delhi (1997).

Reference Books:

1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York.
2. Introduction to Non-Conventional Energy Resources -Raja et. al., Sci. Tech Publications.
3. S. Rao and Dr. ParuLekar, Energy technology.

Web Resources:

1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1
2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/
3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy
4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/
5. https://www.acciona.com/renewable-energy/solar-energy/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	1	2	1	3	3	2	3	2
CO2	3	3	3	3	1	2	1	3	3	2	2	2
CO3	3	3	3	3	1	2	1	3	3	2	2	2
CO4	3	3	3	3	1	2	1	3	3	2	3	2
CO5	3	3	3	3	1	2	1	3	3	2	3	2
TOTAL	**15**	**15**	**15**	**15**	**5**	**10**	**5**	**15**	**15**	**10**	**13**	**10**
AVERAGE	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**3**	**3**	**2**	**2.6**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE I: b) CRYSTAL GROWTH AND THIN FILMS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231EC2	5	-	-	-	3	5	75	25	75	100

Pre-requisite:

Students should know the Fundamentals of Crystal Physics

Learning Objectives:

1. To acquire the knowledge on Nucleation and Kinetics of crystal growth and to study various methods of Crystal growth techniques
2. To understand the thin film deposition methods and to apply the techniques of Thin Film Formation and thickness Measurement

Course Outcomes

On the successful completion of the course, student will be able to:		
1	acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	K1
2	understand the Crystallization Principles and Growth techniques	K2, K4
3	study various methods of Crystal growth techniques	K3
4	understand the Thin film deposition methods	K2
5	apply the techniques of Thin Film Formation and thickness Measurement	K3, K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze

Units	Contents	No. of Hours
I	**UNIT I: CRYSTAL GROWTH KINETICS**: Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - super saturation - equilibrium of finite phases equation of Thomson - Gibbs - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation - Growth from vapour phase solutions, solutions and melts - epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films	15
II	**UNIT II: CRYSTALLIZATION PRINCIPLES:**Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram - Super solubility - expression for super saturation - Metastable zone and introduction period - Miers TC diagram - Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.	15
III	**UNIT III: GEL, MELT AND VAPOUR GROWTH:** Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.	15
IV	**UNIT IV: THIN FILM DEPOSITION METHODS:** Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.	15

V	**UNIT V: THIN FILM FORMATION**: Thin Film Formation and thickness Measurement Nucleation, Film growth and structure - Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques.	**15**
	TOTAL	**75**

Self -Study	Basic concepts of crystal growth, Crystallization Principles and Growth techniques, Classes of Crystal system

Textbooks:

1. Markov. V, 2004, Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2nd edition).
2. Heinz K. Henish, 1973, “Crystal Growth in Gels”, Cambridge University Press. USA.

Reference Books:

1. J.C. Brice, 1986, Crystal Growth Process (John Wiley, New York, 1986)
2. Goswami, 2008, Thin Film Fundamentals, New Age, New Delhi.
3. Buckley, H.E, 1951, Crystal Growth, John Wiley and Sons, New York
4. Pamplin, B.R, 1980, Crystal Growth, Pergman Press, London.

Web Resources:

1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp
2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF
3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw
5. https://www.electrical4u.com/thermal-conductivity-of-metals/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	2	2	2	3	3	3	3	3	3
CO3	3	3	2	2	2	2	3	3	3	3	3	2
CO4	3	3	2	2	2	2	2	3	2	2	2	2
CO5	3	3	3	2	2	3	3	3	3	3	3	3
TOTAL	**15**	**15**	**12**	**11**	**11**	**12**	**14**	**15**	**14**	**14**	**14**	**13**
AVERAGE	**3**	**3**	**2.4**	**2.2**	**2.2**	**2.4**	**2.8**	**3**	**2.8**	**2.8**	**2.8**	**2.6**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE I: c) MATERIAL SCIENCE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231EC3	5	-	-	-	3	5	75	25	75	100

Prerequisites:

Basic knowledge on different types of materials**.**

Learning Objectives:

1. To gain knowledge on optoelectronic materials.
2. To learn about ceramic processing and advanced ceramics.
3. To understand the processing and applications of polymeric materials.
4. To gain knowledge on the fabrication of composite materials.
5. To learn about shape memory alloys, metallic glasses and nanomaterials.

Course Outcomes

On the successful completion of the course, students will able to:		
1	acquire knowledge on optoelectronic materials	**K1**
2	be able to prepare ceramic materials	**K3**
3	be able to understand the processing and applications of polymeric materials	**K2& K3**
4	be aware of the fabrication of composite materials	**K5**
5	be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	**K1**

K1 - Remember; **K2** – Understand; **K3** - Apply; **K4** - Analyze; **K5** – Evaluate

Units	Contents	No. of Hours
I	**OPTOELECTRONIC MATERIALS**: Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi-Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.	**15**
II	**CERAMIC MATERIALS:** Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, almina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics.	**15**
III	**POLYMERIC MATERIALS**: Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers.	**15**
IV	**COMPOSITE MATERIALS**: Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.	**15**
V	**NEW MATERIALS**: Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity	

	and pseudo-elasticity, examples and applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials, single walled and multi walled carbon nanotubes	**15**
TOTAL		**75**

Self Study	Inter-band and intra-band transitions, Electronic ceramics Viscoelasticity, Fiber reinforced composites, Nanomaterials: classification

Textbooks:

1. Jasprit Singh, 2007, Electronic and optoelectronic properties of semiconductor structures. Cambridge University Press, Cambridge.
2. Raghavan, V, 2003, Materials Science and Engineering,(4th Edition), Prentice- Hall India, New Delhi. (For units 2,3,4 and 5)
3. Arumugam, M, 2002, Materials Science, (3rd revised Edition), Anuratha Agencies.

Reference Books:

1. Narula, G.K., Narula, K.S., and Gupta, V.K., 1988. Materials Science. Tata McGraw-Hill.
2. Mallick, P. K., 2008, Fiber-Reinforced Composites, CRC Press.

Web Resources :

1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview
2. https://nptel.ac.in/courses/112104229
3. https://archive.nptel.ac.in/courses/113/105/113105081
4. https://nptel.ac.in/courses/113/105/113105025/
6. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	1	2	1	3	3	2	3	2
CO2	3	3	3	3	1	2	1	3	3	2	2	2
CO3	3	3	3	3	1	2	1	3	3	2	2	2
CO4	3	3	3	3	1	2	1	3	3	2	3	2
CO5	3	3	3	3	1	2	1	3	3	2	3	2
TOTAL	**15**	**15**	**15**	**15**	**5**	**10**	**5**	**15**	**15**	**10**	**13**	**10**
AVERAGE	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**3**	**3**	**2**	**2.6**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

SPECIFIC VALUE-ADDED COURSE: COMPUTER MAINTENANCE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231V01	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Knowledge of parts of a computer.

Learning Objectives

1. Students will be able to analyse problems associated with PC components and provide solutions to troubleshoot and isolate the problems.
2. Students will be able to prevent Viruses and Malware and Speed up their Computer.

On the successful completion of this course, students will be able to:		
1	understand the basic components of a computer	**K1**
2	install different types of operating systems	**K2**
3	assemble and disassemble a personal computer	**K3**
4	troubleshoot the problems	**K4**
5	evaluate the features of the Control Panel	**K5**

K1- Remember- **K2-** Understand- **K3 –** Apply- **K4-** Analyze- **K5-** Evaluate

Units	Contents	No. of Hours
I	**COMPUTER HARDWARE** Introduction to Computer Hardware - Parts of Computer - Motherboard: Block Diagram- Types -Identification of Ports, Chip, Slot, Connector - Computer Assembling & Dissembling - How to Upgrade Computer.	6
II	**COMPUTER SOFTWARE** Introduction to windows, Identification of windows - Windows Installation (win 7, 8, & 10) without data loss - Driver Installation (offline / online) - Software Installation - Hard Disk Partition - Windows Backup & Restore	6
III	**SOLDERING AND DESOLDERING** Removing component from motherboard - Fixing component from motherboard - Changing Port & Slot from motherboard - Removing& fixing all ICs from motherboard	6
IV	**FAULT FINDING AND REPAIRING IN EXTERNAL HARDWARE** Keyboard Problem - Mouse Problem- Battery Problem - Overheating Problem - Hard Disk Problem - USB Problem - LAN Problem - Monitor Problem - Display White Problem - Blue Screen Problem - Shorting Problem	6
V	**FAULT FINDING AND REPAIRING COMPUTER INTERNAL** Windows Problem - Software Problem - Network Problem - Virus Problem – Antivirus - RAM Problem - Slow Working Problem - Hang Problem – Restart Problem - Control Panel Setting- Data recovery - Password Breaking	6
TOTAL		**30**

Self-study	Computer internal parts

Textbooks:

1. Scott Muelle, 2017. *Upgrading and Repairing PCs*, USA: McGraw Hill Education.
2. Hack, 2019. *Simple Practical Hacks to Optimize, Speed Up and Make Computer Faster*, India: Khanna Publishers.

Reference Books:

1. Adane Nega Tarekegn, Alemu Kumilachew Tegegne, 2015. *A Simple Guide to Computer Maintenance and Troubleshooting*, Germany: LAP LAMBERT Academic Publishing,
2. John Paul Mueller, 2015. *Computer Repair with Diagnostics: A Technician's Guide*, India: QUE Publishing.
3. Andrew Bunnie Huang, 2015. *The Hardware Hacker: Adventures in Making and Breaking Hardware*, California:No Starch Press.
4. David Pogue, 2015. PCs: The Missing Manual, USA: O′Reilly.
5. Morris Rosenthal, 2013. Computer Repair with Diagnostic Flowcharts, USA: Foner Books.

Web Resources:

1. https:// www.tomshardware.com/
2. https:// www.pcmag.com/
3. https://www. techspot.com/blog
4. https://www.hackster.io/projects/tags/internet+of+things
5. https://www.techtarget.com/iotagenda/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	3	3	3	3	2
CO2	3	3	3	2	3	3	2	3	3	3	3	2
CO3	3	3	3	2	3	3	2	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	2
TOTAL	**15**	**15**	**15**	**12**	**15**	**15**	**10**	**15**	**15**	**15**	**15**	**10**
AVERAGE	**3**	**3**	**3**	**2.4**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

SPECIFIC VALUE-ADDED COURSE: FUNDAMENTALS OF COMMUNICATION

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP231V02	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Knowledge of radio waves and Mobile phones.

Learning Objectives:

1. To understand the fundamental principles of radar system, including their operation, types, and characteristics.
2. To apply knowledge of satellite communication to design and implement mobile-based appliances.

Course Outcomes

On the successful completion of this course, students will be able to:		
1.	identify different types of radars.	**K1**
2.	compare the different applications of optical fibres.	**K2**
3.	use the principle of optical fibres for designing and integrating into appliance systems.	**K3**
4.	correlate transmission and reception of radio waves	**K4**
5.	prioritize the working of internet protocol television.	**K5**

K1- Remember- **K2**- Understand- **K3 –** Apply- **K4**- Analyze- **K5**- Evaluate

Units	Contents	No. of Hours
I	**BASICS OF RADIO WAVES** Radio transmission and reception-transmitter – modulation - types of modulation – amplitude modulation – limitations of amplitude modulation – frequency modulation	6
II	**FIBER OPTIC COMMUNICATION** Basic principle of fiber optics –construction of optical fiber – classification based on the refractive index profile —advantages of fiberoptic communication	6
III	**RADAR COMMUNICATION** Basic radar system –radar range –pulsed radar system – search radar system–tracking radar – moving target indicator -Doppler effect– Doppler radar	6
IV	**SATELLITE COMMUNICATION** History of satellites – satellite communication system – satellite orbits – basic components of satellite communication system – commonly used frequency in satellite-satellite communication in India	6
V	**MOBILE COMMUNICATION** Basic cellular mobile radio system – cellphone– VSAT (very small aperture terminals) modem IPTV (internet protocol television) -Wi-Fi-4G (basic ideas).	6
	Total	30

Self-study	Satellite communication system, Mobile Phone

Textbooks:

1. Metha V K, 2013. *Principles of Electronics,* S. Chand & Co. Ltd, New Delhi.

2. Anokh Singh and Chopra A.K., 2013. *Principles of Communication Engineering,* S. Chand & Co. Ltd, New Delhi.
3. Chitode J S, 2020. *Digital Communications*, Unicorn publications, Chennai.
4. Senior John..2009. *Optical Fiber Communications*, Pearson Education.
5. Horne D F, 1988. *Measuring Systems and Transducers for Communication,* Philadelphia, Pennsylvania: IOP Publishing.

Reference Books:

1. Dennis Roody, Coolen, 1995. *Electronic Communications*. (4th Edition), Prentice Hall of India, New Jersey: Prentice Hall.
2. Ohba R, 2006. *Advanced Electronics Communication Systems*. New York: John Wiley & Sons.
3. Pallas Areny R, Webster J G, 1999. *Electronics Communications,* New York: John Wiley & Sons.
4. Wayne Tomasi, 1998. *Advanced Electronics Communication System,* (4th edition), Prentice Hall of India, New Jersey: Prentice Hall.
5. Salivahanan S , 2009. *Electronic Devices and Circuits,* (2nd Edition), Tata McGraw-Hill Publishing Company Limited, New Delhi.

Web Resources:

1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/
3. http://nptel.iitm.ac.in/
4. http://web.ewu.edu/
5. http://nptel.iitm.ac.in/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3	3	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**15**	**15**	**14**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**14**
AVERAGE	**3**	**3**	**2.8**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE COURSE IV: STATISTICAL MECHANICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232CC1	6	-	-	-	5	6	90	25	75	100

Prerequisites:

Laws of thermodynamics, phase transition, entropy, ensembles, partition function, classical and quantum statistics, thermal equilibrium, Brownian motion.

Learning Objectives:

1. To identify the relationship between statistic and thermodynamic quantities.
2. To comprehend the concept of partition function, canonical, grand canonical ensembles, ideal, real gases and fluctuations.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	**K1 & K2**
2	interpret the macroscopic properties such as pressure, volume, temperature, specific heat, elastic module etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. describe the peculiar behaviour of the entropy by mixing two gases. Relate the connection between statistics and thermodynamic quantities	**K2& K3**
3	distinguish canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	**K3 & K4**
4	analyze and apply the different statistical concepts to assess the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish the three types of statistics.	**K4& K5**
5	evaluate and generalise the thermodynamical behaviour of gases under fluctuation and also using Ising model	**K5& K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**- Create

Unit	Contents	No. of Hours
I	**PHASE TRANSITIONS:** Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications - Third law of Thermodynamics: Nernst Heat Theorem. Order parameters - Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis: Scaling Hypothesis - Universality of Critical Behaviour- Law of Corresponding states.	**18**
II	**STATISTICAL MECHANICS AND THERMODYNAMICS:** Foundations of statistical mechanics - Specification of states of a system: Microscopic and Macroscopic States - Phase space – Liouville's theorem- Microcanonical ensemble: Isolated systems- Microcanonical distribution- Principle of Equal a Priori Probabilities - Entropy - Connection between statistics and thermodynamics - Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.	**18**
III	**CANONICAL AND GRAND CANONICAL ENSEMBLES:** Canonical and grand canonical ensembles: Systems at fixed temperature- Systems with fixed chemical potential- Trajectories and density of states: Canonical and Grand Canonical distribution - Equipartition theorem –Quantum Canonical Partition function - Calculation of statistical quantities –Free energy of an ideal gas- Thermodynamic functions- Energy and density fluctuations.	**18**

IV	**CLASSICAL AND QUANTUM STATISTICS:** Statistical density matrix – Equilibrium Statistical ensemble - Statistics of indistinguishable particles –The ideal gases in the microcanonical ensemble- Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy: Weakly degenerate – strongly degenerate – Bose Einstein statistics –Black-body radiation: The Photon Gas- Planck radiation formula - Ideal Bose gas – Bose Einstein condensation.	**18**
V	**REAL GAS, ISING MODEL AND FLUCTUATIONS:** Cluster expansion for a classical gas - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model - Mean-field theories of the Ising model in three, two and one dimensions - Exact solutions in one dimension. Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena - Brownian motion - Langevin's theory – Fluctuation dissipation theorem - The Fokker-Planck equation	**18**
	TOTAL	**90**

Self Study	Phase Transitions, Ideal gases in a micro canonical ensemble, Grand canonical Ensemble Bose gas, Ising model

Textbooks:

1. Sinha, S.K., 2005. Introduction to Statistical Mechanics. Narosa Publishing House, New Delhi.
2. Agarwal, B.K. and Eisner, M., 2016. Statistical Mechanics (Second Edition), New Age International, New Delhi, India.
3. Bhattacharjee, J.K.,2002. Statistical Mechanics: An Introductory Text. Allied Publication New Delhi, India.
4. Sethna, James P.,2008. Statistical mechanics: entropy, order parameters, and complexity, Oxford University Press, New Delhi.

Reference Books:

1. Pathria, R.K., 2005. Statistical Mechanics, Elsevier India, New Delhi.
2. Donal A. McQuarrie., 2008. Statistical Mechanics, Viva Books, New Delhi.
3. Huang, K., 2002. Statistical Mechanics, Taylor and Francis, London.
4. Arnold Sommerfeld, Bopp, F., Meixner, J.,2005. Thermodynamics and statistical mechanics: lectures on theoretical physics, Levant Books, Kolkata.
5. Gupta, A.B., Roy, H., 2002.Thermal Physics, Books and Allied, Kolkata.

Web Resources:

1. https://byjus.com/chemistry/third-law-of-thermodynamics/
2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	3	3	3	2	3	2	2
CO2	3	3	2	3	3	3	2	3	3	3	3	3
CO3	3	3	3	2	3	3	2	3	3	3	3	3
CO4	3	3	2	2	2	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	3	3	3	3
TOTAL	**15**	**15**	**12**	**12**	**12**	**15**	**13**	**15**	**14**	**15**	**14**	**14**
AVERAGE	**3**	**3**	**2.4**	**2.4**	**2.4**	**3**	**2.6**	**3**	**2.8**	**3**	**2.8**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE COURSE V: QUANTUM MECHANICS - I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232CC2	6	-	-	-	5	6	90	25	75	100

Prerequisites: Newton's laws of motion, Schrodinger's equation, integration, differentiation.

Learning Objectives:

1. To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
2. To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the basic postulates of quantum mechanics which serve to formalize the rules of quantum mechanics.	**K1 & K2**
2	interpret and relate the Schrodinger equation to solve one dimensional problems and three dimensional problems.	**K2& K3**
3	apply and analyze various representations, space time symmetries and formulations of time evolution.	**K3 & K4**
4	construct and prioritize the approximation methods for various quantum mechanical problems.	**K4& K5**
5	apply and formulate non-commutative algebra for angular and spin angular momentum and assess spectral line splitting.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit	Contents	No. of Hours
I	**BASIC FORMALISM:** Interpretation of the wave function – Time dependent Schrodinger equation –Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation.	**18**
II	**ONE DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS:** Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator.	**18**
III	**GENERAL FORMALISM:** Dirac's notation-Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation– Momentum representation: Probability Density– Operator for Position Coordinate-Operator for Momentum-Equation of Motion- Symmetries and conservation laws- Unitary transformation – Parity and time reversal.	**18**

IV	**APPROXIMATION METHODS:** Time independent perturbation theory: Basic Concepts- Non-degenerate energy levels: First and second order correction to the Energy and Wave function – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation: The WKB method – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.	**18**
V	**ANGULAR MOMENTUM:** Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Angular momentum matrices- Matrix representation – Spin angular momentum: spin- (1/2) systems- Addition of angular momenta – Clebsh- Gordan Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.	**18**
	TOTAL	**90**

Self-study	Postulates of Quantum Mechanics, Bloch waves in a periodic potential, Unitary transformation, Degenerate energy levels Pauli's exclusion principle.

Textbooks:

1. Aruldhas, G., 2009. Quantum Mechanics (Second Edition). Prentice Hall of India, New Delhi.
2. Mathews, P.M., Venkatesan, K., 2010. A Text book of Quantum Mechanics (Second Edition). Tata McGraw-Hill , New Delhi.
3. BhaskarJyoti Hazarik,2022. Quantum Mechanics: Concepts and Applications, Mahaveer Publications, India.
4. Susskind, Leonard and Friedman.,2015. Quantum Mechanics: The Theoretical Minimum, Penguin Books, London.

Reference Books:

1. Paul A M Dirac , 2012. Lectures on Quantum Mechanics , Snowball Publishing, USA.
2. David J Griffiths, 2011. Introduction to Quantum Mechanics (Fourth Edition). Cambridge, India.
3. Nouredine Zettili, 2009. Quantum Mechanics Concepts and Applications ,Wiley, USA.
4. Devanathan, V., 2011. Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford.

Web Resources:

1. http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
2. http://www.feynmanlectures.caltech.edu/III_20.html
3. http://web.mit.edu/8.05/handouts/jaffe1.pdf
4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_ pdf
5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	3	3	3	2	3	2	2
CO2	3	3	3	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	3	3	3	3
TOTAL	**15**	**15**	**14**	**14**	**13**	**15**	**13**	**15**	**14**	**15**	**14**	**14**
AVERAGE	**3**	**3**	**2.8**	**2.8**	**2.6**	**3**	**2.6**	**3**	**2.8**	**3**	**2.8**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE LAB COURSE: ADVANCED PHYSICS LAB II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232CP2	-	-	6	-	4	6	90	25	75	100

Prerequisites:

Knowledge and handling of basic general and electronics experiments of Physics.

Learning Objectives:

1. To calculate the thermodynamic quantities and physical properties of materials.
2. To learn about Combinational Logic Circuits and Sequential Logic Circuits.

Course Outcomes

On the successful completion of the course, students will able to:		
1.	acquire knowledge on thermal behaviour and strength of the materials.	**K1**
2.	understand the theoretical principles of magnetism through the experiments.	**K2**
3.	improve the analytical and observation ability in physics experiments	**K4**
4.	analyze various parameters related to operational amplifiers.	**K4**
5.	apply the concepts of arithmetic function and solve simultaneous equations using IC's	**K3**

K1 - Remember; **K2** – Understand; **K3** - Apply; **K4** - Analyze

Contents

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
2. Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.
3. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility
4. Measurement of dielectric constants of a liquid-LCR circuit.
5. Determination of Band gap of a given crystal
6. Determination of Mutual inductance B.G
7. Solving simultaneous equations – IC 741 / IC LM324.
8. Op-Amp –Active filters: Low pass and High pass filters.
9. BCD to Excess- 3 and Excess 3 to BCD code conversion.
10. Construction of triangular wave generator using IC 741.
11. Construction of Schmidt trigger circuit using IC555.
12. Construction of Multiplexer and Demultiplexer using ICs.
13. Op-Amp: Band pass filters.
14. Determination of I-V Characteristics and efficiency of solar cell.
15. IC 7490 as scalar and seven segment display using IC7447.
16. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193.
17. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser.
18. Magneto restriction.
19. Interpretation of XRD spectra of a given material.
20. B-H curve using CRO.

Reference Books:

1. Singh, S.P, 2019. Advanced Practical Physics, Pragati Prakasan, India.

2. Anavas, K, 2008. Electronic lab manual, Vol I, , Rajath Publishing.Kochi.
3. Chattopadhayay, D and Rakshit, C.R, 2011. An advanced course in Practical Physics, New Central Book Agency Pvt. Ltd, Calcutta.
4. Kuriachan T.D and Syam Mohan, 2010. Electronic lab manual Vol II, Ayodhya Publishing, India.
5. Ramakanth A Gaykwad, 2015. Op-Amp and linear integrated circuit, Eastern Economy Edition.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	2	1	3	1	3	3	1	3	1
CO2	2	3	3	2	1	3	1	3	3	1	3	1
CO3	2	3	3	2	1	3	1	3	3	1	3	1
CO4	2	3	3	2	1	3	1	3	3	1	3	1
CO5	2	3	3	2	1	3	1	3	3	1	3	1
TOTAL	**10**	**15**	**15**	**10**	**5**	**15**	**5**	**15**	**15**	**5**	**15**	**5**
AVERAGE	**2**	**3**	**3**	**2**	**1**	**3**	**1**	**3**	**3**	**1**	**3**	**1**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE II: a) ADVANCED OPTICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232EC1	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Students should know the basic knowledge in ray properties and wave nature of light.

Learning Objectives:

1. To impart an extensive understanding of the optical phenomenon of various optical strategies like laser, fibre optics, non -linear optics and electro magneto optics.
2. To study the working of different types of Lasers and optical fibers.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	discuss the transverse character of light waves and different polarization phenomenon	**K1**
2	discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	**K2**
3	demonstrate the basic configuration of a fiber optic – communication system and advantages	**K3, K4**
4	identify the properties of nonlinear interactions of light and matter	**K4**
5	interpret the group of experiments which depend for their action on an applied magnetics and electric field	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** – Evaluate

Units	Contents	No. of Hours
I	**UNIT I: POLARIZATION AND DOUBLE REFRACTION** Classification of polarization–Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wiregridpolarizerandthepolaroid–Polarizationbyreflection–Polarization by double refraction–Polarizationbyscattering–Thephenomenonofdoublerefraction–Normal and oblique incidence–Interference of polarized light :Quarter and half waveplates–Analysis of Polarized light–Optical activity	**12**
II	**UNIT II: LASERS** Basic principles – Spontaneous and stimulated emissions – Components of the laser–Resonator and lasing action– Types of lasers and its applications–Solid state lasers–Ruby laser–Nd:YAG laser – gas lasers – He-Ne laser – CO_2 laser – Chemical lasers – HCl laser–Semi conductor laser.	**12**
III	**UNIT III: FIBER OPTICS** Introduction – Total internal reflection – The optical fiber – Glass fibers –The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers–Ray dispersion in multimode step index fibers–Parabolic-index fibers–Fiber-optic sensors: precision displacement sensor–Precision vibration sensor.	**12**

IV	**UNITIV: NON-LINEAROPTICS** Basic principles – Harmonic generation – Second harmonic generation – Phasematching–Thirdharmonicgeneration–Opticalmixing–Parametricgenerationoflight–Self-focusingoflight.	**12**
V	**UNITV: MAGNETO OPTICS AND ELECTRO OPTICS** Magneto-optical effects–Zeeman effect–Inverse Zeeman effect–Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect –Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect.	**12**
	TOTAL	**60**

Self -Study	Polarization by double refraction, Total Internal reflection, Zeeman effect.

Textbooks:

1. Optics, 2012. (Classical and Quantum) –R.K Kar, Books and Allied Pvt Ltd.
2. B.B.Laud, 2017.LasersandNon–LinearOptics,3rdEdition,NewAge International (P)Ltd.
3. Ajoy Ghatak, 2017.Optics,6thEdition, McGraw–Hill Education Pvt. Ltd.
4. Optical Fiber and Laser, 2010. Anuradha De, New AGE International (P), Limited.
5. Fiber Optic Communication Systems, 2012. Govind P. Agarwal, Wiley India pvt, Ltd, New Delhi

Reference Books:

1. Dieter Meschede, 2017. Optics, Light and Lasers, Wiley – VCH, Varley GmbH.
2. Lipson, S. G. Lipson and H. Lipson, 2011. Optical Physics, (4th Edition), Cambridge University Press, New Delhi.
3. Y. B. Band, 2006. Light and Matter, (1st edition), John Wiley and Sons Inc.
4. Subirkumar Sarkar, 2008. Optical fibres and fibre optic communication systems, S. Chand & Company Ltd, New Delhi
5. Wilson, Hawkes, 2005. An Introduction to Optoelectronics, Prentice Hall of India, New Delhi.

Web Resources

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	3	3	3	3	3	3	3	2
CO2	3	3	3	2	3	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	2	3	3	3	3	3
CO4	3	2	2	2	2	2	2	3	3	2	2	2
CO5	3	3	2	2	3	3	3	3	3	3	3	3
TOTAL	**15**	**13**	**12**	**10**	**13**	**14**	**13**	**15**	**15**	**14**	**14**	**14**
AVERAGE	**3**	**2.6**	**2.4**	**2**	**2.6**	**2.8**	**2.6**	**3**	**3**	**2.8**	**2.8**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE II: b) NON-LINEAR DYNAMICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232EC2	**4**	**-**	**-**	**-**	**3**	**4**	**60**	**25**	**75**	**100**

Prerequisites: Basics of Numerical methods and Differential equations, fundamentals of linear and nonlinear waves, and Basics of communication systems.

Learning Objectives:

1. To learn the analytical and numerical techniques of nonlinear dynamics.
2. To make the students aware of the applications of solutions, chaos and fractals.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	gain knowledge about the available analytical and numerical methods to solve various nonlinear systems.	**K1 & K2**
2	understand the concepts of different types of coherent structures and their importance in science and technology.	**K2 & K3**
3	apply and analyze simple and complex bifurcations and the routes to chaos	**K3 & K4**
4	analyze and evaluate the various types of oscillators, chaos and fractals.	**K4 & K5**
5	evaluate and create the applications of solitons in telecommunication, applications of chaos in cryptography, computations and that of fractals.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit	Contents	No. of Hours
I	**GENERAL** Linear waves-ordinary differential equations (ODEs) -Partial differential equations (PDEs)-Methods to solve ODEs and PDEs.- Numerical methods – Linear and Nonlinear oscillators: Linear Oscillators and Predictability- -Damped and Driven Nonlinear Oscillators- Nonlinear Oscillations and Bifurcations- Nonlinear waves-Qualitative features: Dynamical Systems as Coupled First-Order Differential Equations: Equilibrium Points-Classification of Equilibrium Points: Two-Dimensional Case	**12**
II	**COHERENT STRUCTURES** Linear and Nonlinear dispersive waves - Linear Waves - Linear Nondispersive Wave Propagation- Linear Dispersive Wave Propagation- Fourier Transform and Solution of Initial Value Problem - Wave Packet and Dispersion-Solitons – KdV equation – Basic theory of KdV equation –Ubiquitous soliton equations – AKNS Method, Backlund transformation, Hirotabilinearization method, Painleve analysis - Perturbation methods.	**12**
III	**BIFURCATIONS AND ONSET OF CHAOS** One dimensional flows – Two dimensional flows – Phase plane – Limit cycles – Simple bifurcations: Saddle-Node Bifurcation- The Pitchfork Bifurcation- Transcritical Bifurcation-HopfBifurcation -Discrete Dynamical system – Strange attractors: Strange Attractor in the Henon Map - The Period Doubling Phenomenon- Self-Similar Structure - Other Routes to Chaos - Quasiperiodic Route to Chaos-Intermittency Route to Chaos - Type-I Intermittency Standard Bifurcations in Maps.	**12**
IV	**SOLITONS IN OPTICAL COMMUNICATION** Solitons in Optical fibres – Applications: Soliton Amplification- Pulse Compression-Soliton Bit rate- Timing jitter- Soliton Photonic Switches - Soliton based communication systems: Optical Soliton Based Communications - Soliton Based Optical Computing- Photo-Refractive Materials and the Manakov Equation - Soliton Solutions and Shape Changing Collisions -Optical Soliton Based Computation.	**12**

V	**APPLICATIONS** Synchronization of chaos: Chaos in the DVP Oscillator -Synchronization of Chaos in the DVP Oscillator -Chaotic Signal Masking and Transmission of Analog Signals - Chaotic Digital Signal Transmission-Chaos based communication – Cryptography – Chaotic Cryptography - Basic Idea of Cryptography -An Elementary Chaotic Cryptographic System -Using Chaos (Controlling) to Calm the Web - Some Other Possibilities of Using Chaos - Communicating by Chaos - Chaos and Financial Markets .Computational Chaos, Shadowing – Time Series analysis -Estimation of Time-Delay and Embedding Dimension - Largest Lyapunov Exponent - Stochastic Resonance .	**12**
TOTAL		**60**

Self Study	Linear and Nonlinear oscillators, Perturbation methods Discrete Dynamical system, Solitons in Optical fibres Cryptography.

Textbooks:

1. Lakshmanan, M., Rajasekar, S., 2012. Nonlinear Dynamics: Integrability, Chaos and Patterns.Springer, Berlin ,Hieldelberg.
2. Drazin, P. G. 2012. Nonlinear Systems. Cambridge University Press, UK.
3. Porsezian, K and Kuriakose, V.C., 2003, Optical Solitons: Theoretical and Experimental Challenges, Springer-Verlag.
4. Wiggins, S. 2003. Introduction to Applied Nonlinear Dynamical Systems and Chaos. Springer, Berlin ,Hieldelberg.
5. Strogatz, Steven H. 2014. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, U.S.A.

Reference Books:

1. JamshidGhaboussi, Michael F Insana, 2017. Understanding Systems A Grand Challenge for 21st Century, World Scientific Publishing Co Pte Ltd, India.
2. Carla M.A. Pinto, 2022. Nonlinear Dynamics and Complexity Mathematical Modelling of Real-World Problems, Springer, Berlin ,Hieldelberg.
3. Albert C. J. Luo, 2019. Bifurcation &Stability in Nonlinear Dynamical Systems, Springer, Berlin , Hieldelberg.
4. PawełOlejnik, Jan Awrejcewicz and Michal Fečkan, 2017. Modeling, Analysis and Control of Dynamical Systems With Friction and Impacts, World Scientific Publishing Co Pte Ltd, India.
5. Amon, Axelle and Lefranc,Marc.,2023.Nonlinear Dynamics,Berlin, Boston: De Gruyter

Web Resources:

1. https://www.digimat.in/nptel/courses/video/108106135/L06.html
2. http://digimat.in/nptel/courses/video/115105124/L01.html
3. https://www.digimat.in/nptel/courses/video/108106135/L01.html
4. http://complex.gmu.edu/neural/index.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	3	3	3	3	3	2
CO2	3	3	2	3	3	3	2	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	2	2	3	3	3	3	3	2	3	3
CO5	3	3	3	3	2	3	3	3	3	3	3	3
TOTAL	15	15	13	12	14	15	14	15	15	14	15	14
AVERAGE	3	3	2.6	2.4	2.8	3	2.8	3	3	2.8	3	2.8

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE II: c) QUANTUM FIELD THEORY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232EC3	4	-	-	-	3	4	60	25	75	100

Pre-requisite: Prior exposure on fundamentals of Quantum mechanics and Special Relativity will be essential.

Learning Objectives:

1. To make the students aware of the applications of solutions, chaos and fractals.
2. To school the students about the analytical and numerical techniques of nonlinear dynamics.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the interconnection of Quantum Mechanics and Special Relativity	K1
2	enable the students to understand the method of quantization to various field	K2
3	employ the creation and annihilation operators for quantization	K5
4	summarizes the interacting field, in quantum domain, and gives a discussion on how perturbation theory is used here.	K1 & K3
5	understand the concept of Feynman diagram	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K5** – Evaluate

Unit	Contents	No. of Hours
I	**Symmetry Principles** Relativistic kinematics, relativistic waves, Klein-Gordon (KG) equation as a relativistic wave equation, treatment of the KG equation as a classical wave equation: its Lagrangian and Hamiltonian, Noether's theorem and derivation of energy-momentum and angular momentum tensors as consequence of Poincaré symmetry, internal symmetry and the associated conserved current - Wilson's Approach to Field Theories – Renormalization Group Flow.	12
II	**Quantization Of Klein-Gordan Field** Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, definition of the vacuum and N-particle eigenstates of the Hamiltonian, vacuum expectation values, propagators, spin and statistics of the KG quantum - Particle creation by a classical source - The Casimir effect – Casimir force - Fields as operator-valued distributions.	12
III	**Quantization of Dirac Field** Review of Dirac equation and its quantization, use of anti-commutators, creation and destruction operators of particles and antiparticles, Dirac propagator, energy, momentum and angular momentum, spin and statistics of Dirac quanta - Dirac matrices - Dirac bilinear operators - Lorentz transformations for spin-½ particles and fields - Discrete symmetries of the Dirac field – Degrees of divergences – Cancellation of divergences.	12
IV	**Quantization of Electromagnetic Fields** Classical Electromagnetic field - Review of free Maxwell's equations – Normal modes – B field –Lagrangian -gauge transformation and gauge fixing –Hamiltonian and EM field Hamiltonian - Interation of EM fields with matter - Electric field in cavity - Zero point energy -quantization in	12

	terms of transverse delta functions - expansion in terms of creation operators - spin, statistics -propagator of the photon.	
V	**PERTURBATIVE INTERACTION AT TREE LEVEL** Introduction to interacting quantum fields - Wick's Theorem -Feynman Diagram -Examples from quantum electrodynamics at the tree level: positron-electron and electron-electron scattering - Time-dependent perturbation theory – Generating functional perturbation theory - Cross sections and decay rates - Wigner's representation theorem - First order perturbation – single photon events – Electric polarisation and Dielectrics.	**12**
	Total	**60**

Self Study	Noether's theorem, creation and annihilation operators Maxwell's equations

Textbooks:

1. Kerson Huang. 2010. Quantum Field theory: From Operators to Path Integrals, 2nd edition. Peacock Books. India.
2. Amitabha Lahiri, Palash B. Pal. 2005. A First Book of Quantum Field Theory,2nd edition,Alpha Science International. London.

Reference Books:

1. A. Zee, 2015. Quantum Field Theory in a Nutshell, 2nd edition,Princeton University Press, New Jersey.
2. Michael E. Peskin, Daniel V. Schroeder. 2019. An Introduction To Quantum Field Theory, 1stedition, CRC Press, Florida.
3. Ramamurti Shankar.2021. Quantum Field Theory And Condensed Matter: An Introduction, 1st edition,Cambridge India, New Delhi.
4. Badis Dr Ydri. 2019. Modern Course in Quantum Field Theory, 1st edition, Iop Publishing Ltd., Bristol, England.
5. Jean Zinn-Justin. 2019. Quantum Field Theory and Critical Phenomena, 5thedition, Oxford University Press, Oxford, England.

Web Resources:

1. https://homepages.dias.ie/ydri/QFTNOTES4v2.pdf
2. https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/referencespapers.aspx?re ferenceid=2605249
3. https://archive.nptel.ac.in/courses/115/106/115106065/4.http://www.nhn.ou.edu/~milton/p6433/p6433.html
4. https://plato.stanford.edu/entries/quantum-field-theory/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	1	3	3	2	2	3	2	2	1	3
CO2	3	1	2	1	1	2	3	1	3	3	2	1
CO3	2	3	2	3	3	3	2	3	2	2	2	3
CO4	2	3	2	3	3	2	3	3	2	3	1	3
CO5	2	3	3	3	3	3	2	3	2	2	2	3
TOTAL	**11**	**13**	**10**	**13**	**13**	**12**	**12**	**13**	**11**	**12**	**8**	**13**
AVERAGE	**2.2**	**2.6**	**2**	**2.6**	**2.6**	**2.4**	**2.4**	**2.6**	**2.2**	**2.4**	**1.6**	**2.6**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE III: a) MEDICAL PHYSICS

Course Code	L	T	P	S	Credit s	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232EC4	4	-	-	-	3	4	60	25	75	100

Pre-requisite: Fundamentals of physiological concepts, Basics of instruments principle

Learning Objectives:

1. To understand the major applications of Physics to Medicine.
2. To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	learn the fundamentals, production and applications of X-rays.	K1 & K2
2	understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	K1 & K2
3	apply knowledge on Radiation Physics	K2 & K3
4	analyze Radiological imaging and filters	K3 & K5
5	assess the principles of radiation protection	K5 & K6

K1 – Remember; **K2** – Understand; **K3** – Apply; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**X-RAYS AND TRANSDUCERS** : Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – Transducers- Principle of Transducers – Types of Transducers - photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer.	12
II	**BLOOD PRESSURE MEASUREMENTS**: Introduction – Sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI). Pressures in the body: pressure in the cardiovascular system - hydrostatic pressure - respiratory pressures - foot pressures - eye and ear pressures.	12
III	**RADIATION PHYSICS** : Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness – Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter	12
IV	**MEDICAL IMAGING PHYSICS** : Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display)	12

V	**RADIATION PROTECTION** : Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter- Energy content of body fuel - energy storage molecules - loss of body heat - body temperature- energy requirement - energy from food - regulation of body temperature.	**12**
	TOTAL	**60**

Self-study	Piezoelectric transducer, Basic principles of electro-neurography (ENG),Inverse Square Law, Thyroid Uptake System Pocket Dosimeter

Textbooks:

1. Thayalan K., 2003. Basic Radiological Physics, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi.
2. Dewhurst D. J., 2014. An Introduction to Biomedical Instrumentation (First Edition), Elsevier Science.
3. Khan F.M, 2003. Physics of Radiation Therapy (Third Edition), Scientific Research publishers.
4. Irving P. Herman, 2007. Physics of Human Body (First Edition), Springer publications.

Reference Books:

1. Muhammad Maqbool, 2017. An Introduction to Medical Physics (First Edition), Springer International Publishing.
2. Daniel Jirák, FrantišekVítek, 2018. Basics of Medical Physics (First Edition), Charles University, Karolinum Press.
3. Venkata Ram,K. 2001. Bio-Medical Electronics and Instrumentation (First Edition), Galgotia Publications, New Delhi.
4. Khandpur R.S., 2005. Hand Book of Biomedical Instrumentations (First Edition), TMG, New Delhi.
5. Stephen Keevil, Renato Padovani, Slavik Tabakov, Tony Greener, Cornelius Lewis, 2022. Introduction to Medical Physics, Taylor and Francis publication, (First Edition), United Kingdom.

Web Resources:

1. https:nptel.ac.in/courses/108/103/108103157/
2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692
3. https://www.technicalsymposium.com/alllecturenotes_biomed.html
4. https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78
5. https://www.modulight.com/applications-medical/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	1	2	3	3	3	3	3	1
CO2	3	3	3	2	1	2	3	3	3	3	3	2
CO3	3	3	3	2	1	2	3	3	3	3	3	1
CO4	3	3	3	2	1	2	3	3	3	3	3	1
CO5	3	3	3	1	1	2	3	3	3	3	3	1
TOTAL	**15**	**15**	**15**	**8**	**5**	**10**	**15**	**15**	**15**	**15**	**15**	**6**
AVERAGE	**3**	**3**	**3**	**1.6**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**1.6**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE III: b) ADVANCED SPECTROSCOPY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232EC5	4	-	-	-	3	4	60	25	75	100

Prerequisites: Basic knowledge of spectroscopy.

Learning Objectives:

1. Analyse real experimental data to retrieve information about the structure and electronic properties of atoms and molecules.
2. To explore laser operation and how the properties of laser light can be exploited.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	comprehend set of operations associated with symmetry elements of a molecule, apply mathematical theory while working with symmetry operations. Apply mathematical theory while working with symmetry operations. To use group theory as a tool to characterize molecules.	K1& K2
2	align with the recent advances in semiconductor laser technology combined sensitive spectroscopic detection techniques.	K2& K3
3	understand principle behind Mossbauer spectroscopy and apply the concepts of isomer shift and quadrupole splitting to analyse molecules.	K2& K3
4	assimilate this XPES quantitative technique and the instrumentation associated with this, as applied in understanding surface of materials.	K4& K5
5	employ IR and Raman spectroscopic data along with other data for structural investigation of molecules. Analyze thermodynamic functions and other parameters to evolve molecular models.	K3& K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Unit	Contents	No. of Hours
I	**MOLECULAR SPECTROSCOPY AND GROUP THEORY:** Group axioms –subgroup, simple group, Abelian group, cyclic group, order of a group, class- Lagrange's theorem statement and proof - Symmetry operations and symmetry elements - Application: construction of group multiplication table (not character table) for groups of order 2, 3, cyclic group of order 4, noncyclic group of order 4 – reducible and irreducible representations- Unitary representations – Schur's lemmas – Great orthogonality theorem - point group -Simple applications : Symmetry operations of water and ammonia- Construction of character table for C_{2v} (water) and C_{3v} (ammonia) molecules	12
II	**LASER SPECTROSCOPY** Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission- ultra short pulses- laser cooling -Single and multi-mode lasers- Laser tenability- Fluorescence spectroscopy with lasers- Laser Raman Spectroscopy – Non-linear Spectroscopy – Applications of Laser Spectroscopy in medical fields- Applications of Laser Spectroscopy in materials science research.	12
III	**MOSSBAUER SPECTROSCOPY:** Basic idea of Mossbauer spectroscopy -Nuclear Electric quadrupole interaction-Energy levels – Transition frequency – Excitation and Detection – Effect of magnetic field–Principle- Mossbauer effect- Recoilless emission and absorption- Chemical shift -Effect of electric and magnetic fields – hyperfine interactions- instrumentation-Applications: understanding molecular and electronic structures	12

IV	**XRAY PHOTOELECTRON SPECTROSCOPY**: Principle – XPS spectra and its interpretation- Electrochemically active surface area (ECSA) analysis-Energy-dispersive X-ray analysis (EDAX)- other forms of XPS – chemical shift - Applications : - stoichiometric analysis- electronic structure- XPES techniques used in astronomy, glass industries, paints and in biological research	**12**
V	**MOLECULAR MODELLING**: Determination of force constants- force field from spectroscopic data-normal coordinate analysis of a simple molecule (H2O) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from spectroscopic data- molecular modelling using data from various spectroscopic studies	**12**
TOTAL		**60**

Self-study	Construction of group multiplication table (not character table) for groups of order3, cyclic group of order 4, Fluorescence spectroscopy with lasers, Hyperfine interactions XPES techniques used in astronomy, Molecular modelling using data from various spectroscopic studies

Textbooks:

1. Maurya, R.C. and Mir, J.M,2019. Molecular Symmetry and Group Theory: Approaches in Spectroscopy and Chemical Reactions, De Gruyter, Germany
2. Abramczyk, H, 2005. Introduction to Laser Spectroscopy, Elsevier Science. Netherlands
3. Guido Langouche, Yutaka YoshidaMössbauer Spectroscopy: Tutorial Book, 2013. Springer Berlin Heidelberg, Germany.

Reference Books:

1. William Kemp, 2019. Organic Spectroscopy (2nd Edition) MacMillan, Indian Edition.
2. C N Banwell and McCash, 1994. Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
3. D.N. Satyanarayana, 2001. *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. David. L. Andrews, Introduction to Laser Spectroscopy, Springer, 2020.
5. Kalsi.P.S, 2016. Spectroscopy of Organic Compounds (7th Edition) New Age International Publishers.
6. J M Hollas, 2002. Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.

Web Resources:

1. Fundamentals of Spectroscopy - Course (nptel.ac.in)
2. http://mpbou.edu.in/slm/mscche1p4.pdf
3. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
4. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu5.https://serc.carleton.edu/research_education/geochemsheets/techniques/mossbauer.html.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2	3	2	2	2	2	2	2
CO2	3	2	3	3	3	2	2	2	2	2	2	2
CO3	3	2	2	3	3	2	2	2	3	2	2	3
CO4	3	2	3	3	2	2	2	3	2	3	2	2
CO5	2	2	3	3	2	2	2	3	2	2	2	2
TOTAL	**14**	**10**	**14**	**15**	**12**	**11**	**10**	**12**	**11**	**11**	**10**	**11**
AVERAGE	**2.8**	**2**	**2.8**	**3**	**2.4**	**2.2**	**2**	**2.4**	**2.2**	**2.2**	**2**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE III: c) CHARACTERIZATION OF MATERIALS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232EC6	**4**	**-**	**-**	**-**	**3**	**4**	**60**	**25**	**75**	**100**

Prerequisites:

Fundamentals of Heat and Thermodynamics, Basics of Optical systems,
Microscopic systems, Electrical measurements and Fundamentals of Spectroscopy.

Learning Objectives:

1. To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA.
2. To make the students understand some important electrical and optical characterization techniques for semiconducting materials.

Course Outcomes

On the successful completion of the course, students will able to:		
1.	describe the TGA, DTA, DSC and TMA thermal analysis techniques and make interpretation of the results.	**K1, K3**
2.	the concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	**K2**
3.	the working principle and operation of SEM, TEM, STM and AFM.	**K2, K3**
4.	understood Hall measurement, four –probe resistivity measurement, C-V, I-V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	**K3, K4**
5.	the theory and experimental procedure for x- ray diffraction and some important spectroscopic techniques and their applications.	**K4,K5**

K1 - Remember; **K2** – Understand; **K3** - Apply; **K4** - Analyze; **K5** – Evaluate

Units	Contents	No. of Hours
I	**THERMAL ANALYSIS:** Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- Instrumentation- transition temperature cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.	**12**
II	**MICROSCOPIC METHODS:** Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy –differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.	**12**
III	**ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY:** EDAX,: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- EPMA,: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- TEM,: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- SEM,: working principle and Instrumentation – sample preparation –Data	**12**

	collection, processing and analysis- Scanning tunneling microscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.	
IV	**ELECTRICAL METHODS AND OPTICAL CHARACTERISATION :** Two probe and four probe methods- van der Pauw method – Hall probe and measurement –Application- scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.	**12**
V	**X-RAY AND SPECTROSCOPIC METHODS:** Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis-application - Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.	**12**
TOTAL		**60**

Self-Study	specific heat capacity measurements, digital holographic microscopy, STEM, impurity concentration, Powder diffraction

Textbooks:

1. Rosalinda Inguanta and Carmelo Sunseri ,2018. Semiconductors: Growth and Characterization, Intechopen, United Kingdom.
2. Joseph I. Goldstein , Dale E. Newbury , Joseph R. Michael , Nicholas W.M. Ritchie , David C. Joy ,2018,Scanning Electron Microscopy and X-Ray Microanalysis, Springer, USA.
3. Lawrence E. Murr, 2019. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York.

Reference Books:

1. Kealey, D & Haines, P.J,2002.Analytical Chemistry. Viva Books Private Limited, New Delhi.
2. Li, Lin, Ashok Kumar, 2008. Materials Characterization Techniques Sam Zhang; CRC Press.
3. Lawrence E. Murr, 2015. Handbook of Materials Structures, Properties, Processing and Performance, Springer, USA.

Web Resources:

1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf
2. http://www.digimat.in/nptel/courses/video/113106034/L11.html
3. https://nptel.ac.in/courses/104106122
4. https://nptel.ac.in/courses/118104008
5. https://www.sciencedirect.com/journal/materials-characterization

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	1	2	1	3	3	2	3	2
CO2	3	3	3	3	1	2	1	3	3	2	2	2
CO3	3	3	3	3	1	2	1	3	3	2	2	2
CO4	3	3	3	3	1	2	1	3	3	2	3	2
CO5	3	3	3	3	1	2	1	3	3	2	3	2
TOTAL	**15**	**15**	**15**	**15**	**5**	**10**	**5**	**15**	**15**	**10**	**13**	**10**
AVERAGE	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**3**	**3**	**2**	**2.6**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

SKILL ENHANCEMENT COURSE I: SOLAR ENERGY UTILIZATION

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232SE1	4	-	-	-	2	4	60	25	75	100

Pre-requisite: Basic knowledge of heat energy, way of transfer of heat, solar energy, materials types.

Learning Objectives:

1. To impart fundamental aspects of solar energy utilization.
2. To develop an industrialist mindset by utilizing renewable source of energy.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	gained knowledge in fundamental aspects of solar energy utilization	K1 & K2
2	equipped to take up related job by gaining industry exposure	K1 & K2
3	develop entrepreneurial skills	K2 & K3
4	skilled to approach the needy society with different types of solar cells	K3 & K5
5	gained industrialist mindset by utilizing renewable source of energy	K5 & K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**HEAT TRANSFER AND RADIATION ANALYSIS** Conduction: Conduction in extended surface – Radiation and Convection – Forced convection and wind loss – Solar radiation at the Earth's surface – Basic Earth sin angles – Determination of solar time – Solar energy measuring instruments and its classifications.	12
II	**SOLAR COLLECTORS** Introduction – Physical Principle of the conversion of solar radiation into heat - Description of flat plate collectors- General characteristics of flat plate collectors – Selection of materials of flat plate collectors	12
III	**SOLAR HEATERS** .Introduction – Types of solar water heaters – Collectors and storage tanks - Combined heating and cooling systems - Solar pond: Introduction – Principle of operation of solar pond – Types of solar ponds – Application of solar ponds	12
IV	**SOLAR ENERGY CONVERSION** Photovoltaic principle: Semiconductor junction, Basic Photovoltaic system for power generation – Advantages and disadvantages of photovoltaic solar energy conversion – Types of solar cells – Applications of solar photovoltaic system	12
V	**NANOMATERIALS IN FUEL CELL APPLICATIONS:** Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nanotechnology in hydrogen production and storage.	12
	TOTAL	60

Self study	Solar Radiation,conversion of solar radiation, Solar heating system,Types of solar cells Fuel cell catalysts

Textbooks:

1. Solar energy utilization - G.D.Rai – Khanna publishers – Fifth Edition, fifth Reprint, 2004.
2. Maheshwar Sharon, Madhuri Sharon, Carbon "Nano forms and Applications", Mc Graw-Hill, 2010.
3. Soteris A. Kalogirou, "Solar Energy Engineering: Processes and Systems", Academic Press, London, 2009.
4. Tiwari G.N, "Solar Energy – Fundamentals Design, Modelling and applications", Narosa Publishing House, New Delhi, 2002.
5. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

Reference Books:

1. Romer, R.H., Freeman, W.H., 1976. Energy – An Introduction to Physics.
2. John A.Drife and William., 1974. Solar energy thermal processes.
3. John W. Twidell& Anthony D.Weir, 2005. Renewable Energy Resources.
4. John A. Duffie, William A. Beckman, 2013. Solar Energy: Thermal Processes, (Fourth Edition).John Wiley and Sons.
5. Duffie, J.A., Beckman, W.A., 2007. "Solar Energy Thermal Process", John Wiley and Sons.

Web Resources:

1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb
2. https://books.google.vg/books?id=lXHcwZo9XwC&sitesec=buy&source=gbs_vpt_re ad
3. www.nptel.ac.in/courses/112105051
4. www.freevideolectures.com
5. http://www.e-booksdirectory.com

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	1	2	3	3	3	3	3	1
CO2	3	3	3	2	1	2	3	3	3	3	3	2
CO3	3	3	3	2	1	2	3	3	3	3	3	1
CO4	3	3	3	2	1	2	3	3	3	3	3	1
CO5	3	3	3	1	1	2	3	3	3	3	3	1
TOTAL	**15**	**15**	**15**	**8**	**5**	**10**	**15**	**15**	**15**	**15**	**15**	**6**
AVERAGE	**3**	**3**	**3**	**1.6**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**1.6**

3 – Strong, 2- Medium, 1- Low

SEMESTER I & II

LIFE SKILL TRAINING – I ETHICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST1	**1**	**-**	**-**	**-**	**1**	**1**	**15**	**50**	**50**	**100**

Prerequisites: Value education-its purpose and significance in the present world

Learning Objectives:

1. To familiarize students with values of the individual, society, culture, one's own health and life philosophy,
2. To impart knowledge of professional ethical standards, codes of ethics, obligations, safety, rights, and other worldwide challenges.

Course Outcomes

On completion of this course the student will be able to		
1	understand deeper insight of the meaning of their existence.	**K1**
2	recognize the philosophy of life and individual qualities	**K2**
3	acquire the skills required for a successful personal and professional life.	**K3**
4	develop as socially responsible citizens.	**K4**
5	create a peaceful, communal community and embrace unity.	**K3**

K1-Remember;K2-Understand;K3-Apply;K4-Analyze

Unit	Contents	No. of Hours
I	Goal Setting: Definition - Brainstorming Session – Setting Goals – Few components of setting goals.	**3**
II	Group Dynamics: Definition - Nature of Groups – Types of Groups – Determinants of group behavior	**3**
III	Conflict Resolution: Definition – What is a conflict resolution – Why should conflicts be resolved? - Lessons for life	**3**
IV	Decision Making: Definition – 3C's of decision making – Seven Steps to effective decision making – Barriers in effective decision making	**3**
V	Anger Management: Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	**3**
	TOTAL	**15**

Self-Study:	Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.

Textbooks

Life Skill Training – I Ethics, Holy Cross College (Autonomous), Nagercoil

Reference Books

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.
2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Swati Mehrotra. (2016). Inspiring Souls Moral Values and Life Skills (1st ed.) [English]. Acevision Publisher Pvt. Ltd.
4. Irai Anbu, v. (2010, August). Random Thoughts (1st ed.) [English]. THG Publishing Private Limited, 2019.

5. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's hallenges. Sipca Computers.

Web Resources

1. https://positivepsychology.com/goal-setting-exercises/
2. https://www.gov.nl.ca/iet/files/CCB_GroupDynamicsGuide.pdf
3. https://en.wikipedia.org/wiki/Conflict_resolution
4. https://asana.com/resources/decision-making-process
5. https://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/anger-management/art-20045434

SEMESTER III

CORE COURSE VI: CONDENSED MATTER PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233CC1	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.

Learning Objectives:

1. To gain a comprehensive understanding of the fundamental principles in condensed matter physics, including crystallography, lattice dynamics, the theory of metals, semiconductors, magnetism and superconductivity.
2. To apply advanced concepts and theories learned in condensed matter physics to analyze and interpret experimental observations and phenomena in material science.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	identify various crystal structures, symmetry and differentiate different types of bonding.	**K1**
2.	understand the lattice dynamics and apply it to concept of specific heat.	**K2**
3.	articulate different types of magnetic materials and explain the underlying phenomena.	**K3**
4.	relate the concepts of superconductivity, the underlying theories – related to current areas of research.	**K4**
5.	assess various theories of electrons in solids and their impact in distinguishing solids.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** – Evaluate

Units	Contents	No. of Hours
I	**CRYSTAL PHYSICS** Types of lattices - Miller indices - Symmetry elements and allowed rotations - Simple crystal structures - Atomic Packing Factor- Crystal diffraction - Bragg's law - Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc) - Structure and properties of liquid crystals - Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).	**18**
II	**LATTICE DYNAMICS** Lattice with two atoms per primitive cell - First Brillouin zone - Group velocity - Long Wavelength Limit - Derivation of Force Constants from Experiment - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons –Phonon Heat capacity- Planck Distribution- Normal Mode Enumeration- Density of States in Three Dimensions- Debye's theory of lattice heat capacity - Thermal Conductivity - Umkalapp processes.	**18**
III	**THEORY OF METALS AND SEMICONDUCTORS** Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz law - Band theory of metals and semiconductors -	**18**

	Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration - Temperature Dependence - Mobility - Impurity conductivity - Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect.	
IV	**MAGNETISM** Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism.	**18**
V	**SUPERCONDUCTIVITY** Meissner effect - Critical field – Critical current - Entropy and heat capacity - Energy gap - Type I and II Superconductors - Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory - Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS.	**18**
	Total	**90**

Self-study	Types of crystal binding, High temperature Superconductors

Textbooks:

1. Kittel C, 2005. *Introduction to Solid State Physics*, (8th Edition), Wiley, New York.
2. Rita John, 2014. *Solid State Physics*, (1st Edition), Tata Mc-Graw Hill Publication,New Delhi.
3. Srivastava J P, 2014. *Elements of Solid State Physics*. (4th Edition), Prentice Hall of India, New Delhi.
4. Ali Omar M, 1993. *Elementary Solid State Physics – Principles and Applications*, (4th Edition), Addison – Wesley, Michigan.
5. Myers H P, 1998. *Introductory Solid State Physics*, (2nd Edition), Viva Book, New Delhi.

Reference Books:

1. Blakemore J S, 1974. *Solid state Physics*, (2nd Edition), W.B. Saunder Company, Philadelphia.
2. Rosenburg H M, 1993. *The Solid State*, (3rd Edition), Oxford University Press, Oxford.
3. Ziman J M, 1979. *Principles of the Theory of Solids*, (2nd Edition), Cambridge University Press, London.
4. Rose Innes A C, Rhoderick E.H, 1978. *Introduction to Superconductivity*, (2nd Edition), Pergamon, Oxford.
5. Ibach H, Luth H, 2004. *Solid State Physics*, (4th Edition), Springer, New York.

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES
AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	2	2	3	3	3	3	3
CO2	3	3	3	3	2	2	2	2	3	3	3	3
CO3	3	3	3	3	2	2	2	3	3	3	3	3
CO4	3	3	3	3	2	2	2	3	3	3	3	3
CO5	3	3	3	3	2	2	2	3	2	3	3	3
TOTAL	**15**	**15**	**15**	**15**	**10**	**10**	**10**	**14**	**14**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2.8**	**2.8**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

CORE COURSE VII: ELECTROMAGNETIC THEORY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233CC2	**6**	**-**	**-**	**-**	**5**	**6**	**90**	**25**	**75**	**100**

Pre-requisite:

Different coordinate systems, Laplace's equation, conducting and non-conducting medium, basic definitions in magnetism, propagation of electromagnetic waves.

Learning Objectives:

1. To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables
2. To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understand the basic laws of electromagnetism.	**K1**
2.	recognize the behaviour of electric and magnetic fields in simple configurations under different boundary conditions.	**K2**
3.	apply the concepts of electrodynamics and derive the Maxwell's equation.	**K3**
4.	analyse the concept of propagation in linear media.	**K4**
5.	prioritize the magnetic properties of matter.	**K5**

K1 - Remember; **K2** - Understand; **K3**- Apply; **K4** - Analyse; **K5** – Evaluate

Units	Contents	No. of Hours
I	**ELECTROSTATICS:** Coulomb's law- Electric field – field lines, flux and Gauss's Law in differential form – application of Gauss's law – curl of E - Poisson's equation- Laplace's equation -one and two dimensions –boundary conditions and uniqueness theorem – solution in cartesian and spherical polar coordinates – electric displacement -gauss's law in the presence of dielectrics –linear dielectrics -electrostatic energy in the presence of dielectric.	**18**
II	**MAGNETOSTATICS:** Lorentz force Law -Biot-Savart's Law –Steady currents – The magnetic field of a steady current - – divergence and curl of B -Magnetic vector potential – The vector potential – Magnetostatic boundary conditions – Multipole expansion of the vector potential-Magnetization - torques and forces on magnetic dipoles –Effect of a magnetic field on atomic orbits–Ampere's law in magnetized materials - Uniformly magnetized sphere.	**18**
III	**MAXWELL EQUATIONS:** Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Energy and momentum of the field -Poynting's theorem - Maxwell's stress tensor - Conservation of momentum- Electromagnetic waves -Waves in one dimension – wave equation – sinusoidal waves – reflection and transmission – Polarization - scalar and vector potentials – Gauge Transformation - Coulomb and Lorentz gauge.	**18**
IV	**WAVE PROPAGATION:** Electromagnetic waves in vacuum – The wave equation for E and B – Monochromatic plane waves – energy and momentum in electromagnetic waves - Electromagnetic waves in matter –	**18**

	Propagation in Linear Media – Reflection and transmission at normal incidence – Reflection and transmission at oblique incidence - Propagation of waves in a rectangular wave guide - the co– axial transmission line.	
V	**RELATIVISTIC ELECTRODYNAMICS:** Special theory of relativity-Einstein's Postulates-geometry of relativity –relativity of simultaneity-time dilation –Lorentz contraction-relativistic mechanics-proper Time and velocity-relativistic energy-momentum-kinematics-dynamics- relativistic electrodynamics-magnetism as a relativistic phenomenon-field transformation Electrodynamics in tensor potentials -relativistic potentials – d'Alembertian	**18**
	Total	**90**

Self-study	Examples of solutions for boundary value problems, The field of a Magnetized object, Conservation laws for a system of charges and electromagnetic fields, Reflection and transmission at oblique incidence, Magneto-hydrodynamic waves

Textbooks:

1. Griffiths D J, 2004. *Introduction to Electrodynamics,* (3rd Edition), Prentice-Hall of India, New Delhi.
2. Reitz J R, Milford F J and Christy R W, 2008. *Foundations of Electromagnetic Theory,* (4th Edition), Addison-Wesley Publishing, Boston.

Reference Books:

1. Chakraborty B, 2002. *Principles of Electrodynamics,* Books and Allied, Kolkata.
2. Andrew Zangwill, 2013. *Modern Electrodynamics,* (3rd Edition), Cambridge University Press, USA.
3. Feynman P, Leighton R B and Sands M, 2011. *The Feynman Lectures on Physics,* 2, (1st Edition), Narosa Publishing House, New Delhi.
4. Kraus J D, Fleisch D A, 1999. *Electromagnetics with Applications,* (5th Edition), WCB McGraw-Hill, New York.
5. Jackson J D, 1975. *Classical Electrodynamics,* (2nd Edition), Wiley Eastern Ltd. New Delhi.

Web Resources:

1. https://www.studysmarter.co.uk/explanations/physics/electromagnetism/three-dimensional-laplace-equation/
2. https://staff-old.najah.edu/jaber/published-research/effect-magnetic-field-atomic-orbital
3. https://web.mit.edu/6.013_book/www/chapter11/11.2.html
4. https://web.mit.edu/6.013_book/www/chapter13/13.4.html
5. https://lweb.cfa.harvard.edu/~namurphy/Lectures/Ay253_2016_07_MHDwaves.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	2	3	2	3	3	3	3	3
CO2	3	2	3	1	2	3	2	3	3	3	3	3
CO3	3	2	3	1	2	3	2	3	3	3	3	3
CO4	3	2	3	1	2	3	2	3	3	3	3	3
CO5	3	2	3	1	2	3	2	3	3	3	3	3
TOTAL	**15**	**10**	**15**	**5**	**10**	**15**	**10**	**15**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**2**	**3**	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

CORE LAB COURSE III: ADVANCED PHYSICS LAB-III

PROGRAMMING IN MICROPROCESSOR AND MICROCONTROLLER

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233CP1	-	-	6	-	5	6	90	25	75	100

Prerequisite:

Fundamentals of digital principles.

Learning Objectives:

1. To become familiar with the instruction set of Intel 8085 microprocessor and microcontroller 8051.
2. To provide practical hands-on experience with Assembly Language Programming and interfacing with 8085 microprocessors.

Course Outcomes

On the successful completion of the course, students will able to:		
1.	illustrate the features of microprocessor and microcontroller in different applications.	**K1**
2.	understand the theory and working of Microprocessor, Microcontroller.	**K2**
3.	apply assembly language programming on microprocessor (Data Manipulation, Square of numbers, Counters).	**K3**
4.	devise the interfacing of microprocessor 8085 with I/O devices (A/D& D/A, Stepper motor).	**K4**
5.	evaluate and develop experiments with assembly language programming on 8085 microprocessor and 8051 microcontroller (Addition, Subtraction, Multiplication and Division).	**K5 & K6**

K1 - Remember; **K2 –** Understand; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate; K6- Create

Contents(Any Twelve Experiments)

1. Assembly language program for block move and logical operations
2. Assembly language program for Addition, Subtraction, Multiplication and Division
3. Arranging an array of data in Ascending and descending orders
4. Finding the largest, smallest and search for any number of an array using Micro processor
5. Sum of series of even numbers and odd numbers from the list of numbers
6. Counters using microprocessor
7. Wave form generation using microprocessor
8. Display of any character (Rolling display)
9. Code conversion using microprocessor
10. AD/DA converters using microprocessor
11. Number of zeros, positive, negative numbers and square of a number using 8085 microprocessor
12. Interfacing–Stepper motor using microprocessor
13. Interfacing–Traffic Control
14. Microcontroller–Logic operations,1's and 2's compliment
15. Microcontroller–Addition, Subtraction, Multiplication and Division

Textbooks:

1. Douglas V. Hall, 2017. *Microprocessors and Interfacing programming and Hardware*, (3rd Edition), Tata Mc Graw Hill Education, New Delhi.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. Mckinlay, 2007. The 8051 *Microcontroller and Embedded Systems*, (2nd Edition), Pearson Education India, New Delhi.
3. Vijayendran V, 2009, *Fundamentals of Microprocessor*-8085, (3rd Edition), S.Visvanathan Pvt, Ltd, Chennai.
4. Udaya Kumar K, Uma Shankar S, 2008. *The 8085 Microprocessor, Architecture, Programming and Interfacing*, (1st Edition), Pearson Education, New Delhi.
5. Ram B, 2021. *Fundamentals of Microprocessors and Microcontrollers*, (2nd Edition), Dhanpat Rai Publications (P) Ltd, New Delhi.

Reference Books:

1. Ramesh Gaonkar, 2013. *Microprocessor Architecture, Programming and Applications with 8085*, 1, (2nd Edition), Penram International Publishing, Mumbai.
2. Douglas V. Hall. 2008. *Microprocessors and Interfacing programming and Hardware*, 1, (3rd Edition), Tata Mc Graw Hill Publications, Noida.
3. Godse. A P, Godse. D A. 2013. *Microprocessors*, 1, (2nd Edition), Technical Publications, Pune.
4. Nagoor Kani. A. 2017. *Microprocessors & Microcontrollers*, 1, (2nd Edition), McGraw Hill Education.
5. Barry B. Brey, 2008, *The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486*, 1, (8th Edition), Pearson India.

Web Resources:

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm
2. https://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/
3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/
4. https://www.tutorialspoint.com/microprocessor/microcontrollers_8051_interrupts.htm
5. https://www.geeksforgeeks.org/addressing-modes/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	2	3	2	3	3	3	3	3
CO2	3	2	3	2	2	3	2	3	3	3	3	3
CO3	3	2	3	2	2	3	2	3	3	3	3	3
CO4	3	2	3	2	2	3	2	3	3	3	3	3
CO5	3	2	3	2	2	3	2	3	3	3	3	3
TOTAL	**15**	**10**	**15**	**10**	**10**	**15**	**10**	**15**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

CORE RESEARCH PROJECT

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233RP1	**-**	**-**	**5**	**-**	**4**	**5**	**75**	**25**	**75**	**100**

Pre-requisite:

Identification of Research Problem.

Learning Objectives:

1 To enable students to design experiment, analyze data and interpret results.

2 To develop skills to identify subject related problems in the neighborhood and report to the scientific community.

Course Outcomes

Upon completion of this course, the students will be able to:		
1.	recognise new areas of research in physics.	**K1**
2.	interpret a research problem and construct tools for data collection.	**K2**
3.	apply skills to serve in science related industries and agencies.	**K3**
4.	correlate research reports and results in the scientific community.	**K4**
5.	develop prototypes and publish articles in reputed journals.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Guidelines

- All the students must undertake project work at the final year (III semester).
- The students, with the consent of the Supervisor, HOD and the Principal can pursue their project in another institution, especially with MoU/ Collaboration for the successful completion of the project work.

Distribution of marks for project

Internal : External = 25:75

Internal Components

Internal Viva= 5 marks

Regularity and Systematic work = 20 marks

External Components

Dissertation = 40 marks

Innovation = 10 marks

Presentation and Viva = 25 marks

Evaluation	Marks	Month/ Date	Evaluator
Proposed title, review of literature and objectives.	–	3rd Week of III Semester	–
I Review	5	July	Supervisor
II Review	10	August	Supervisor
Internal	10	September/ October	Supervisor
Final– External (Dissertation and Innovation)	50	October /November	Ext. examiner
* Final–Project Viva (group & open)	25	October /November	Ext. examiner
Total marks	**100**		

*Mode of presentation by Power Point

Project framework

1. The Project format should be in:
   - Font – Times New Roman
   - Heading – Font size 14 (Bold) – Uppercase

- ❖ Sub headings – Font size 12 (Bold) — Lowercase; should be numbered. (Eg: Introduction 1; Subheading 1.1; 1.2)
- ❖ Text, the content of the dissertation — Font size – 12 (Normal).
- ❖ Citation – Any works of other researchers, if used either directly or indirectly should be indicated at appropriate places in the text.

The citation may assume any one of the following forms:

i) A paper, a monograph or a book with single author may be designatedby the name of the *fast* author followed by the year of publication, placedinside brackets at the appropriate places in the text.

ii) A paper, a monograph or a book with two authors may be designated by the name of the first and second author followed by the year of publication, placed inside brackets at the appropriate places in the text.

A paper, a monograph or a book with more than two authors may be designated by the name of the first author followed by et al, and the year of publication, placed inside brackets at the appropriate places in the text.

- ❖ Line space – 1.5
- ❖ Margin – 2" on the left and 1" on the right, Gutter – 0.5.
- ❖ Page Numbering Bottom middle alignment; excluding initial pages andreference
- ❖ Total number of pages Minimum 30, Maximum 50

  (Excluding initial pages and reference).
- ❖ The Tables and Figures should be included subsequently after referring them in the text of the Report.

II. Project Report must be completed within the stipulated time.

III Submission of Project Report:

- ❖ one soft copy (PDF format in CD)
- ❖ Three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

The Project Report will have three main parts:

I. Initial Pages – in the following sequence

i). Title Page
ii). Certificate from the Supervisor
iii). Declaration by the candidate endorsed by the Supervisor and HOD
iv). Acknowledgement (within one page – signed by the candidate).
v). Table of Contents
vi). List of abbreviations
vii). Abstract

II. Main body of the dissertation

i) Introduction with Literature review and Objectives
ii) Methodology
iii) Results
iv) Discussion
v) Summary
vi) References

The guidelines for reference

Journal Article : with Single Author

Waldron, S 2008, "Generalized Welch bound equality sequences are tight frames", IEEE Transactions on Information Theory, vol. 49, no. 9, pp. 2307– 2309.

Journal Article : with Two Authors

Conley, TG & Galeson, DW 1998, "Nativity and wealth in mid– nineteenth century cities", Journal of Economic History, vol. 58, no. 2, pp. 468– 493.

Journal Article: with more than two Authors

Alishahi, K, Marvasti, F, Aref, VA & Pad, P 2009, „Bounds on the sum capacity of synchronous binary CDMA channels", Journal of Chemical Education, vol. 55, no. 8, pp. 3577– 3593.

Books

Holt, DH 1997, Management Principles and Practices, Prentice– Hall, Sydney. Centre for Research, M S University – Ph.D. Revised Guidelines Page | 39 / 41

E– book

Aghion, P & Durlauf, S (eds.) 2005, Handbook of Economic Growth, Elsevier, Amsterdam. Available from: Elsevier books. [4 November 2004].

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	3	3	3	3	2
CO2	3	3	3	2	3	3	2	3	3	3	3	2
CO3	3	3	3	2	3	3	2	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	2
TOTAL	**15**	**15**	**15**	**12**	**15**	**15**	**10**	**15**	**15**	**15**	**15**	**10**
AVERAGE	**3**	**3**	**3**	**2.4**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

ELECTIVE COURSE IV: a) COMMUNICATION ELECTRONICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233EC1	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Knowledge of high frequency antennas and satellites.

Learning Objectives:

1. To acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth.
2. To understand the general theory and operation of satellite communication systems.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	identify the use of optical fiber as wave guide and compare the different types of optical fiber.	**K1 & K2**
2.	articulate the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances.	**K3**
3.	correlate the methods of generation of microwaves through wave guides.	**K4**
4.	relate the importance of satellite communication in our daily life-distinguish between orbital and geostationary satellites elaborate the linking of satellites with ground station on the earth	**K4**
5.	reframe the energy and power radiated by the different types of antenna and develop a prototype.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**ANTENNAS AND WAVE PROPAGATION** Radiation field and radiation resistance of short dipole antenna-grounded antenna-ungrounded antenna-antenna arrays-broadside and end side arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere- Ecles and Larmor theory- Magneto ionic theory-ground wave propagation	**12**
II	**MICROWAVES** Microwave generation—multi cavity Klystron-reflex klystron-magnetron travelling wave tubes (TWT) and other microwave tubes-MASER-Gunn diode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio(SWR)	**12**
III	**RADAR AND TELEVISION** Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers-radar receivers and indicators-pulsed systems-other radar systems- colour TV transmission and reception-colour mixing principle-colour picture tubes- Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV	**12**
IV	**OPTICAL FIBER** Propagation of light in an optical fibre-acceptance angle-numerical aperture-single mode and multimode fibres-step index and graded index fibres-Fabrication of optical fibres-Double crucible technique-optical fibres as a cylindrical wave guide-wave guide equations-wave guide equations in step index fibres - dispersion in optical fibres-applications	**12**

V	**SATELLITE COMMUNICATION** Orbital satellites-geostationary satellites-satellite system link models-satellite system parameters- Communication Satellite Systems - Telemetry - Tracking and Command System-satellite system link equation link budget-INSAT communication satellites-Multiple access - Error Detection.	**12**
	TOTAL	**60**

Self-study	Orbital satellites-geostationary satellites, INSAT communication satellites

Textbooks:

1. Gerd Keiser, 2003. *Optical communications Essentials*, (5th Edition), Tata McGraw Hill Publishing Company Ltd, New Delhi.
2. George Kennedy, Bernard Davis, Prasanna S R M, 2015. *Electronic communication systems*, (5th edition), McGraw Hill Education (India) Private Limited, New Delhi.
3. Gupta and Kumar, 2008. *Handbook of Electronics*, Pragati Prakash, Meerut.
4. Taub and Schilling, 1991. *Principles of communication systems*, (2nd Edition), Tata Mc Graw Hill Publishing Company Ltd, New Delhi.
5. M. Kulkarani, 1998. *Microwave and radar engineering*, Umesh Publications, New Delhi.

Reference Books:

1. Louis E. Frenzel, 2011. *Communication Electronics: Principles And Applications*, (3rd Edition), Mcgraw-Hill Education, U.S.A.
2. Vijayendran. V &Viswanathan S, 2011. *Introduction to Integrated Electronics Digital and Analog*, (1st Edition), Printers and Publishers Pvt. Ltd., Chennai.
3. Dennis Roody and Coolen, 1995. *Electronic communications*, (4th Edition), Prentice Hall of India, New Jersey.
4. Wayne Tomasi, 1998. *Advanced electronics communication systems*, (4th Edition), Prentice Hall of India, New Jersey.
5. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009. *Electronic Devices and Circuits*, (2nd Edition), Tata McGraw-Hill Publishing Company Limited, New Delhi,

Web Resources:

1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/
3. http://nptel.iitm.ac.in/
4. http://web.ewu.edu/
5. http://nptel.iitm.ac.in/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3	3	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**15**	**15**	**14**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**14**
AVERAGE	**3**	**3**	**2.8**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

ELECTIVE COURSE IV: b) MICROPROCESSOR AND MICROCONTROLLER

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233EC2	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Knowledge of number systems and binary operations.

Learning Objectives:

1. To offer insight into the architecture and operation of microprocessor 8085A and to the techniques for interfacing I/O devices and memory with the microprocessor.
2. To introduce programming and applications for the 8085A, along with exploring the architecture and instruction sets of the 8051 microcontroller.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	illustrate the architecture and functionality of the 8085 microprocessor.	**K1**
2	infer the architecture and functionality of the 8051 Microcontroller.	**K2**
3	apply the addressing modes and data transfer scheme for 8085 microprocessor and 8051 microcontroller.	**K3**
4	categorise instructions to develop programs for measuring various electrical and physical quantities.	**K4**
5	evaluate the interfacing of microprocessors and microcontrollers and develop external devices across various applications.	**K5 & K6**

K1 - Remember; **K2 -** Understand; **K3** – Apply; **K4 -** Analyze; **K5 -** Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**8085 ARCHITECTURE, PROGRAMMING AND PERIPHERALS** Intel 8085 microprocessor –Pin configuration– Architecture– Instruction set –Data transfer operations - Arithmetic operations – Logical operations– Branching and machine control operations– Memory and I/O interfacing- Data transfer schemes - Programmable peripheral interface–Control group and control word– Programmable DMA controller.	12
II	**8085 INTERFACING APPLICATIONS** 8085 interrupts – Seven segment display interface – Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface – Measurement of electrical quantities – Voltage and current Measurement – Measurement of physical quantities –Temperature measurement and control – strain measurement.	12
III	**8051 MICROCONTROLLER HARDWARE** Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit, internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/ Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory.	12
IV	**8051 ASSEMBLY LANGUAGE PROGRAMMING** Addressing modes – Data transfer instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions –	12

	Arithmetic instructions - Decimal arithmetic – Jump and CALL instructions: Jump, Call and subroutines.	
V	**INTERRUPT AND INTERFACING TO EXTERNAL WORLD** 8051 Interrupts –Enabling and disabling an interrupt–Interrupt priority: Nested interrupts –Software triggering – LED Seven segment display interface – Interfacing of D/A converter and A/D converter - Stepper motor interface – Measurement of electrical quantities –Voltage and current– Measurement of physical quantities –Temperature and strain.	**12**
	Total	**60**

Self-study	Programmable DMA controller, Memory organization of 8051, Enabling and disabling an interrupt, Interrupt priority in the 8051

Textbooks:

1. Ram B, 2016. *Fundamentals of Microprocessors & Microcontrollers*, 1, (2nd Edition), Dhanpat Rai publications, New Delhi.
2. Ramesh Gaonkar, 2013. *Microprocessor Architecture, Programming and Applications with 8085*, 1, (2nd Edition), Penram International Publishing, Mumbai.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D, Mckinlay, 2008. *The 8051Microcontroller and Embedded Systems*, 1, (2nd Edition), Pearson Education, London.

Reference Books:

1. Vijayendran V, 2005. *Fundamentals of Microprocessor-8085*, 1, (3rd Edition), S.Visvanathan Pvt, Ltd., Chetpet.
2. Douglas V. Hall. 2008. *Microprocessors and Interfacing programming and Hardware*, 1, (3rd Edition), Tata Mc Graw Hill Publications, Noida.
3. Godse. A P, Godse. D. A. 2013. *Microprocessors*, 1, (2nd Edition), Technical Publications, Pune.
4. Nagoor Kani. A. 2017. *Microprocessors & Microcontrollers*, 1, (2nd Edition), McGraw Hill Education.
5. Barry B. Brey, 2008, *The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486*, 1, (8th Edition), Pearson India.

Web Resources:

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm
2. https://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/
3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/
4. https://www.tutorialspoint.com/microprocessor/microcontrollers_8051_interrupts.htm
5. https://www.geeksforgeeks.org/addressing-modes/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	3	2	3	3	2	3	3
CO2	3	3	3	2	2	3	2	3	3	2	3	3
CO3	3	3	3	2	2	3	2	3	3	2	3	3
CO4	3	3	3	2	2	3	2	3	3	2	3	3
CO5	3	3	3	2	2	3	2	3	3	2	3	3
TOTAL	**15**	**15**	**15**	**10**	**10**	**15**	**10**	**15**	**15**	**10**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

ELECTIVE COURSE IV: c) ADVANCED MATHEMATICAL PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233EC3	4	-	-	-	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite:

Good knowledge in basic mathematics.

Learning Objectives:

1. To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics.
2. To analyze and solve complex problems in theoretical and mathematical physics, demonstrating a deep understanding of topics such as group theory and tensor analysis.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	identify both discrete and continuous groups.	**K1**
2.	classify group theory and articulate tensors to pursue research.	**K2& K3**
3.	contrast various important theorems in group theory.	**K4**
4.	evaluate group multiplication table, character table relevant to important branches of physics.	**K5**
5.	develop Ricci tensor applications.	**K6**
K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create		

Units	Contents	No. of Hours
I	**DISCRETE GROUPS:** Definition of a group, subgroup, class– Lagrange's theorem– invariant subgroup– Homomorphism and isomorphism between two groups– Representation of a group –unitary representations – reducible and irreducible representations – Schur's lemmas – orthogonality theorem– character table – reduction of Kronecker product of representations – criterion for irreducibility of a representation.	**12**
II	**CONTINUOUS GROUPS:** Infinitesimal generators–Lie algebra; Rotation group – representations of the Lie algebra of the rotation group – representation of the rotation group– D-matrices and their basic properties – Addition of two angular momenta and C.G. coefficients – Wigner-Eckart theorem.	**12**
III	**SPECIAL UNITARY GROUPS:** Definition of unitary, unimodular groups SU (2) and SU(3) – Lie algebra of SU(2) – Relation between SU(2) and rotation group –Lie algebra of SU(3)-Gellmann's matrices– Cartan form of the SU(3) – Lie algebra, roots and root diagram for SU(3) – Weights and their properties, weight diagrams for the irreducible representations 3.3* – 6,6 8, 10 and 10 of SU(3) – Direct product of two SU(3) representations – Young tableaux method of decomposition of products of IR's illustrations with the representations of dim<10 – C.G. coefficients for 3 x 3* and 3 x 6 representations – SU(3) symmetry in elementary particle physics, quantum numbers of hadrons and SU(2) and SU(3) classification of hadrons.	**12**
IV	**TENSORS:** Cartesian vectors and tensors – Transformation of coordinates–The Summation Convention and Kroneckar delta symbol – contra variant and covariant vectors and tensors, mixed tensors– Tensor algebra, addition, subtraction, direct	**12**

	product of tensors – quotient theorem – symmetric and antisymmetric tensors– illustration with moment of inertia – conductivity, dielectric tensors – Four vector in special relativity, vectors and tensors under Lorentz transformations.	
V	**TENSOR CALCULUS:** Parallel transport– covariant derivative of a tensor, affine connection Metric tensor – Expression for Christoffel symbols in terms of and its derivatives (assuming D g = 0). Curvature tensor – Ricci tensor and Einstein tensor– Bianchi's identities –Schwarzschild solution to the Einstein equation G=0.	**12**
	Total	**60**

Self-study	Representation of a group, D-matrices and their basic properties, Direct product of two SU (3) representations.

Textbooks:

1. Joshi A W,2018. *Group Theory for Physicists*, (5th Edition), New Age International Publisher, Kerala.
2. Lichtenberg DB, 2013. *Unitary Symmetry and Elementary Particles,* Academic Press, United States.
3. Robert F. Snider, 2018. *Irreducible Cartesian Tensors*, Volume 43, deGruyter, Berlin
4. Boas M L. 2006. *Mathematical Methods in the Physical Sciences*, (3rd Edition), John Wiley & Sons, Inc., New York.
5. Narlikar J V. 2012. *General Relativity & Cosmology*,Cambridge University Press.

Reference Books:

1. Balakrishnan V, 2020. *Mathematical Physics*, Springer, Switzerland.
2. Tarasankar Nag, 2017. *Fundamentals of Mathematical Physics*, McGraw Hill Education (India) Private Limited, Chennai.
3. George B. Arfken, Hans J. Weber, Frank E. Harris, 2012. *Mathematical Methods for Physicists*,(7th Edition),Elsevier pub, Academic Press, Amsterdam.
4. Mirjana Dalarsson, Nils Dalarsson, 2015. *Tensors, Relativity and Cosmology*, Elsevier Publication, Netherland.
5. Dass. H K, Rama Verma, 2014. *Mathematical Physics*, (7th Edition), S. Chand & Company Pvt Ltd, New Delhi.

Web Resources:

1. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particles-c4qsfejthkc0
2. https://physics.iith.ac.in/HEP_Physics/slides/poplawskitalk.pdf
3. https://www.hindawi.com/journals/amp/
4. https://projecteuclid.org/journals/advances-in-theoretical-and-mathematical-physics
5. https://www.springer.com/journal/11232

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	2	3	2	3	3	3	3	3
CO2	3	2	3	2	2	3	2	3	3	3	3	3
CO3	3	2	3	2	2	3	2	3	3	3	3	3
CO4	3	2	3	2	2	3	2	3	3	3	3	3
CO5	3	2	3	2	2	3	2	3	3	3	3	3
TOTAL	**15**	**10**	**15**	**10**	**10**	**15**	**10**	**15**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SKILL ENHANCEMENT COURSE II: SEWAGE AND WASTE WATER TREATMENT AND REUSE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233SE1	3	-	-	-	2	3	45	25	75	100

Pre-requisite:

Basic knowledge on classification of sewage and solid waste and its harmful effects.

Learning Objectives:

1. To gain basic knowledge in sewage and waste water Treatment procedures.
2. To sensitize the importance of healthy practices in waste water management.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	identify solid waste management methods.	**K1**
2.	interpret factors affecting disinfection.	**K2**
3.	use advanced waste water treatment for removal of suspended solids in the nearby areas.	**K3**
4.	connect to related job by gaining industry exposure.	**K4**
5.	defend managing solid wastes in and around the locality and develop entrepreneurial skills.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** – Evaluate; K6- Create

Units	Contents	No. of Hours
I	**RECOVERY & REUSE OF WATER** Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication	**9**
II	**DISINFECTION** Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile -Bacteriostatic and Bactericidal - factors affecting disinfection.	**9**
III	**CHEMICAL DISINFECTION** Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment - Disinfection By-Products(DBPs)	**9**
IV	**PHYSICAL DISINFECTION** Introduction - Ultraviolet Radiation - Solar Disinfection - Heat Treatment - Filtration Methods - Distillation - Electrochemical Oxidation Water Disinfection by Microwave Heating.	**9**
V	**ADVANCED WASTE WATER TREATMENT** Removal of suspended solids - Removal of dissolved solids – Nitrogen removal – Phosphorous removal - Advanced biological systems – Chemical oxidation.	**9**
	Total	**45**

Self-study	Factors affecting disinfection, Distillation, pressure filters.

Textbooks:

1. Anirudhha Balachandra, 2013. *Drinking water and disinfection technique,* CRC press, New York.
2. Shashi Bushan, 2015. *Design of Water and Wastewater Treatment Systems,* Jain Bro Publication, New Delhi.
3. Sarbhukan M.M, 2013. *Integrated Water Resources Management*, CBS Publication, Bengaluru.
4. Rao CS, 2007. *Environmental Pollution Control Engineering,* New Age International, Kerala.

Reference Books:

1. Frank. R Spellman, 2020. *Handbook of Water and Wastewater Treatment Plant Operations*, CRC Press, New York.
2. Mritunjay Chaubey, 2021.*Wastewater Treatment Technologies*, Wiley, New Jersy.
3. Metcalf, Eddy, 2002. *Wastewater Engineering*, (4th Edition), McGraw Hill Higher Edu., New Delhi.
4. Mahajan S P, 2012. *Pollution control in process industries*, (27th Edition), Tata McGraw Hill Publishing Company Ltd., New Delhi.
5. Lancaster, 2010. *Green Chemistry: An Introductory* Text, (2nd Edition), RSC publishing, Cambridge .

Web Resources:

1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en
2. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648?
3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
5. https://www.amazon.in/Design-Wastewater-Treatment-Systems-CV-424/dp/B00IG2PI6K/ref=asc_df_B00IG2PI6K/?tag=googleshopmob-21&linkCode=df0&hvadid=397013004690&hvpos=&hvnetw=g&hvrand=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3	2	3	3	2	2	3	2
CO2	2	3	3	3	3	2	3	3	2	2	3	2
CO3	2	3	3	3	3	2	3	3	2	2	3	2
CO4	2	3	3	3	3	2	3	3	2	2	3	2
CO5	2	3	3	3	3	2	3	3	2	2	3	2
TOTAL	**10**	**15**	**15**	**15**	**15**	**10**	**15**	**15**	**10**	**10**	**15**	**10**
AVERAGE	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SPECIFIC VALUE-ADDED COURSE: SENSOR BASED APPLIANCES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233V01	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Knowledge of Transducers and Detectors.

Learning Objectives:

1. To understand the fundamental principles of sensors, including their operation, types, and characteristics.
2. To apply knowledge of sensors to design and implement sensor-based appliances.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	illustrate sensor types, principles, and applications in modern appliances.	**K1**
2.	understand the concepts of Sensor appliances.	**K2**
3.	articulate expertise in designing and integrating sensors into appliance systems.	**K3**
4.	correlate sensor-based appliances with smart home systems for enhanced functionality.	**K4**
5.	defend the accuracy of sensors to detect signals.	**K5**

K1- Remember- **K2-** Understand- **K3 –** Apply- **K4-** Analyze- **K5-** Evaluate

Units	Contents	No. of Hours
I	**BASICS OF SENSORS** Sensors and Transducers – Basics - Introduction to Sensors - Materials for sensors - Introduction to Sensor Parameters –*Sensitivity* - *Range* – *Accuracy* - *Resolution* - Physics of Sensors	6
II	**SENSORS CLASSIFICATION** Electrical sensors - Optic sensors - Temperature sensors - pressure sensors -Intensity sensor – High frequency sensor - velocity sensors - Acoustic sensors – magnetic sensors – bio sensors – radiation detectors	6
III	**SENSORS AND THEIR APPLICATIONS** Automobile sensor - Home appliance sensor - Aerospace sensors - sensors for manufacturing - medical diagnostic sensors - environmental monitoring	6
IV	**HOME APPLIANCE SENSORS** Smart Homes: Smart Appliances, Security and Safety - Occupancy and Motion Detectors -Applications in kitchen appliances –Liquid level monitoring - refrigerator appliances – cleaning appliances	6
V	**BASICS OF SENSOR SYSTEMS AND CIRCUITS** Microfabrication Technologies - Sensor System: Basic Circuits - Amplifier Circuits - Instrumentation Amplifier - Filter Circuits - Sensor System: Experimental Demonstration	6
TOTAL		**30**

Self-study	Smart Appliances, Medical sensors

Textbooks:

1. Ramon P A and Webster J G, 2001. *Sensors and Signal Conditioning,* 1(2), John Wiley and Sons, New Jersey.
2. Jacob Fraden, 2015. *Hand Book of Modern Sensors: Physics, Designs and Applications*, 1 (1), Springer, New York.
3. Jon S Wilson, 2011.*Sensor Technology Hand Book*, 1 (1), Elsevier, Netherland.
4. Hordeski, G.M. 1985. *Design of Microprocessor Sensor and Control Systems.*, Englewood Cliffs, New Jersey: Reston.
5. Horne, D F. 1988. *Measuring Systems and Transducers for Industrial Applications,* Philadelphia, Pennsylvania: IOP Publishing.

Reference Books:

1. Norton, H N. 1992. *Sensor and Analyzer Handbook*. Englewood Cliffs, New Jersey: Prentice Hall.
2. Ohba, R. 1992. *Intelligent Sensor Technology*. New York: John Wiley & Sons.
3. Pallas-Areny, R., and J.G. Webster. 1991. *Sensors and Signal Conditioning*, New York: John Wiley & Sons.
4. Cluley, J C., 1985. *Transducers for Microprocessor Systems*. New York: Macmillan.
5. Fraden, J. 1993. *AIP Handbook of Modern Sensors*. New York: American Institute of Physics.

Web Resources:

1. https://blog.arduino.cc/
2. https://blog.bosch-si.com/
3. https://www.link-labs.com/blog
4. https://www.hackster.io/projects/tags/internet+of+things
5. https://www.techtarget.com/iotagenda/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	3	3	3	3	2
CO2	3	3	3	2	3	3	2	3	3	3	3	2
CO3	3	3	3	2	3	3	2	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	2
TOTAL	**15**	**15**	**15**	**12**	**15**	**15**	**10**	**15**	**15**	**15**	**15**	**10**
AVERAGE	**3**	**3**	**3**	**2.4**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SPECIFIC VALUE-ADDED COURSE: RECENT ADVANCES IN ASTROPHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233V02	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Basic knowledge of Stars and Galaxies.

Learning Objectives:

1. To understand the recent advances in astrophysics, including their interpretation of various heavenly phenomena.
2. To provide an understanding of the physical nature of celestial bodies.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	remember the different layers of the Sun and its phenomenon.	**K1**
2.	understand the basic concepts of Solar systems.	**K2**
3.	apply the basic principles of astrophysics for recognising total and annular solar and lunar eclipses.	**K3**
4.	contrast the distinct properties of planets revolving around the sun.	**K4**
5.	analyse the principle of planetary motion and evaluate its applications towards science and technology.	**K4 & K5**

K1- Remember; **K2-** Understand**; K3 –** Apply**; K4-** Analyse**; K5-** Evaluate

Units	Contents	No. of Hours
I	**THE SOLAR CORONA** The Sun – A typical star – Photosphere – Limb darkening - Chromosphere – Spicules –Solar corona – The inner corona – The outer corona – The emission corona - sunspots - solar flares	**6**
II	**COMETS AND METEORITES** Comets – Nucleus – Coma – Hydrogen cloud – Dust tail – Ion tail - Asteroids – Debris – Meteors – Shooting stars – Falling stars – Meteoroids - Kuiper belt –inner planets - outer planets	**6**
III	**SOLAR AND LUNAR ECLIPSES** Types of eclipses – Solar eclipse – Solar eclipse geometry - Total and annular solar eclipse – Lunar eclipse – Umbra – Penumbra - Total and partial lunar eclipse	**6**
IV	**STELLAR EVOLUTION** H-R diagram – birth and death of low mass, intermediate mass and massive stars – Chandrasekar limit – white dwarfs – neutron stars – pulsars – black holes – supernovae.	**6**
V	**GALAXIES** Classification of galaxies – galaxy clusters –interactions of galaxies, dark matter and super clusters – evolving universe-radio telescopes – Hubble space telescope.	**6**
	Total	**30**

Self-study	Galaxies, Black holes

Textbooks:

1. Baidyanath Basu, 2010. *An introduction to Astrophysics*, (2nd edition), Prentice Hall of India (P) Ltd, New Delhi
2. Krishnaswamy K S, 2002. *Astrophysics: a modern perspective*, New Age International (P) Ltd, New Delhi.
3. Shylaja B S, Madhusudan H. R, 1999. *Eclipse: A Celestial Shadow Play*, Universities Press Private limited, India
4. Bradley W. Carroll, 2017. *An introduction to modern astrophysics*, (2nd edition), University Press, Cambridge
5. Charles Keeton, 2014. *Principles of Astrophysics*, Springer

Reference Books:

1. Abhyankar K D, 2009. *Astrophysics of the solar system*, (2nd edition), Universities press Private limited, India.
2. Stan Owocki, 2021. *Fundamentals of Astrophysics*, Cambridge University Press.
3. GerardinJeyam, 2008. *Physics Every day*, Holy Cross College (Autonomous), Nagercoil.
4. Gourav Banerjee, 2021. *Becoming an Astronomer: A Friendly Guide to Pursue Astronomy as a Career*, Palmview Publishing, Kolkata.
5. Madhur Sorout, 2019. *Astrophysics Simplified: A Simple Guide to the Universe*, Notion Press, Chennai.

Web Resources:

1. https://optcorp.com/blogs/telescopes-101/refractor-vs-reflector-telescopes
2. https://pages.uoregon.edu/jschombe/glossary/bode_titus_relation.html
3. https://www.timeanddate.com/eclipse/eclipse-information.html
4. https://pressbooks.online.ucf.edu/astronomybc/chapter/23-1-the-death-of-low-mass-stars/
5. https://science.nasa.gov/universe/galaxies/types/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	3	3	3	3	2
CO2	3	3	3	2	3	3	2	3	3	3	3	2
CO3	3	3	3	2	3	3	2	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	2
TOTAL	15	15	15	12	15	15	10	15	15	15	15	10
AVERAGE	3	3	3	2.4	3	3	2	3	3	3	3	2

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SELF-LEARNING COURSE: NATIONAL ELIGIBILITY TEST: PHYSICS –I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP233SL1	-	-	-	-	1	-	-	25	75	100

Pre-requisite:

Skill in mathematics and mechanics.

Learning Objectives:

1. To give an introduction to students in the areas of general mechanics and mathematical methods for qualifying National Eligibility Exams.
2. To apply the mathematical techniques to the concepts of quantum mechanics.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall the basic concepts of mathematical methods.	**K1**
2.	understand the theoretical aspects of classical mechanics.	**K2**
3.	apply Maxwell's equations in free space and linear isotropic media.	**K3**
4.	devise the variational method in quantum mechanics.	**K4**
5.	evaluate problems in electronics and error analysis.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate

Units	Contents
I	**MATHEMATICAL METHODS OF PHYSICS:** Dimensional analysis –Vector algebra and vector calculus – Linear algebra, matrices – Cayley-Hamilton Theorem – Eigenvalues and eigenvectors –Linear ordinary differential equations of first & second order –Special functions (Hermite, Bessel, Laguerre and Legendre functions) – Fourier series, Fourier and Laplace transforms – Elements of complex analysis, analytic functions– Taylor & Laurent series; poles, residues and evaluation of integrals – Elementary probability theory, random variables, binomial, Poisson an d normal distributions –Central limit theorem.
II	**CLASSICAL MECHANICS:** Newton's laws –Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions – scattering in laboratory and Centre of mass frames– Rigid body dynamics– moment of inertia tensor– Non-inertial frames and pseudoforces –Variational principle – Generalized coordinates– Lagrangian and Hamiltonian formalism and equations of motion – Conservation laws and cyclic coordinates– Periodic motion: small oscillations, normal modes. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy equivalence.
III	**ELECTROMAGNETIC THEORY:** Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems– Magnetostatics: Biot-Savart law, Ampere's theorem– Electromagnetic 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.
IV	**QUANTUM MECHANICS:** Wave-particle duality– Schrödinger equation (time-dependent and time-independent) –Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier–Wave-function in coordinate and momentum representations – Commutators and Heisenberg uncertainty principle–

	Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta – Hydrogen atom. Stern-Gerlach experiment –Time- independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules– Identical particles, Pauli exclusion principle, spin-statistics connection.
V	**ELECTRONICS AND ERROR ANALYSIS:** Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications –Opto - electronic devices (solar cells, photo-detectors, LEDs) –Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits)– A/D and D/A converters –Microprocessor and microcontroller basics– Data interpretation and analysis– Precision and accuracy. Error analysis, propagation of errors–Least squares fitting.

Textbooks:

1. George Arfken, Hans J Weber, 2012. *Mathematical Methods for Physicists – A Comprehensive Guid*e (4th edition), Academic press, London.
2. Goldstein H, 2002. *Classical Mechanics*, (3rd Edition), Pearson Edu. England.
3. Vijayendran, V. 2008. *Introduction to Integrated electronics (Digital & Analog)*, S. Viswanathan Printers & Publishers Private Ltd, New Delhi, India.
4. Griffiths D J, 2004. *Introduction to Electrodynamics,* (3rd edition), Prentice-Hall of India, New Delhi.
5. Mathews P M., Venkatesan, K., 2010. *A Text book of Quantum Mechanics* (Second Edition). Tata McGraw-Hill , New Delhi, India.

Reference Books:

1. Malemnganba Chengle, W, 2012. *UGC-CSIR NET (JRF & LS) Physical Science*, Arihant Publishers, New Delhi.
2. Chattopadhyay P K, 2013. *Mathematical Physics* (2nd edition), New Age, New Delhi
3. Gupta S L, Kumar, V., Sharma, H.V, 1998. *Classical Mechanics*, Meerut: Pragati Prakashan Publications, India.
4. Ramakant A, Gayakwad. 2012. *OP-AMP and Linear Integrated Circuits*, Forth Edition). Prentice Hall / Pearson Education, New Delhi, India
5. Andrew Zangwill, 2013. *Modern Electrodynamics*, (3rd edition), Cambridge UniversityPress, USA.

Web Resources:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
2. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimiz ed.pdf
3. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
4. https://lweb.cfa.harvard.edu/~namurphy/Lectures/Ay253_2016_07_MHDwaves.pdf
5. http://web.mit.edu/8.05/handouts/jaffe1.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	2	2	2	2	3	2	2	2
CO2	2	3	3	2	2	2	3	3	2	2	1	2
CO3	2	3	2	2	2	2	3	3	2	2	1	1
CO4	3	2	2	2	2	3	3	3	2	3	2	3
CO5	2	3	3	2	2	2	3	2	3	2	3	3
TOTAL	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**10**	**11**
AVERAGE	**2.8**	**3**	**2.8**	**2.8**	**2.8**	**3**	**2.8**	**3**	**2**	**2**	**2**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

CORE COURSE VIII: NUCLEAR AND PARTICLE PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234CC1	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

Knowledge of basic structure of atom and nucleus.

Learning Objectives:

1. To impart in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles.
2. To acquire knowledge on nuclear decay with relevant theories.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	define the concepts of helicity, parity, angular correlation and internal conversion.	**K1**
2.	interpret fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	**K2**
3.	articulate the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	**K3**
4.	correlate data from nuclear scattering experiments to identify different properties of the nuclear force.	**K4**
5.	appraise the concept of allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate

Units	Contents	No. of Hours
I	**NUCLEAR MODELS** Liquid drop model – Analogy between nucleus and liquid drop - Weizacker mass formula – Isobaric mass parabola - Bohr Wheeler theory of fission – Shell model – Spin-orbit coupling – Magic numbers – Angular momenta and parity of ground states – Magnetic moment – Schmidt model – Electric Quadrapole moment - Bohr and Mottelson collective model – Rotational and vibrational bands.	**18**
II	**NUCLEAR FORCES** Fundamental Forces-Nucleon – Nucleon interaction – Tensor forces – Characteristics of nuclear forces – Ground state of deuteron – Exchange Forces - Meson theory of nuclear forces –Nucleon-nucleon scattering – Neutron-proton scattering at low energy- Effective range theory of neutron-proton scattering– spin dependence of nuclear forces - charge independence and charge symmetry of nuclear force– isospin formalism.	**18**
III	**NUCLEAR REACTIONS** Kinds of nuclear reactions – Endoergic reactions – Exoergic reactions- Reaction kinematics – Q-value – Partial wave analysis of scattering cross section - Reaction cross section – scattering length – Compound nuclear reactions – Reciprocity theorem – Nuclear resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.	**18**

IV	**NUCLEAR DECAY** Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life –Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – nuclear isomerism – angular momentum and parity selection rules.	**18**
V	**ELEMENTARY PARTICLES** Classification of Elementary Particles – Leptons - Mesons- Baryons- Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks – SU (2) and SU (3) groups - Gell Mann matrices– Gell Mann Okuba Mass Formula-Quark Model. Standard model of particle physics – Higgs boson.	**18**
	Total	**90**

Self-study	Types of Interaction, Families of elementary particles

Textbooks:

1. D. C. Tayal. 2011. *Nuclear Physics*, Himalaya Publishing House, India.
2. Kenneth. S. Krane, 2008. *Introductory Nuclear Physics*, John Wiley & Sons, New York.
3. Francesco Terranova, 2021. *Particle & Nuclear Physics*, Oxford University Press, UK.
4. Kaplan, 2002. *Nuclear Physics,* (2nd Edition), Narosa Publishing House, New Delhi.
5. Patel S B, 2011. *Nuclear Physics An Introduction*, (2nd Edition), New Age International Pvt Ltd Publishers, New Delhi.

Reference Books:

1. Brian R. Martin, Graham Shaw, 2019. *Nuclear and Particle Physics*, John Wiley & Sons Ltd, USA.
2. Bernard L Cohen, 2001. *Concepts of Nuclear Physics*, McGraw Hill Higher Education, India.
3. Martin B R., 2009. *Nuclear and Particle Physics: An Introduction,*(2nd Edition), *Wiley*-Blackwell Publisher, United States.
4. Roy R and Nigam B P, 2014. *Nuclear Physics: Theory and Experiments*, (2nd Edition),New Age Publishers, India.
5. Cottingham W N and Green Wood D A, 2004. *An Introduction to Nuclear Physics*, (2nd Edition), Cambridge University Press, UK.

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES
AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	3	3	3	3	2
CO2	3	3	3	2	3	3	2	3	3	3	3	2
CO3	3	3	3	2	3	3	2	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3	3	3	2
CO5	3	3	3	3	3	3	2	3	3	3	3	2
TOTAL	**15**	**15**	**15**	**12**	**15**	**15**	**10**	**15**	**15**	**15**	**15**	**10**
AVERAGE	**3**	**3**	**3**	**2.4**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

CORE COURSE IX: SPECTROSCOPY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234CC2	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

Fundamental concepts of Physics and Spectroscopy.

Learning Objectives:

1. To comprehend the theory behind different spectroscopic methods.
2. To know the working principles along with an overview of construction of different types of spectrometers involved.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recognise fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behavior.	**K1**
2.	understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy.	**K2**
3.	apply the resonance spectroscopic techniques for quantitative and qualitative estimation of a substance.	**K3**
4.	analyze the different types of spectrum.	**K4**
5.	evaluate structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate

Units	Contents	No. of Hours
I	**MICROWAVE SPECTROSCOPY:** Classification of molecules –Interaction of Radiation -Rotational spectra of rigid diatomic molecules - Effect of isotopic substitution -Intensity of Rotational Lines- Non rigid Rotator – Polyatomic molecules – linear – Symmetric- asymmetric top molecules -Stark effect- Quadrupole hyperfine interaction–Microwave spectrometer -Information Derived from Rotational Spectra.	**18**
II	**INFRA-RED SPECTROSCOPY:** Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator –overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra	**18**
III	**RAMAN SPECTROSCOPY:** Theory of Raman Scattering - classical theory – molecular polarizability - quantum theory- rotational Raman spectra - symmetric top molecules – stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 - determination of N_2O structure -Instrumentation technique-structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- SERS	**18**
IV	**RESONANCE SPECTROSCOPY:** Introduction-Nuclear spin and Magnetic Moment-Nuclear Magnetic Resonance-Theory of NMR Spectroscopy-Precession of particles in a field- Relaxation processes in NMR-Experimental methods of NMR Spectroscopy-Interpretation of NMR Spectra-Types of	**18**

	environmental effects-chemical shift and spin-spin splitting-shielding and de-shielding effects of magnetic nuclei-Factors affecting chemical shift. Electron Spin Resonance: Basic principle –ESR spectrometer-Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals	
V	**UV SPECTROSCOPY:** The Nature of Electronic Excitations- origin of UV band structure- Principles of absorption spectroscopy- Instrumentation- Laws of absorption – Lambert Bouguer law – Lambert Beer law- Chromophore - effect of Conjugation- Effect of Conjugation on Alkenes - Woodward–Fieser rules for Dienes- Electron-releasing and electron withdrawing effects - Visible spectra-Color in Compounds -Simple applications	**18**
	Total	**90**

Self-study	Medical applications of ESR and Simple applications

Textbooks:

1. Banwell C N and McCash E M, 1994. *Fundamentals of Molecular Spectroscopy*, (4th Edition), Tata McGraw–Hill, New Delhi.
2. Aruldhas G, 2008. *Molecular Structure and Molecular Spectroscopy*, (2nd Edition) Prentice–Hall of India, New Delhi.
3. Satyanarayana D N, 2001.*Vibrational Spectroscopy and Applications*, New Age International Publication.
4. Sharma B K, 2015.*Spectroscopy*, Goel Publishing House, Meerut.
5. Pavia D L, Lampman G M, Kriz G S, Vyvyan J A, 2014.*Introduction to Spectroscopy*, (5th Edition), Cengage Learning Private Limited, New Delhi, India.

Reference Books:

1. McHale J L, 2008. *Molecular Spectroscopy*, Pearson Education India, New Delhi.
2. Straughan B P and Walker S, 2012. *Spectroscopy* Volume I, Chapman and Hall, New York.
3. K. Chandra, 2004. *Introductory Quantum Chemistry*, (4th Edition), Tata McGraw Hill, New Delhi.
4. Demtroder W, 2013. *Laser Spectroscopy: Basic concepts and Instrumentation*, Springer, Berlin Heidelberg.
5. Kalsi P S, 2016. *Spectroscopy of Organic Compounds*,(7th Edition), New Age International Publishers, New Delhi.

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO2	3	3	2	3	2.6	2.4	2.6	2	3	3	3	3
CO3	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO4	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO5	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
TOTAL	**15**	**15**	**14**	**15**	**13**	**12**	**13**	**14**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**2.8**	**3**	**2.6**	**2.4**	**2.6**	**2.8**	**3**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

CORE LAB COURSE IV: ADVANCED PHYSICS LAB-IV

NUMERICAL METHODS AND COMPUTER PROGRAMMING C++

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234CP1	-	-	6	-	5	6	90	25	75	100

Prerequisite:

Basic knowledge in differential equation and linear algebra, operating system and computer fundamentals.

Learning Objectives:

1. To enable the students to solve problems in C++ using different numerical methods.
2. To make the mathematical calculations simpler.

Course Outcomes

On the successful completion of the course, students will able to:		
1.	identify the basic numerical interpolation methods.	**K1**
2.	interpret the numerical methods used in computation and programming using C++.	**K2**
3.	articulate the software tools to explore the concepts of physical science.	**K3**
4.	connect the computational skill using various mathematical tools.	**K4**
5.	reframe mathematical formulations and develop the real time applications using physics.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** - Create

Contents

(Any Twelve Experiments)

1. Curve fitting to straight line and data interpolation (Cauchy's constants)
2. Currents in a Wheatstone's bridge – Gauss elimination method
3. Solution of radioactive decay problem – Runge Kutta method
4. Computer simulation (frequency response of a series LCR resonance circuit)
5. Inverse and determinant of a matrix
6. Matrix multiplication (application – rotation matrices)
7. Solution of a physical problem – Newton Raphson method
8. Newton's forward/backward interpolation for table of points
9. Numerical integration – Simpson's 1/3 and 3/8th rule
10. Numerical differentiation – Compute the value of derivative for the function y = f(x) (whose tabular values are given) at a given value of x using Newton's forward/backward difference formula
11. Numerical integration – Trapezoidal rule
12. (a) Pseudo random number generation b) Monte Carlo method of estimating the value of π
13. Monte Carlo integration – estimating the area of an ellipse or a simple integral
14. Differential equation – Newton's law of cooling by Euler's method
15. Boundary value problem – solution to Poisson's equation

Self-study	Solution of ordinary differential equations – Euler and Runga Kutta methods

Textbooks:

1. Sastry S.S, 2009. *Introductory Methods of Numerical analysis*, (3rd Edition), PHI, New Delhi

2. Jain M.K, Iyengar S.R and Jain R K, 2012. *Numerical Methods for Scientific and Engineering Computation*, (3rd Edition), New Age Intl, New Delhi
3. Balagurusamy E, 2017. *Numerical Methods*, (1st Edition), Tata McGraw Hill Publication, New Delhi.
4. Rajaraman V, 1993. *Computer oriented Numerical Methods*, (3rd Edition). PHI, New Delhi
5. Conte S.D and de Boor C, 1981. *Elementary Numerical analysis-an algorithmic approach*, (3rd Edition), McGraw Hill Publication, New Delhi.

Reference Books:

1. Conte S.D and de Boor C, 1981. *Elementary Numerical analysis-an algorithmic approach*, (3rd Edition), McGraw Hill Publication, New Delhi.
2. Gerald B.F, and Wheatley P.O, 1994. *Applied Numerical analysis*, (5th Edition), Addison-Wesley, America.
3. Carnagan B, Luther H.A and Wilkes J.O, 1969. *Applied Numerical Methods*, (1st Edition), Wiley, New York.
4. Kuo S.S, 1996. *Numerical Methods and Computers*, (1st Edition), Addison-Wesley, America
5. Rajaraman V, 2019. *Computer Programming in C++*, (2nd Edition), PHI, New Delhi

Web Resources:

1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman
2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspxreferenceid=1682874
3. https://nptel.ac.in/course/122106033/
4. https://nptel.ac.in/course/103106074/
5. https://onlinecourses.nptel.ac.in/noc20_ma33/preview

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	3	2	3	3	2	3	3
CO2	3	3	3	2	2	3	2	3	3	2	3	3
CO3	3	3	3	2	2	3	2	3	3	2	3	3
CO4	3	3	3	2	2	3	2	3	3	2	3	3
CO5	3	3	3	2	2	3	2	3	3	2	3	3
TOTAL	**15**	**15**	**15**	**10**	**10**	**15**	**10**	**15**	**15**	**10**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE V: a) NUMERICAL METHODS AND COMPUTER ALGORITHMS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234EC1	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Prior knowledge on computer and basic mathematics.

Learning Objectives:

1. To calculate parameters in an equation by fitting that equation to measured data.
2. To apply advanced concepts learned in numerical methods to find approximate solutions of problems.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recognize different numerical approaches to solve a problem.	**K1**
2.	compare various numerical methods for differentiation and integration.	**K2**
3.	relate various interpolation methods for finite difference concepts.	**K3**
4.	devise the numerical solutions of linear system of equations.	**K4**
5.	prioritise computational methods and design C++ programs for day-to-day life applications.	**K5 & K6**

K1 – Remember; **K2** – Understand; **K3** – Apply; **K4** –Analyze; **K5** – Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**SOLUTIONS OF EQUATIONS** Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations - Zeros of polynomials –Roots of polynomials, nonlinear algebraic equations and transcendental equations using Bisection and Newton-Raphson methods – Convergence of solutions in Bisection and Newton-Raphson methods – Limitations of Bisection and Newton-Raphson methods.	12
II	**LINEAR SYSTEM OF EQUATIONS** Simultaneous linear equations and their matrix representation– Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations – Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method - Eigen values and eigenvectors of matrices – Direct method - Power method and Jacobi Method to find the Eigen values and Eigen vectors.	12
III	**INTERPOLATION AND CURVE FITTING** Interpolation with equally spaced points - Newton forward and backward interpolation – Interpolation with unevenly spaced points – Lagrange interpolation – Hermite's Interpolation formula - Curve fitting – Fitting a straight line – Nonlinear Curve Fitting – Method of least squares – Fitting a polynomial.	12
IV	**DIFFERENTIATION AND INTEGRATION** Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's 1/3 rule – Simpson's 3/8 rule – Newton Cotes Integration Formula – Error estimates – Gauss-Legendre, Gauss-Laguerre, Gauss-Hermite and Gauss – Chebyshev quadrature – solution of ordinary differential equations – Euler and Runga Kutta methods.	12
V	**PROGRAMMING WITH C++** Subroutines and functions – Programs for the following computational methods:	12

	(a) Zeros of polynomials by the bisection method, (b) Zeros of polynomials/non-linear equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange Interpolation, (d) Trapezoidal and Simpson's Rules, (e) Solution of first order differential equations by Euler's method.	
	Total	**60**

Self-study	Interpolation with equally spaced points, Subroutines

Textbooks:

1. Sastry S S, 2009. *Introductory Methods of Numerical analysis*, (3rd Edition), PHI, New Delhi
2. Jain M K, Iyengar S.R and Jain R K, 2012. *Numerical Methods for Scientific and Engineering Computation*, (3rd Edition), New Age Intl, New Delhi
3. Balagurusamy E, 2017. *Numerical Methods*, (1st Edition), Tata McGraw Hill Publication, New Delhi.
4. Rajaraman V, 1993. *Computer oriented Numerical Methods*, (3rd Edition), PHI, New Delhi
5. Rajaram R, 2007. *Object Oriented Programming and C++*, (2nd Edition), New Age International Publishers, India.

Reference Books:

1. Conte S D, De Boor C, 1981. *Elementary Numerical analysis-an algorithmic approach*, (3rd Edition), McGraw Hill Publication, New Delhi.
2. Gerald B F, and Wheatley P O, 1994. *Applied Numerical analysis*, (5th Edition), Addison-Wesley, America.
3. Scheid F, 1988. *Numerical Analysis*, (2nd Edition), Schaum's series, McGraw Hill Education, New York.
4. Kuo S S, 1996. *Numerical Methods and Computers*, (1st Edition), Addison-Wesley, America
5. Rajaraman V, 2019. *Computer Programming in C*, (2nd Edition), PHI, New Delhi

Web Resources:

1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman
2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=1682874
3. https://nptel.ac.in/course/122106033/
4. https://nptel.ac.in/course/103106074/
5. https://onlinecourses.nptel.ac.in/noc20_ma33/preview

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2.6	2.6	3	2.6	3	3	3	3	3
CO2	3	3	3	2.6	2.6	3	2.6	2	3	3	3	3
CO3	3	3	3	2.6	2.6	3	2.6	3	3	3	3	3
CO4	3	3	3	2.6	2.6	3	2.6	3	3	3	3	3
CO5	3	3	3	2.6	2.6	3	2.6	3	2	3	3	3
TOTAL	**15**	**15**	**15**	**13**	**13**	**15**	**13**	**14**	**14**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**2.6**	**2.6**	**3**	**2.6**	**2.8**	**2.8**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE V: b) ANALYSIS OF CRYSTAL STRUCTURES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234EC2	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Fundamentals of crystal structures, symmetry and X-Ray Diffraction techniques.

Learning Objectives:

1. To provide a background to X-ray generation, scattering theory and experimental diffraction from single crystals
2. To understand the methods and basis for determining low-molecular weight crystal structures using X-ray Crystallography and structure refinement using Rietveld method.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understand crystal symmetry and reciprocal lattice concept for X-ray diffraction	**K1**
2.	interpret of X-ray generation, X-ray photography with Laue, oscillation and moving film methods, and space group determination	**K2**
3.	apply program packages for predicting the crystal structure.	**K3**
4.	analyse powder diffraction, data collection, data interpretation, and structure refinement using Rietveld method.	**K4**
5.	evaluate methods to solve protein structures and develop the structural aspects of proteins and nucleic acids.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

Units	Contents	No. of Hours
I	**CRYSTAL LATTICE** Unit cell and Bravais lattices - crystal planes and directions - basic symmetry elements operations - translational symmetries - point groups - space groups - equivalent positions - Bragg's law - reciprocal lattice concept -Laue conditions - Ewald and limiting spheres - diffraction symmetry - Laue groups.	12
II	**DIFFRACTION** X-ray generation, properties - sealed tube, rotating anode, synchrotron radiation - absorption - filters and monochromators Atomic scattering factor - Fourier transformation and structure factor - anomalous dispersion - Laue, rotation/oscillation, moving film methods- interpretation of diffraction patterns - cell parameter determination - systematic absences - space group determination.	12
III	**STRUCTURE ANALYSIS** Single crystal diffractometers - geometries - scan modes - scintillation and area detectors - intensity data collection - data reduction - factors affecting X-ray intensities - temperature and scale factor - electron density - phase problem - normalized structure factor - direct method fundamentals and procedures -Patterson function and heavy atom method.	12
IV	**POWDER METHODS** Fundamentals of powder diffraction - Debye Scherrer method - diffractometer geometries - use of monochromators and Soller silts - sample preparation and data collection - identification of unknowns - powder diffraction files (ICDD) - Rietveld refinement fundamentals - profile analysis - peak shapes - whole pattern fitting - structure refinement procedures.	12
V	**PROTEIN CRYSTALLOGRAPHY**	12

Units	Contents	No. of Hours
	Globular and fibrous proteins, nucleic acids - primary, secondary, tertiary and quaternary structures - helical and sheet structures - Ramachandran map and its significance – crystallization methods for proteins - factors affecting protein crystallization - heavy atom derivatives – methods used to solve protein structures - anomalous dispersion methods.	
	Total	**60**

Self-study	Bragg's law - reciprocal lattice concept -Laue conditions - Ewald and limiting spheres - diffraction symmetry - Laue groups.

Textbooks:

1. Cullity B D, Stock S R, 2014. *Elements of X-ray Diffraction*, (3rd Edition), Pearson Educational Limited, London.
2. Bhat H L, 2015. *Introduction to Crystal Growth Principles and Practice*, (1st Edition), CRC Press, Taylor & Francis Group, Florida.
3. John Drenth, 2013. *Principles of Protein X-ray crystallography*, (3rd Edition), Springer, New York.
4. Gaurav Kohli, 2017. *X-ray Crystallography*, Random Publications, New Delhi.

Reference Books:

1. Ladd MFC, Palmer R A, 2012.*Structure Determination by X-ray Crystallography*, (3rd Edition), Plenum Press, New York.
2. 2.Sam Zhang, Lin Ki, Ashok Kumar, 2009.*Materials Characterization Techniques*, CRC Press, Taylor & Francis Group, Florida.
3. Jenny Pickworth Glusker, Kenneth N Trueblood, 2010.*Crystal Structure Analysis: A Primer*, Oxford University Press, New York.
4. Mark Ladd , Rex Palmer, 2013.*Structure Determination by X-ray Crystallography Analysis by X-rays and Neutrons*,Springer New York, New York.
5. Stout G H, Jensen L, 2016. *X-ray Structure Determination, A Practical Guide*, (2nd Edition), Wiley, India.

Web Resources:

1. https://archive.nptel.ac.in/courses/112/106/112106227/
2. https://archive.nptel.ac.in/courses/104/108/104108098/
3. https://www.digimat.in/nptel/courses/video/102107086/L11.html
4. https://onlinecourses.nptel.ac.in/noc19_cy35/previewhttps://onlinecourses.nptel.ac.in/noc19_cy35/preview
5. https://nptel.ac.in/courses/104/104/104104011/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	3	2	3	3	2	3	2
CO2	3	3	3	2	3	3	2	3	3	2	3	2
CO3	3	3	3	2	3	3	2	3	3	2	3	2
CO4	3	3	3	2	3	3	2	3	3	2	3	2
CO5	3	3	3	2	3	3	2	3	3	2	3	2
TOTAL	**15**	**15**	**15**	**10**	**15**	**15**	**10**	**15**	**15**	**10**	**15**	**10**
AVERAGE	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE V: c) PLASMAPHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234EC3	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Fundamentals of Electricity and Magnetism, Electromagnetic theory, Maxwell's equation, Basic knowledge of electrical and electronics instrumentation.

Learning Objectives:

1. To understand the plasma phenomena in the universe by means of in-site and ground-based observations.
2. To explore the physical processes which occur in the space environment.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	identify the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state.	**K1**
2.	understand the magneto-hydrodynamics concepts applied to plasma.	**K2**
3.	solve the maxwell's equation to quantitative analysis of plasma.	**K3**
4.	contrast the different principle and techniques to diagnostics of plasma.	**K4**
5.	defend the possible applications of plasma by incorporating various electrical and electronic instruments.	**K4**

K1 - Remember; **K2 –** Understand; **K3 -** Apply; **K4 -** Analyze; **K5 -** Evaluate

Units	Contents	No. of Hours
I	**FUNDAMENTALS OF PLASMA** Kinetic pressure in a partially ionized - mean free path and collision cross section - Mobility of charged particles - Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity- Effect of magnetic field- Quasi- neutrality of plasma Debye shielding distance - Optical properties of plasma.	**12**
II	**MOTION OF CHARGED PARTICLES** Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and magnetic fields- Motion of charged particle inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement	**12**
III	**PLASMA OSCILLATIONS AND WAVES** Introduction, theory of simple oscillations - electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation - Ion oscillation and waves in a magnetic field - thermal effects on plasma oscillations - Landau damping - Hydro magnetic waves - Oscillations in an electron beam.	**12**
IV	**PLASMA DIAGNOSTICS TECHNIQUES** Single probe method - Double probe method - Use of probe technique for measurement of plasma parameters in magnetic field - microwave method - spectroscopic method - -laser as a tool for plasma diagnostics-X-ray diagnostics of plasma - acoustic method – conclusion-motion of an electron	**12**

	in a time varying electric field	
V	**APPLICATIONS OF PLASMA PHYSICS** Magneto hydrodynamic Generator - Basic theory - Principle of Working- Fuel in MHD Generator - Generation of Microwaves Utilizing High Density Plasma - Plasma Diode - Magneto- hydrodynamics - Magneto-hydrodynamic equations – Condition for magneto hydrodynamic behaviour-Transverse Electromagnetic Waves	**12**
	Total	**60**

Self-study	X-ray diagnostics of plasma, Oscillations in an electron beam

Textbooks:

1. Goswami S N, 2011. *Elements of Plasma Physics*, (3rd Edition), New Central Book Agency (P), Limited, New Delhi.
2. Sen S N, 2020. *Plasma Physics*, (4th Edition), Anu Books Publisher & Distributor, Meerut, UP.

Reference Books:

1. Beryl Browning, 2008. *Basic Plasma Physics*, (2nd Edition), Lulu Publishing company, India.
2. Chen F F, 2001. *Introduction to Plasma Physics*, (2nd Edition), Springer, New York.
3. Nicholson,2013. *Introduction to Plasma Theory*, springer, New York.
4. Shohet J L, 2009.*The Plasma State*, Academic Press Inc, Cambridge, United States.
5. Hazeltine R D, and Waelbroeck F L, 2004. *The Framework of Plasma Physics*, Boulder, CO: Westview Press. Huddlestone.

Web Resources:

1. https://fusedweb.llnl.gov/Glossary/glossary.html
2. http://farside.ph.utexas.edu/teaching/plasma/lectures1/index.html
3. http://www.plasmas.org/
4. http://www.phy6.org/Education/whplasma.html
5. http://www.plasmas.org/resources.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3	2	3	3	2	2	3	2
CO2	2	3	3	3	3	2	3	3	2	2	3	2
CO3	2	3	3	3	3	2	3	3	2	2	3	2
CO4	2	3	3	3	3	2	3	3	2	2	3	2
CO5	2	3	3	3	3	2	3	3	2	2	3	2
TOTAL	**10**	**15**	**15**	**15**	**15**	**10**	**15**	**15**	**10**	**10**	**15**	**10**
AVERAGE	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VI: a) PHYSICS OF NANOSCIENCE AND TECHNOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234EC4	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic knowledge in properties of materials.

Learning Objectives:

1. To provide the basic knowledge about nanoscience and technology and to learn the structures and properties of nanomaterials.
2. To acquire the knowledge about synthesis methods and characterization techniques and its applications.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	identify the different types of nanomaterials and surface effects of the nanomaterials.	**K1**
2.	understand various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	**K2**
3.	utilise the process and mechanism of synthesis and fabrication of nanomaterials.	**K3**
4.	correlate the various characterizations of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	**K4**
5.	grade the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy sectors and design devices.	**K5 & K6**

K1 - Remember; **K2 -** Understand; **K3** – Apply; **K4 -** Analyse; **K5 -** Evaluate; **K6** – Create

Units	Contents	No. of Hours
I	**FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY** Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology – Classification of Nanomaterials – Metal and Semiconductor Nanomaterials – 2D, 1D, 0D nanostructured materials – Quantum dots – Quantum wires – Quantum wells – Surface effects of nanomaterials.	12
II	**PROPERTIES OF NANOMATERIALS** Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant – Mechanical behavior: Elastic properties – Optical properties: – Surface Plasmon Resonance – Quantum size effects – Electrical properties – Conductivity, Ferroelectrics and dielectrics – Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).	12
III	**SYNTHESIS AND FABRICATION** Physical vapour deposition – Chemical vapour deposition – sol-gel – Wet deposition techniques – electrochemical deposition method – Plasma arching – Electrospinning method – ball milling technique – pulsed laser deposition – Nanolithography: photolithography	12
IV	**CHARACTERIZATION TECHNIQUES** Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) –	12

	UV-visible spectroscopy – Photoluminescence – Scanning electron microscopy (SEM) –Transmission electron microscopy (TEM) – Scanning probe microscopy (SPM) – Scanning tunneling microscopy (STM) – Atomic Force Microscopy (AFM) – Vibrating sample Magnetometer.	
V	**APPLICATIONS OF NANOMATERIALS** Sensors: Nanosensors based on optical and physical properties – Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanorobots – display screens – GMR – Carbon Nanotube Emitters – Photocatalytic application – Medicine: Imaging of cancer cells – biomarkers and bio imaging – Targeted drug delivery – photodynamic therapy – Energy: fuel cells – rechargeable batteries – supercapacitors – photovoltaics.	**12**
	Total	**60**

Self-study	Rechargeable batteries – Supercapacitors – Photovoltaics.

Text Books:

1. Pradeep T. 2012. *A textbook of Nanoscience and Nanotechnology*, Tata McGraw-Hill Publishing Co.
2. Shah M.A. Ahmad T. 2010. *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House Pvt Ltd.
3. Chattopadhyay K. K. Banerjee A.N. 2012. *Introduction to Nanoscience and Nanotechnology*, PHI Learning Pvt. Ltd., New Delhi.
4. Sr. Gerardin Jayam, Sonia S, 2019. *Nanophysics*, Holy Cross College (Autonomous), Nagercoil.

Reference Books:

1. Richard Booker, Earl Boysen, 2005. *Nanotechnology*, Wiley Publishing Inc. USA
2. Fendler John Wiley J H. 2007. *Nano particles and Nano structured films; Preparation, Characterization and Applications*.
3. Murty B S. 2012. *Textbook of Nanoscience and Nanotechnology*, Universities Press.
4. Parag Diwan, Ashish Bharadwaj. 2005. *The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology)*, Pentagon Press, New Delhi.
5. Kothari DP,Velmurugan V. Rajit Ram Singh. 2018. *Nanotechnology and Nanoelectronics*, Narosa Publishing House Pvt. Ltd, New Delhi.

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	2	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	3	3	2	2	2	3	3	3	3	3
CO5	3	3	3	3	3	1	3	3	2	3	3	3
TOTAL	**15**	**15**	**15**	**15**	**13**	**12**	**12**	**14**	**14**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**3**	**2.6**	**2.4**	**2.4**	**2.8**	**2.8**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VI: b) BIO PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234EC5	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Fundamental concepts of molecular and protein structures.

Learning Objectives:

1. To understand the organization of cell structure and different types of cell.
2. To understand the fundamentals of macromolecular structure and the analytical techniques in characterizing biomolecular interactions and its structure.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	identify the physical principles involved in cell function maintenance.	**K1**
2.	understand the fundamentals of macromolecular structures involved in propagation of life.	**K2**
3.	apply the biophysical function of membrane and neuron for nervous systems.	**K3**
4.	categorise various kinds of radiation and their effects on living system and to know the hazards posed by such radiations and the required precautions.	**K4**
5.	reframe the physical principles behind the various techniques available for interrogating biological macromolecules.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate

Units	Contents	No. of Hours
I	**CELLULAR BIOPHYSICS** Architecture and Life Cycle of cells - Organelles of Prokaryotic and Eukaryotic cell - Cell size and shape - Fine structure of Prokaryotic and Eukaryotic cell organization - Compartment & assemblies membrane system - Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells.	12
II	**MOLECULAR BIOPHYSICS** Macromolecular structure: Protein structure - amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation - Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.	12
III	**MEMBRANE AND NEURO BIOPHYISCS** Models membranes - Biological membranes and dynamics - Membrane Capacitors - Transport across cell and organelle membranes - Ion channels. Nervous system: Organization of the nervous system - Membrane potential - Origins of membrane potential - Electrochemical potentials - Nernst equation - Goldman equation.	12
IV	**RADIATION BIO PHYSICS** X-Ray: Effects on bio-macromolecules - Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles - UV radiation: Effects on bio-macromolecules and	12

	proteins - Radiation hazards and protection - use of radiations in cancer.	
V	**PHYSICAL METHODS IN BIOLOGY** Spectroscopy: UV-Visible absorption spectrophotometry - Optical Rotatory Dispersion (ORD) - Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) - Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.	**12**
	Total	**60**

Self-study	Radiation hazards and protection, Use of radiations in cancer.

Textbooks:

1. Cooper G M, Hausman R E, 2013. *The cell: A molecular approach*, (6th Edition), ASM Press United States: Sinauer.
2. Pattabhi V, Gautham N, 2009. *Biophysics*, (2nd Edition), Alpha Science International, United Kingdom.
3. Misra P S, 2012. *Biophysic*s, (2nd Edition), Intech Open, Rijeka, India.
4. Subramanian, 2019. *Biophysics: Principles and Techniques*, (1st Edition), MJP Publisher, India.
5. Veerakumari, 2019. *Bioinstrumentation*, (1st Edition), MJP Publishers, India.

Reference Books:

1. Beard D A, Qian H, 2008. *Chemical Biophysics: Quantitative Analysis of Cellular Systems.* (1st Edition), Cambridge University Press.
2. Alberts B, Bray D, Hopkin K, Johnson A D, Lewi J, Raff M, Roberts K, Walter P, 2013. *Essential Cell Biology*. United States: CRC Press.
3. Hoppe W, Lohmann W, Markl H, Ziegle H, 2012. *Biophysics*, Germany: Springer Berlin Heidelberg.
4. Ashrafuzzaman M, Tuszynski J A, 2012. *Membrane Biophysics*, Germany: Springer Berlin Heidelberg.
5. Campbell, Iain D, Dwek, Raymond A, 1984. *Biological spectroscopy*, Benjamin-Cummings Publishing Co. Subs. of Addison Wesley.

Web Resources:

1. General Bio: http://www.biology.arizona.edu/DEFAULT.html
2. Spectroscopy: http://www.cis.rit.edu/htbooks/nmr/inside.htm
3. http://learn.genetics.utah.edu/content/labs/gel/Online biophysics programs
4. http://mw.concord.org/modeler/
5. https://blanco.biomol.uci.edu/WWWResources.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO2	3	3	3	3	2.6	2.4	2.6	2	3	3	3	3
CO3	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO4	3	3	3	3	2.6	2.4	2.6	3	3	3	3	3
CO5	3	3	3	3	2.6	2.4	2.6	3	2	3	3	3
TOTAL	**15**	**15**	**15**	**15**	**13**	**12**	**13**	**14**	**14**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**3**	**2.6**	**2.4**	**2.6**	**2.8**	**2.8**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VI: c) GENERAL RELATIVITY AND COSMOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234EC6	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basics of Relativity and Cosmology, Skill in mathematics and mechanics.

Learning Objectives:

1. To acquire knowledge in the areas of general relativity and cosmology.
2. To apply the mathematical techniques to the concepts of cosmology.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall the basic concepts of tensors.	**K1**
2.	interpret the theoretical aspects of general relativity and cosmology.	**K2**
3.	apply space time curvature for gravitation.	**K3**
4.	analyse problems using mathematical skills.	**K4**
5.	evaluate the tensor in relativity.	**K5**

K1 – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyse; **K5** – Evaluate

Units	Contents	No. of Hours
I	**TENSORS** Tensors in index notation - Kronecker and Levi Civita tensors - inner and outer products - contraction - symmetric and antisymmetric tensors - quotient law - metric tensors - covariant and contravariant tensors - vectors - the tangent space - dual vectors - tensors - tensor products - the Levi-Civita tensor - tensors in Riemann spaces	12
II	**TENSORS FIELD** Vector-fields, tensor-fields, transformation of tensors - gradient and Laplace operator in general coordinates - covariant derivatives and Christoffel connection - Elasticity: Field tensor - field energy tensor - strain tensor - tensor of elasticity- curvature tensor	12
III	**GENERAL RELATIVITY** The space time interval - the metric - Lorentz transformations - space-time diagrams - world-lines - proper time - energy-momentum vector - energy-momentum tensor - perfect fluids - energy-momentum conservation - parallel transport - the parallel propagator - geodesics - affine parameters - the Riemann curvature tensor - symmetries of the Riemann tensor - the Bianchi identity	12
IV	**TENSOR IN RELATIVITY** Ricci and Einstein tensors - Weyl tensor - Killing vectors - the Principle of Equivalence - gravitational redshift - gravitation as space-time curvature - the Newtonian limit - physics in curved space-time - Einstein's equations - the Weak Energy Condition - causality - spherical symmetry - the Schwarzschild metric - perihelion precession	12
V	**COSMOLOGY** Expansion of the Universe - thermal history - and the standard cosmological model - Friedmann - Robertson-Walker type models of the Universe - Primordial inflation and the theory of cosmological	12

	fluctuations - Theory and observations of the cosmic microwave background and of the large-scale structure of the Universe - Dark matter and dark energy - theoretical questions and observational evidence - inflation - origin of galaxies and other open problems	
	Total	**60**

Self-study	Field tensor - field energy tensor - strain tensor - tensor of elasticity- curvature tensor

Textbooks:

1. Sean Carroll, 2016. *The Big Picture: On the orgins of life, Meaning and the Universe*, Random House, New York
2. Spiegel M. R., 1974. *Vector Analysis- Schaum'a outline series*, McGraw Hill, New York.
3. James Hartle, 2002. *Gravity: An introduction to Einstein's general relativity,* San Francisco, Addison-Wesley

Reference Books:

1. Adler R, Bazin M, Schiffer M, 1974. *Introduction to General Relativity*,(2nd Edition), McGraw Hill, New York.
2. Sean Carroll, 2019. *Spacetime and Geometry: An Introduction to General Relativity*, Cambridge University Press, England.
3. Jerzy Plebanski, Andrzej Krasinski, 2006. *An Introduction to General Relativity and Cosmology*, Cambridge University Press, England
4. Meisner, Thorne, Wheeler, 1973. *Gravitation*, W. H. Freeman & Co., San Francisco Publishers, USA.
5. Robert M. Wald, 1992. *Space, Time, and Gravity: the Theory of the Big Bang and Black Holes*, Univ. of Chicago Press. USA

Web Resources:

1. http://www.fulviofrisone.com/attachments/article/486/A%20First%20Course%20In%20General%20Relativity%20-%20Bernard%20F.Schutz.pdf
2. https://link.springer.com/book/9780387406282
3. https://ocw.mit.edu/courses/8-962-general-relativity-spring-2020/resources/lecture-18-cosmology-i/
4. https://www.youtube.com/watch?v=U6M7_Pt0d14
5. https://www.youtube.com/watch?v=yuD34tEpRFw

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	3	2	3	3	2	3	2
CO2	3	3	2	3	2	3	2	3	3	2	3	2
CO3	3	2	2	3	2	3	2	3	3	2	3	2
CO4	3	2	2	3	2	3	2	3	3	2	3	2
CO5	3	2	2	3	2	3	2	3	3	2	3	2
TOTAL	**15**	**15**	**10**	**15**	**10**	**15**	**10**	**15**	**15**	**10**	**15**	**10**
AVERAGE	**3**	**3**	**2**	**3**	**2**	**5**	**2**	**3**	**3**	**2**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

SKILL ENHANCEMENT COURSE III: SOLID WASTE MANAGEMENT

Course Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
PP234SE1	4	-	-	-	2	4	25	75	100

Prerequisites:

Basic knowledge of solid waste and its types.

Learning Objectives:

1. To gain basic knowledge in solid waste management procedures.
2. To gain industry exposure and be equipped to take up a job.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	illustrate the different types of solid waste management.	**K1**
2.	infer the concept of Solid Waste Management hierarchy.	**K2**
3.	apply entrepreneurial skills for promoting Waste Treatment Systems.	**K3**
4.	conclude the status of the solid wastes in the nearby areas.	**K4**
5.	defend the management of solid wastes in and around the locality.	**K5**

K1 – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyse; **K5** – Evaluate

Units	Contents	No. of Hours
I	**SOLID WASTE MANAGEMENT** Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act- - Location Restrictions- Operating Criteria- Clean Air Act Amendments of 1990 – Hazardous Waste: Municipal Solid waste and non-municipal solid waste	**12**
II	**SOLID WASTE CHARACTERISTICS** Solid Waste Characteristics: Methods of Characterizing Municipal Solid Waste - Solid Waste Management hierarchy - Directing Material Flows- Preventing and Reducing Waste- The Great R's: Re-use, Recycle, Recover- Recovering Materials and Energy from Waste	**12**
III	**TOOLS AND EQUIPMENT** Assessment Tools for Waste Treatment Systems- An Introduction to Life-Cycle Assessment- Mechanical Sorting Processes and Material Recycling- Glass Recycling- Recycling of Paper and Cardboard - Transportation - Disposal techniques	**12**
IV	**ECONOMIC DEVELOPMENT** Solid Waste Management for economic development – Mixed MSW composting – Yard waste composting - environmental protection – Water and air resources – Vectors – Industrial health and safety – Fires – Constrains on use of the compost - Linking Solid Waste Management and climate change	**12**
V	**LANDFILLING** The landfill method of solid waste disposal – Classification of landfills – Landfilling methods - Reactions occurring in landfills – Composition of landfill gas – Management of landfill **–** Structural characteristics – Settlement of landfills	**12**
	Total	**60**

Self-study	Renewal act, factors affecting SW generation, Land filling technique

Textbooks:

1. George Tchobanoglous, 2002. *Handbook of Solid Waste Management*, McGraw Hill, USA.
2. Christian Ludwig, Samuel Stucki, Stefanie Hellweg, 2012. *Municipal Solid Waste Management*, Springer Berlin Heisenberg.

Reference Books:

1. Hosett B B, 2006. *Prospects and Perspectives of Solid Waste Management*, New Age International (P) Ltd., New Delhi.
2. Rao M N, 2020. *Solid and Hazardous Waste Management*, BS Publications / BSPBooks, India.
3. Techobanoglous George, Kreith, Frank, 2002. *Solid Waste*, McGraw Hill Publication, New Delhi.
4. Vasudevan Rajaram, 2016. *Solid Waste Management (SWM)*, PHI learning private limited, New Delhi.
5. Eliot Fox, 2017. *Biodegradable Waste and Management*, Larsen and Keller Education, USA.

Web Resources:

1. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648
2. https://testbook.com/learn/environmental-engineering-solid-waste-management/
3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28
5. https://amzn.eu/d/5VUSTDI

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	2	2	2	2	3	2	2	2
CO2	2	3	3	2	2	2	3	3	2	2	1	2
CO3	2	3	2	2	2	2	3	3	2	2	1	1
CO4	3	2	2	2	2	3	3	3	2	3	2	3
CO5	2	3	3	2	2	2	3	2	3	2	3	3
TOTAL	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**10**	**11**
AVERAGE	**2.8**	**3**	**2.8**	**2.8**	**2.8**	**3**	**2.8**	**3**	**2**	**2**	**2**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III & IV

LIFE SKILL TRAINING II - VALUES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST2	1	-	-	-	1	1	15	50	50	100

Pre-requisites: Value education-its purpose and significance in the present world

Learning Objectives

1. To guide students in making wise choices and decisions, and to help them discover the true purpose of their lives.
2. To ensure students not only grasp the concept of values but also incorporate them into their actions and attitudes.

Course Outcomes

On completion of this course the student will be able to		
1	recognize the perception of life and lead a positive life	**K1**
2	understand relationship with family, friends and the society	**K2**
3	develop as socially responsible citizens.	**K3**
4	assess goals, fix targets and value life	**K4**
5	create a peaceful, communal community and embrace unity.	**K6**

K1-Remember; **K2**-Understand; **K3**-Apply; **K4 – Analyse; K6**- Create

Units	Contents	No. of Hours
I	**Positive Thinking -** Why you should change your thinking? – How to became a better thinker- Putting yourself in the right place to think- Portrait of the good thinker. **Habits-** Habits vs. Addiction- Why are life styles changes so difficult to hold on to? - Habit Swapping.	3
II	**Art of Listening-** Many faces of speech- To be truly present- Valuing the other- Activating the subconscious. **Leadership-** Introduction- Who is a better leader? - Qualities of a Leader- You too can be a leader.	3
III	**Interpersonal Relationship**- Introduction - Factors that build trust- Steps to build a positive personality. **Managing Emotions**- 7 'Root' emotions- Importance of managing emotions- Why is it important to manage emotions?	3
IV	**Stress Management –** Highly effective tips for relieving stress- Fast-Acting Self Relief Strategies. **Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	3
V	**Forgiveness-** What is forgiveness- Value of forgiveness- Benefits of forgiving- Self-forgiveness. **Gratitude –** What is gratitude? – How gratitude arises? –Features of gratitude – Gratitude is recognizing and acknowledging.	3
	TOTAL	15
Self-Study Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.		

Textbooks

Life Skill Training – II, Holy Cross College (Autonomous), Nagercoil

Reference Books

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.
2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Romuald Andrade. (2015). *Habit Triggers: How To Create Better Routines And Success Rituals To Make Lasting Changes In Your Life*. Kindle Edition.
4. William Fergus Martin. (2014). *Four Steps to Forgiveness:* A *Powerful Way To Freedom, Happiness And Success*. Findhorn Press.
5. Robert A. Emmons and Joanna Hill (2001). *Words Of Gratitude for Mind, Body, and Soul*. USA: Templeton Foundation Press.

Web Resources

1. https://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/positive-thinking/art-20043950
2. https://jamesclear.com/habits
3. https://www.skillsyouneed.com/ps/managing-emotions.html
4. https://emeritus.org/in/learn/what-is-leadership/
5. https://www.verywellmind.com/how-to-maintain-interpersonal-relationships-5204856

SEMESTER IV

SELF-LEARNING COURSE: NATIONAL ELIGIBILITY TEST: PHYSICS –II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP234SL1	-	-	-	-	1	-	-	25	75	100

Pre-requisite:

Basic knowledge of solid state, nuclear and particle physics.

Learning Objectives:

1. To give an introduction to students in the areas of statistical mechanics and experimental methods for qualifying National Eligibility Exams.
2. To apply the concepts of solid state, nuclear and particle physics in solving problems.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall the basic concepts of statistical methods.	**K1**
2.	understand the concepts of solid state physics.	**K2**
3.	articulate the theoretical aspects of molecular physics in electronic, rotational, vibrational and Raman spectra of diatomic molecules.	**K3**
4.	correlate the models of nuclear and particle physics.	**K4**
5.	solve problems in experimental techniques.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate

Units	Contents
I	**THERMODYNAMIC AND STATISTICAL PHYSICS:** Laws of thermodynamics and their consequences– Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states– Micro-canonical, canonical and grand-canonical ensembles and partition functions–Free energy and its connection with thermodynamic quantities– Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law– First- and second-order phase transitions– Diamagnetism, para magnetism, and ferromagnetism –Ising model. Bose-Einstein condensation –Diffusion equation. Random walk and Brownian motion –Introduction to nonequilibrium processes.
II	**ATOMIC & MOLECULAR PHYSICS:** Quantum states of an electron in an atom–Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings– Zeeman, Paschen-Bach & Stark effects– Electron spin resonance– Nuclear magnetic resonance, chemical shift– Frank-Condon principle– Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules –Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation –Modes of resonators and coherence length.
III	**CONDENSED MATTER PHYSICS:** Bravais lattices. Reciprocal lattice–Diffraction and the structure factor– Bonding of solids. Elastic properties, phonons, lattice specific heat– Free electron theory and electronic specific heat– Response and relaxation phenomena– Drude model of electrical and thermal conductivity –Hall effect and thermoelectric power– Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors –Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity– Defects and dislocations–Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order –Quasi crystals.
IV	**NUCLEAR AND PARTICLE PHYSICS:** Basic nuclear properties: size, shape and charge

	distribution, spin and parity– Binding energy, semi- empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon -nucleon potential, charge-independence and charge-symmetry of nuclear forces –Deuteron problem. Evidence of shell structure, single-particle shell 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. Classification of fundamental forces –Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.) –Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions –Parity non-conservation in weak interaction–Relativistic kinematics.
V	**EXPERIMENTAL TECHNIQUES:** Linear and nonlinear curve fitting, chi-square test– Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery–Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques–High frequency devices (including generators and detectors)

Textbooks:

1. Agarwal B K, Eisner, 2016. *Statistical Mechanics*, (2nd Edition), New Age International, New Delhi,.
2. Kittel C, 2005. *Introduction to Solid State Physics*, (8th Edition), Wiley, New York.
3. Tayal D C, 2011. *Nuclear Physics*, Himalaya Publishing House, India.
4. Brandsen B H, Joachain C J, 2003. *Physics of atoms and molecules*, (2nd Edition), Pearson Edu. England.
5. Callister W D, 2002. *Materials Science and Engineering – An Introduction*, (6th Edition), John Wiley & Sons, New York.

Reference Books:

1. Malemnganba Chengle W, 2012. *UGC-CSIR NET (JRF & LS) Physical Science*, Arihant Publishers, New Delhi.
2. Brian R. Martin, Graham Shaw, 2019. *Nuclear and Particle Physics*, John Wiley & SonsLtd, USA.
3. Peter F. Breath , 2004. *Spectra of Atoms and Molecules*, Oxford University Press,New York.
4. Pathria R K, 2005. Statistical Mechanics, Elsevier India, New Delhi.
5. Thorne A, Litzén U, Johansson S, 2000. *Spectrophysics: Principles and Applications*, Springer, Verlag.

Web Resources:

1. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
2. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html
3. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.h tml
4. https://elearning.ufl.edu/
5. https://canvas.education.lu.se/courses/11990

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	2	2	2	2	3	2	2	2
CO2	2	3	3	2	2	2	3	3	2	2	1	2
CO3	2	3	2	2	2	2	3	3	2	2	1	1
CO4	3	2	2	2	2	3	3	3	2	3	2	3
CO5	2	3	3	2	2	2	3	2	3	2	3	3
TOTAL	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**10**	**11**
AVERAGE	**2.8**	**3**	**2.8**	**2.8**	**2.8**	**3**	**2.8**	**3**	**2**	**2**	**2**	**2.2**

3 – Strong, 2- Medium, 1- Low