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 & II

Guidelines & Syllabus

DEPARTMENT OF PHYSICS

2023-2026

(With effect from the academic year 2023-2024)

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.

Programme Educational Objectives (PEOs)

PEOs	Upon completion of B.A/B.Sc. degree programme, the graduates will be able to	Mission addressed
PEO 1	apply appropriate theory and scientific knowledge to participate in activities that support humanity and economic development nationally and globally, developing as leaders in their fields of expertise.	**M1& M2**
PEO 2	inculcate practical knowledge for developing professional empowerment and entrepreneurship and societal services.	**M2, M3, M4 & M5**
PEO 3	pursue lifelong learning and continuous improvement of the knowledge and skills with the highest professional and ethical standards.	**M3, M4, M5 & M6**

Programme Outcomes (POs)

POs	Upon completion of B.Sc. Degree Programme, the graduates will be able to:	Mapping with PEOs
PO1	obtain comprehensive knowledge and skills to pursue higher studies in the relevant field of science.	**PEO1**
PO2	create innovative ideas to enhance entrepreneurial skills for economic independence.	**PEO2**
PO3	reflect upon green initiatives and take responsible steps to build a sustainable environment.	**PEO2**
PO4	enhance leadership qualities, team spirit and communication skills to face challenging competitive examinations for a better developmental career.	**PEO1 & PEO3**
PO5	communicate effectively and collaborate successfully with peers to become competent professionals.	**PEO2 & PEO3**
PO6	absorb ethical, moral and social values in personal and social life leading to highly cultured and civilized personality	**PEO2 & PEO3**
PO7	participate in learning activities throughout life, through self-paced and self-directed learning to improve knowledge and skills.	**PEO1 & PEO3**

Programme Specific Outcome (PSOs)

PSOs	Upon completion of B.Sc. Physics Degree Programme, the graduates of Physics will be able to:	Mapping with POs
PSO - 1	understand the core theories and principles of physics which include mechanics, thermodynamics, electronics, material science etc.	**PO1**
PSO - 2	develop extensive comprehension of fundamental and diverse applications of Physics.	**PO2 & PO3**
PSO - 3	apply knowledge of principles, concepts in Physics and analyze their local, national and global impact. Apply the critical reasoning and computing skills to analyze and solve problems in physics.	**PO4 & PO5**
PSO - 4	analyze the observed experimental data and relate the results with theoretical expectations. Communicate appropriately and effectively, in a scientific context using present technology.	**PO6**
PSO - 5	develop entrepreneurial skills, empowered according to the professional requirement and become self-dependent. Understand the professional, ethical, legal, security, social issues and responsibilities.	**PO5 & PO7**

Mapping of PO'S and PSO'S

POs	PSO1	PSO 2	PSO3	PSO4	PSO5
PO 1	S	S	S	S	S
PO 2	M	S	S	S	S
PO 3	M	M	M	S	S
PO4	M	M	S	S	S
PO5	M	M	S	S	S
PO6	M	M	S	S	S
PO7	S	S	S	S	S

Eligibility Norms for Admission

Eligibility: 10 + 2 pattern

Those who seek admission to B.Sc. Physics Course must have passed the Higher Secondary Examinations conducted by the Board of Higher Secondary Examinations, Tamil Nadu with Physics and Mathematics subjects or examination recognized and approved by the Syndicate of Manonmaniam Sundaranar University, Tirunelveli.

Duration of the Programme: 3 years

Medium of Instruction: English

Passing Minimum

A minimum of 40% in the external examination and an aggregate of 40% is required. There is no minimum pass mark for the continuous internal assessment.

Components of the B.Sc. Physics Programme

Part III (Core and Elective)

Core Course	Core-Theory Papers	9x100	900
	Core Project	1x100	100
	Core Practical	6 x 100	600
	Discipline Specific Elective-Theory Papers	4x 100	400
	Total Marks		**2000**
Elective Course	Theory	4x 100	400
	Practical	2x 100	200
	Total Marks		**600**
	Total Marks		**2600**

- Core and Elective Lab Courses carry 100 marks each.
- Practical examination will be conducted at the end of each semester for Core and Elective Courses.

Course Structure

Distribution of Hours and Credits

Curricular Courses:

Course	**S I**	**S II**	**S III**	**S IV**	**S V**	**S VI**	**Total**	
							H	**C**
Part-I Language	6 (3)	6 (3)	6 (3)	6 (3)			24	**12**
Part-II English	6 (3)	6 (3)	6 (3)	6 (3)			24	**12**
Part-III								
Core Course Core Lab Course Core Project	5 (5)+ 3 (3)	5 (5)+ 3 (3)	5 (5)+ 3 (3)	5 (5)+ 3 (3)	6 (5)+ 5 (4)+ 4 (3) 5 (4)	6(5) + 5(3) + 5(3) 4(2)	72	**61**
Elective /Discipline Specific Elective Courses	4 (3)+ 2 (2)	4 (3)+ 2 (2)	4 (3)+ 2 (2)	4 (3)+ 2 (2)	4 (3)+ 4 (3)	4 (3)+ 4 (3)	40	**32**
Part-IV								
Non-major Elective	2 (2)	2 (2)	-	-	-	-	4	**4**
Skill Enhancement Course	-	2(2)	1(1) 2(2)	1(1) 2(2)	-		8	**8**
Foundation Course	2(2)	-	-	-	-	-	2	**2**

Value Education	-	-	-	-	2(2)	-	2	**2**
Summer Internship /Industrial Training					(2)			**2**
Environmental Studies	-	-	1	1 (2)	-	-	2	**2**
Extension Activity	-	-	-	-	-	(1)	-	**1**
Professional Competency Skill						2(2)	2	**2**
Total	**30 (23)**	**30 (23)**	**30 (22)**	**30 (24)**	**30 (26)**	**30 (22)**	**180**	**140**

Co-curricular Courses

Course	**S I**	**S II**	**S III**	**S IV**	**S V**	**S VI**	**Total**
LST (Life Skill Training)	-	(1)	-	(1)			2
SDT (Certificate Course)	(1)						1
Field Project		(1)					1
Specific Value-added Course	(1)		(1)				2
Generic Value-added Course				(1)		(1)	2
MOOC		(1)		(1)		(1)	3
Student Training (ST): Clubs & Committees / NSS				(1)			1
Community Engagement Activity - RUN				(1)			1
Human Rights Education					(1)		1
Gender Equity Studies						(1)	1
Total							**15**

Total number of Compulsory Credits = Academic credits + Non-academic credits: 140 + 15

Courses Offered

Semester I

Course	**Course Code**	**Title of the Course**	**Credits**	**Hours/Week**
Part I	TU231TL1 FU231FL1	Language: Tamil French	3	6
Part II	EU231EL1	English	3	6
Part III	PU231CC1	Core Course I: Properties of Matter and Acoustics	5	5
	PU231CP1	Core Lab Course I: General Physics Lab I	3	3
	PU231EC1	Elective Course I: Allied Physics for Mathematics – I	3	4

	PU231EP1	Elective Lab Course I: Allied Physics Practical for Mathematics – I	2	2
Part IV	PU231NM1	Non-Major Elective NME-I: Physics for Everyday Life	2	2
	PU231FC1	Foundation Course: Introductory Physics	2	2
Total			**23**	**30**

Semester II

Course	Course Code	Title of the Course	Credits	Hours/Week
Part I	TU232TL1 FU232FL1	Language: Tamil French	3	6
Part II	EU232EL1	English	3	6
Part III	PU232CC1	Core Course II: Heat, Thermodynamics and Statistical Physics	5	5
	PU232CP1	Core Lab Course II: General Physics Lab II	3	3
	PU232EC1	Elective Course II: Allied Physics for Mathematics – II	3	4
	PU232EP1	Elective Lab Course I: Allied Physics Practical for Mathematics – II	2	2
Part IV	PU232NM1	Non-major Elective NME-II: Physics of Music	2	2
	PU232SE1	Skill Enhancement Course SEC I: Digital Photography	2	2
Total			**23**	**30**

Semester III

Course	Course Code	Title of the Course	Credits	Hours/Week
Part I	TU233TL1 FU233FL1	Language: Tamil French	3	6
Part II	EU233EL1	English	3	6
Part III	PU233CC1	Core Course III: General Mechanics and Classical Mechanics	5	5
	PU233CP1	Core Lab Course III: General Physics Lab III	3	3
	PU233EC1	Elective Course III: Allied Physics for Chemistry - I	3	4
	PU233EP1	Elective Lab Course III: Allied Physics Practical for	2	2

		Chemistry – I		
Part IV	PU233SE1	Skill Enhancement Course SEC II (Entrepreneurial Skills): Home Electrical Installation	1	1
	PU233SE2	Skill Enhancement Course SEC III: Electrical and Electronic Circuits	2	2
	UG234EV1	Environmental Studies	-	1
Total			**22**	**30**

Semester IV

Course	Course Code	Title of the Course	Credits	Hours/Week
Part I	TU234TL1 FU234FL1	Language: Tamil French	3	6
Part II	EU234EL1	English	3	6
Part III	PU234CC1	Core Course IV: Optics and Spectroscopy	5	5
	PU234CP1	Core Lab Course IV: General Physics Lab IV	3	3
	PU234EC1	Elective Course IV: Allied Physics for Chemistry – II	3	4
	PU234EP1	Elective Lab Course IV: Allied Physics Practical for Chemistry - II	2	2
Part IV	PU234SE1	Skill Enhancement Course SEC IV: Programming with C++	1	1
	PU234SE2	Skill Enhancement Course SEC V: C++ Programming Lab	2	2
	UG234EV1	Environmental Studies	2	1
Total			**24**	**30**

Semester V

Course	Course Code	Title of the Course	Credits	Hours/Week
	PU235CC1	Core Course V: Atomic Physics and Lasers	5	6
Part III	PU235CC2	Core Course VI: Relativity and Quantum Mechanics	4	5
	PU235CP1	Core Lab Course V: General Physics Lab V	3	4
	PU235PW1	Core Project	4	5
	PU235DE1	Discipline Specific Elective I: a) Energy Physics	3	4

	PU235DE2	Discipline Specific Elective I: b) Mathematical Physics	3	4
	PU235DE3	Discipline Specific Elective I: c) Medical Instrumentation		
	PU235DE4 PU235DE5	Discipline Specific Elective II: a) Material Science Discipline Specific Elective II: b) Numerical Methods and C Programming		
	PU235DE6	Discipline Specific Elective II: Lasers and Fiber Optics		
Part IV	PU235VE1	Value Education	2	2
	PU235SI1 / PU235IT1	Summer Internship/Industrial Training	2	
Total			**26**	**30**

Semester VI

Course	Course Code	Title of the Course	Credits	Hours/Week
Part III	PU236CC1	Core Course VII: Nuclear and Particle Physics	5	6
	PU236CC2	Core Course VIII: Solid State Physics	3	5
	PU236CC3	Core Course IX: Digital Electronics and Microprocessor 8085	3	5
	PU236CP1	Core Lab Course VI: General Physics Lab VI	2	4
	PU236DE1	Discipline Specific Elective III: a) Nano Science	3	4
	PU236DE2	Discipline Specific Elective III: b) Digital Photography		
	PU236DE3	Discipline Specific Elective III: c) Advanced Mathematical Physics		
	PU236DE4	Discipline Specific Elective IV: a) Communication Systems	3	4
	PU236DE5	Discipline Specific Elective IV: b) Geo Physics		
	PU236DE6	Discipline Specific Elective IV: c) Bio Physics		
Part IV	PU236EA1	Extension Activity	1	-
	PU236PS1	Professional Competency Skill	2	2
Total			**22**	**30**
TOTAL			**140**	**180**

Co-curricular Courses

Part	Semester	Code	Title of the Course	Credit
Part V	I & II	UG232LC1	Life Skill Training I: Catechism	I
		UG232LM1	Life Skill Training I: Moral	
	I	UG231C01 – UG231C--	Skill Development Training (SDT) - Certificate Course	1
	II, IV& VI	-	MOOC	1+1+1
	III & IV	UG234LC1	Life Skill Training II: Catechism	1
		UG234LM1	Life Skill Training II: Moral	
	II	PU232FP1	Field Project	1
	I & III	PU231V01-PU231V--/ PU233V01 – PU233V--	Specific Value-added Course	1+1
	IV & VI	UG234V01-UG234V--/ UG236V01-UG236V--	Generic Value-added Course	1 +1
	I – IV	UG234ST1	Student Training Activity – Clubs & Committees / NSS	1
	IV	UG234CE1	Community Engagement Activity – RUN	1
	V	UG235HR1	Human Rights Education	1
	VI	UG236GS1	Gender Equity Studies	1
			Total	**15**

Specific Value-Added Course

S. No.	Course code	Title of the course	Total hours
I	PU231V01	Photoshop	30

Examination Pattern

Each paper carries an internal component.

There is a passing minimum for external component.

A minimum of 40% in the external examination and an aggregate of 40% is required.

Part I – Tamil, Part II – English, Part III - (Core/ Elective)

Ratio of Internal and 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
Assignment: (Model Making, Exhibition, Role Play,	10

Seminar, Group Discussion, Problem Solving, Class Test, Open Book Test etc. (Minimum three items per course should be included in the syllabus & teaching plan) (30 marks)	
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
PartB3 x 4 (Internal choice)	12	Part B 5 x 6 (Internal choice)	30
Part C 3 x 8 (Internal choice)	24	PartC 5 x 12(Internal choice)	60
Total	**40**	**Total**	**100**

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	
Minor Practical / Spotters /Record	75
Total	**75**

Core Project

Ratio of Internal and External = 25:75

Components	**Marks**
Internal	25
External	
Report	40
Viva voce	35

Part - IV

i. Non-major Elective, Foundation Course, Skill Enhancement Course, Value Education, Professional Competency Skill

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

Internal Components and Distribution of Marks

Components	Marks
Internal test (2)	10
Quiz (2)	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 5(Open choice any **Five** out **of Eight**)	25
Part C 1 x 9(Open choice O**ne** out of **Three**)	9	Part C 5 x 8(Open choice any **Five** out **of Eight**)	40
Total	**25**	**Total**	**75**

ii. Environmental Studies

Internal Components

Component	Marks
Project Report	15
Viva voce	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 5 (Open choice any **Five** out **of Eight**)	25
Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 8 (Open choice any **Five** out **of Eight**)	40
Total	**25**	**Total**	**75**

iii. Summer Internship/Industrial Training:

Components	Marks
Industry Contribution	50
Report & Viva-voce	50

Co-Curricular Courses:

i. **Life Skill Training: Catechism &Moral, Human Rights Education & Gender Equity Studies**

Internal Components

Component	Marks
Project - Album on current issues	25
Group Song/ Mime/ Skit	25
Total	**50**

External Components

Component	Marks
Quiz	20
Written Test: Open choice – 5 out of 7 questions (5 x 6)	30
Total	**50**

ii. **Skill Development Training (SDT) - Certificate Course:**

Components	Marks
Attendance & Participation	50
Skill Test	50

iii. **Field Project:**

Components	Marks
Field Work	50
Report & Viva-voce	50

iv. **Specific Value-Added Courses & Generic Value-Added Courses:**

Components	Marks
Internal	25
External	75

v. **Community Engagement Activity: Reaching the Unreached Neighbourhood (RUN)**

Components	Marks
Attendance & Participation	50
Field Project	50

vi. **Student Training Activity: Clubs and Committees**

Compulsory for all I & II year students (1 credit).

Component	Marks
Attendance	25
Participation	25
Total	**50**

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:

Programme	Assessment	Lower Order Thinking									Higher order thinking			Total number of questions
		K1			K2			K3			K4, K5, K6			
	Part	A	B	C	A	B	C	A	B	C	A	B	C	
I UG	Internal	2	2		1	1	1	1	-	2	-	-	-	10
	External	5	2	1	3	2	2	2	1	2	-	-	-	20
II UG	Internal	1	-	1	1	2		1	-	1	1	1	1	10
	External	5	1	1	4	1	1	-	3	1	1	-	2	20
III UG	Internal	1	1	-	-	1	-	1	-	1	2	1	2	10

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 of each course shall be done by 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 reappear in such failed course(s) in the subsequent examinations to be held in October/ November or April/May. However, candidates who have arrears in practical examination shall be permitted to reappear for their areas only along with regular practical examinations in the respective semester.

v. Viva-voce: Each project group shall be required to appear for Viva -voce examination in defence of the project.

vi. The results of all the examinations will be published in the college website.

Conferment of Bachelor's Degree

A candidate shall be eligible for the conferment of the Degree of Bachelor of Arts / Science / Commerce only if the minimum required credits for the programme thereof (140 + 18 credits) is earned.

Grading System

For the Semester Examination:

Calculation of Grade Point Average for End Semester Examination:

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

For the entire programme:

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

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

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
40-49	4.0-4.9	C	Satisfactory
00-39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

Overall Performance

CGPA	Grade	Classification of Final Result
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+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
4.0 and above but below 5.0	C	Third Class
0.0 and above but below 4.0	U	Re-appear

*

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

SEMESTER – I

Core Course -I: Properties of Matter and Acoustics

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU231CC1	5	-	-	-	5	5	75	25	75	100

Pre-requisite:

Basic knowledge on Power, Force, Newton's Laws of Motion

Learning Objectives:

1. To Study of the properties of matter leads to information which is of practical value to the physicists.
2. To provide an information about the internal forces which act between the constituent parts of the substance.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
1.	Relate elastic behavior in terms of three modulii of elasticity and working of torsion pendulum.	**K1 & K2**
2.	Appreciate concept of bending of beams and analyze the expression, quantify and understand nature of materials.	**K2 & K3**
3.	Explain the surface tension and viscosity of fluid and support the interesting phenomena associated with liquid surface, soap films provide an analogue solution to many engineering problems.	**K2 & K3**
4.	Analyze simple harmonic motions mathematically and apply them. Understand the concept of resonance and use it to evaluate the frequency of vibration. Set up experiment to evaluate frequency of ac mains	**K1 & K3**
5.	Understand the concept of acoustics, importance of constructing buildings with good acoustics. Also to apply their knowledge of ultrasonics in real life, especially in medical field and assimilate different methods of production of ultrasonic waves.	**K2 & K3**

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

Units	Contents	No. of Hours
I	**ELASTICITY:** Hooke's law – stress-strain diagram – elastic constants –Poisson's ratio – relation between elastic constants and Poisson's ratio – work done in stretching and twisting a wire – twisting couple on a cylinder – rigidity modulus by static torsion– torsional pendulum (with and without masses)	15
II	**BENDING OF BEAMS:** Cantilever– expression for Bending moment – expression for depression at the loaded end of the cantilever– oscillations of a cantilever – expression for time period – experiment to find Young's modulus – non-uniform bending– experiment to determine Young's modulus by Koenig's method – uniform bending – expression for elevation – experiment to determine Young's modulus using microscope	15
III	**FLUID DYNAMICS:** Surface tension: definition – molecular forces– excess pressure over curved surface – application to spherical and cylindrical drops and bubbles – determination of surface tension by Jaegar's method–variation of surface tension with temperature Viscosity:definition – streamline and turbulent flow – rate of flow of liquid in a capillary tube – Poiseuille's formula – corrections – terminal velocity and Stoke's formula– variation of viscosity with temperature	15
IV	**WAVES AND OSCILLATIONS:** Simple Harmonic Motion (SHM) – differential equation of SHM – graphical representation of SHM – composition of two SHM in a straight line and at right angles – Lissajous's figures- free, damped, forced vibrations – resonance and Sharpness of resonance. Laws of transverse vibration in strings –sonometer – determination of AC frequency using sonometer – determination of frequency using Melde's string apparatus	15
V	**ACOUSTICS OF BUILDINGS AND ULTRASONICS:** Intensity of sound – decibel – loudness of sound –reverberation – Sabine's reverberation formula (derivation) – acoustic intensity – factors affecting the acoustics of buildings. Ultrasonic waves: production of ultrasonic waves – Piezoelectric crystal method – magnetostriction effect – application of ultrasonic waves	15
Total		**75**

Self study	Unit I: Elastic constants Unit II: Oscillations of a cantilever Unit III: Molecular forces Unit IV: Lissajous's figures Unit V: Properties of ultrasonic waves

Text Books

1. Mathur, D, S. 2010. Elements of Properties of Matter, S.Chand & Co.
2. BrijLal, Subrahmanyam, N. 2003. Properties of Matter, S.Chand & Co
3. Khanna, D.R. Bedi, R.S. 1969. Textbook of Sound, Atma Ram & sons
4. BrijLal and.Subrahmanyam, N. 1995. A Text Book of Sound, Second revised edition,Vikas Publishing House.
5. Murugesan,R. 2012. Properties of Matter, S.Chand & Co.

Reference Books

1. Smith, C.J. 1960. General Properties of Matter, Orient Longman Publishers
2. Gulati, H.R. 1977. Fundamental of General Properties of Matter (Fifth edition),R. Chand & Co.
3. French, A.P. 1973. Vibration and Waves, MIT Introductory Physics, ArnoldHeinmann India.

Web Resources

1. https://www.biolinscientific.com/blog/what-are-surfactants-and-how-do-theywork
2. https://www.youtube.com/watch?v=m4u-SuaSu1s&t=3s
3. http://www.sound-physics.com/
4. https://www.biolinscientific.com/blog/what-are-surfactants-and-how-do-theywork
5. https://learningtechnologyofficial.com/category/fluid-mechanics-lab/6. http://hyperphysics.phy-astr.gsu.edu/hbase/permot2.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	2	3	2	2	3	2	2	1	1
CO2	2	3	3	3	2	2	3	3	3	2	1	1
CO3	3	2	3	2	3	3	2	3	2	2	1	1
CO4	3	3	3	3	3	2	3	3	2	3	2	1
CO5	2	2	3	3	2	3	3	3	2	2	3	2
TOTAL	13	13	14	15	13	12	13	15	11	11	8	6
AVERAGE	2.6	2.6	2.8	3	2.6	2.4	2.6	3	2.2	2.2	1.8	1.6

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

Core Course Lab – I : General Physics Lab I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU231CP1	**-**	**-**	**3**	**-**	**3**	**3**	**45**	**25**	**75**	**100**

Pre requisite:

Knowledge on basic Physics and Arithmetics

Learning Objectives:

1. To apply various physics concepts to understand Properties of Matter, set up experimentation to verify theories.
2. To do error analysis and correlate results

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 behavior of the materials.	**K1**
3.	analyze the physical principle involved in the various instruments	**K4**
4.	understand the scientific method and an ability to apply the scientific method in practice.	**K2**

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

Contents

(Any Eight Experiments)

Determination of moment of inertia of an irregular body.

Verification of parallel axes theorem on moment of inertia.

Verification of perpendicular axes theorem on moment of inertia.

Determination of Young's modulus by stretching of wire with known masses.

Verification of Hook's law by stretching of wire method.

Determination of Young's modulus by uniform bending – load depression graph.

Determination of Young's modulus by non-uniform bending – scale & telescope.

Determination of Young's modulus by cantilever – load depression graph.

Determination of Young's modulus by cantilever – oscillation method

Determination of rigidity modulus by static torsion.

Determination of Y, n and K by Searle's double bar method.

Determination of surface tension & interfacial surface tension by drop weight method.

Determination of co-efficient of viscosity by Stokes' method – terminal velocity.

Determination of surface tension of liquid by Capillary rise method.

Determination of critical pressure for streamline flow.

Determination of Poisson's ratio of rubber tube.

Determination of viscosity by Poiseullie's flow method.

Determination of radius of capillary tube by mercury pellet method.

Determination of rigidity modulus without mass using Torsional pendulum.

Determination of rigidity modulus with masses using Torsional pendulum.

Reference Books

1. Manual prepared by the department

2. Ouseph, C, C., Rao, U, J. and Vijayendran, V. 2007. Practical Physics and Electronics. S. Viswanathan, Pvt., Ltd. Chennai.

SEMESTER – I

Elective Course –I:Allied Physics For Mathematics – I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU231EC1	**4**				**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite:

Knowledge on basic Physics

Learning Objectives:

1. To impart basic principles of Physics
2. To incorporate concepts of Physics in day to day life

Course Outcomes

On the successful completion of the course, student will be able to:		
1	Acquire knowledge on elementary ideas of waves, properties of matter, electricity and magnetism, electronics	**K1 & K2**
2	Analyze the concepts of ultrasonics, surface tension and study their applications in the medical field.	**K3**
3	Interpret the real-life solution using concepts of electricity, magnetism, and electronics in Digital India.	**K2**
4	Apply their depth knowledge of Physics in day today life.	**K3**
5	Develop their knowledge to carry out the practical by applying these concepts of Physics	**K3**

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

Unit	Contents	No. of Hours
I	**Waves, Oscillations and Ultrasonics** Simple harmonic motion (SHM) – composition of two SHMs at right angles (periods in the ratio 1:1) – Lissajous figures – uses – laws of transverse vibrations of strings – determination of AC frequency using sonometer (steel and brass wires) – ultrasound – production – piezoelectric method – application of ultrasonics: medical field – lithotripsy, ultrasonography – ultrasonoimaging- ultrasonics in dentistry – physiotheraphy, opthalmology – advantages of noninvasive surgery – ultrasonics in green chemistry.	12
II	**Properties Of Matter** Elasticity: elastic constants – bending of beam – theory of non- uniform bending – determination of Young's modulus by non- uniform bending – energy stored in a stretched wire – torsion of a wire – determination of rigidity modulus by torsional pendulum Viscosity: streamline and turbulent motion – critical velocity – coefficient of viscosity – Poiseuille's formula – comparison of viscosities – burette method, Surface tension: definition – molecular theory – droplets formation– shape, size and lifetime – COVID transmission through droplets, saliva – drop weight method – interfacial surface tension.	12
III	**Heat and Thermodynamics** Joule-Kelvin effect – Joule-Thomson porous plug experiment – theory– temperature of inversion – liquefaction of Oxygen– Linde's process of liquefaction of air– liquid Oxygen for medical purpose– importance of cryocoolers – thermodynamic system – thermodynamic equilibrium – laws of thermodynamics – heat engine – Carnot's cycle – efficiency – entropy – change of entropy in reversible and irreversible process.	12
IV	**Electricity and Magnetism** Potentiometer – principle – measurement of thermo emf using potentiometer –magnetic field due to a current carrying conductor – Biot-Savart's law – field along the axis of the coil carrying current – peak, average and RMS values of ac current and voltage – power factor and current values in an AC circuit – types of switches in household and factories– Smart wifi switches- fuses and circuit breakers in houses	12
V	**Digital Electronics and Digital India** logic gates, OR, AND, NOT, NAND, NOR , EXOR logic gates – universal building blocks – Boolean algebra – De Morgan's theorem – verification – overview of Government initiatives: software technological parks under MeitY, NIELIT- semiconductor laboratories under Dept. of Space – an introduction to Digital India	12
TOTAL		**60**

Self Study	Unit I: Application of ultrasonics Unit II: Streamline and turbulent motion. Unit III: Reversible and irreversible process Unit IV: Types of switches Unit V: Logic gates-Universal building blocks

Textbooks

1. Ubald Raj, A. and Jose Robin, G. 2012. Allied Physics. Indira Publications. Marthandam.
2. Murugesan, R. 2001. Allied Physics. S. Chand & Co. New Delhi.

Reference Books

1. Brijlal and Subramaniam, N. 1994. Properties of Matter. S. Chand & Co. New Delhi.
2. Murugesan, R. 2017. Electricity and Magnetism. S. Chand & Co. New Delhi.
3. Ubald Raj, A. and Jose Robin, G. 2004. Basic Electronics. Indira Publications. Marthandam.

Web Resources

1. https://youtu.be/M_5KYncYNyc
2. https://www.youtube.com/watch?v=9mXOMzUruMQ&t=1s
3. https://www.youtube.com/watch?v=m4u-SuaSu1s&t=3s
4. https://www.biolinscientific.com/blog/what-are-surfactants-and-how-do-they-work
5. https://learningtechnologyofficial.com/category/fluid-mechanics-lab/
6. http://hyperphysics.phy-astr.gsu.edu/hbase/permot2.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	1	1	2	3	2	2	3	1
CO2	3	3	3	1	2	2	2	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	2	2	2	3	3	3	2	3
CO5	3	3	3	2	3	3	3	3	3	3	3	3
TOTAL	15	15	14	10	11	11	12	15	14	14	14	13
AVERAGE	3	3	2.8	2	2.2	2.2	2.4	3	2.8	2.8	2.8	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

Elective Lab Course I:

Allied Physics Practical for Mathematics – I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU231EP1			2		2	2	30	25	75	100

Pre-requisite:

Knowledge in basic Physics

Learning Objectives:

1. To make the students more innovative, in hands on experiments.
2. To elucidate theory through simple experiments in physics.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
1	understand the basic principles of Physics through experiments.	**K2**
2	measure and determine the various physical parameters.	**K3**
3	develop an idea about the handling of various instruments.	**K2**
4	get an idea about basic Scientific knowledge and implications of its broad working principle	**K2 & K3**
5	analyze, interpreting and evaluate data.	**K3 & K4**

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

ANY Eight only

1. Young's modulus by non-uniform bending using pin and microscope
2. Young's modulus by non-uniform bending using optic lever, scale and telescope
3. Rigidity modulus by static torsion method.
4. Rigidity modulus by torsional oscillations without mass
5. Verification of laws of transverse vibrations using sonometer
6. Calibration of low range voltmeter using potentiometer
7. Surface tension and interfacial Surface tension – drop weight method
8. Comparison of viscosities of two liquids – burette method.
9. Verification of truth tables of basic logic gates using Ics
10. Verification of De Morgan's theorems using logic gate ICs. *Note* : Use of digital balance permitted.
11. Determination of thermo emf using potentiometer.
12. Specific heat capacity of a liquid.

Reference Books

1. Manual prepared by the department

2. Ubald Raj, A. and Jose Robin, G. 2012. Allied Physics. Indira Publications. Marthandam.

SEMESTER – I
Skill Enhancement Course- SEC I - Non Major Elective:
Physics ForEveryday Life

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU231SE1	2	-	-	-	2	2	30	25	75	100

Pre-requisite:

Students should know about basic knowledge regarding mechanical objects, laser, optical devices and solar energy.

Learning Objectives:

1. To introduce fundamental physics concepts and their applications in everyday life.
2. To comprehend where all physics principles have been applied in everyday life and to appreciate the concepts with a greater understanding, as well as to learn about Indian scientists who have made significant contributions to Physics.

Course Outcomes

	On the successful completion of the course, student will be able to**:**	
1.	Understand the knowledge of basic scientific principles and fundamental concepts in motion of bodies.	**K2**
2.	Understand the basic laws of physics in domestic appliances	**K2**
3.	Recall the physics notions applied in various optical instruments	**K1**
4.	Comprehend the utilization of solar energy in everyday life activities	**K2**
5.	Know about the various physicists contribution towards science and technology	**K2**

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

Units	Contents	No. of Hours
I	**UNIT 1: MECHANICAL OBJECTS** Spring scales – bouncing balls –roller coasters – bicycles – rockets and space travel.	6
II	**UNIT II: OPTICAL INSTRUMENTS AND LASER** Vision corrective lenses – polaroid glasses – UV protective glass – polaroid camera – colour photography – holography and laser.	6
III	**UNIT III: PHYSICS OF HOME APPLIANCES:** bulb – fan – hair drier – television – air conditioners – microwave ovens – vacuum cleaners	6
IV	**UNIT IV: SOLAR ENERGY** Solar constant – General applications of solar energy – Solar water heaters – Solar Photo – voltaic cells – General applications of solar cells.	6
V	**UNIT V: INDIAN PHYSICIST AND THEIR CONTRIBUTIONS** C.V.Raman, HomiJehangirBhabha, Vikram Sarabhai, Subrahmanyan Chandrasekhar, Venkatraman Ramakrishnan, Dr. APJ Abdul Kalam and their contribution to science and technology.	6
	TOTAL	30

Self - Study	Unit III- Brief description about bulb, fan Unit IV- Applications of solar energy

Text Books:

1. The Physics in our Daily Lives, Umme Ammara, Gugucool Publishing, Hyderabad, 2019.
2. For the love of physics, Walter Lawin, Free Press, New York, 2011.

Reference Books:

1. Gerardin Jayam. (2019). Physics in Everyday Life. Published by the Department of Physics, Holy Cross College (Autonomous), Nagercoil.

Web Resources:

1. https://www.scientificworldinfo.com/2021/09/importance-of-physics-in-our-daily-life.html
2. https://www.britannica.com/technology/laser

MAPPING WITH PROGRAMME OUTCOMESAND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	1	2	2	3	2	2	2	2
CO2	3	3	2	1	1	2	2	3	3	3	2	2
CO3	3	2	2	1	2	2	2	3	3	3	3	3
CO4	3	3	3	1	1	3	3	3	3	2	2	2
CO5	2	1	1	3	2	2	2	2	2	2	22	
TOTAL	14	12	10	7	7	11	11	14	13	12	11	11
AVERAGE	2.8	2.4	2	1.4	1.4	2.2	2.2	2.8	2.6	2.4	2.2	2.2

3 – Strong, 2- Medium, 1- Low

SEMESTER I

Foundation Course:

INTRODUCTORY PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU231FC1	2	-	-	-	2	2	30	25	75	100

Pre-requisite:

Students should know the fundamentals of Physics.

Learning Objectives:

1. To help students get an overview of Physics before learning their core courses.
2. To serve as a bridge between the school curriculum and the degree programme.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	Apply concept of vectors to understand concepts of Physics and solve problems	**K2 & K3**
2.	Interpret different forces present in Nature while learning about phenomena related to these different forces.	**K1 & K2**
3.	Describe energy in different process and relate momentum, velocity and energy	**K1 & K2**
4.	Differentiate different types of motions they would encounter in various courses and understand their basis	**K1 & K2**
5.	Relate various properties of matter with their behavior and connect them with different physical parameters involved.	**K2 & K3**

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

Units	Contents	No. of Hours
I	**Vector:** Vectors, scalars, Examples for scalars and vectors from physical quantities, addition, subtraction of vectors, resolution and resultant of vectors, units and dimensions, standard physics constants	6
II	**Force:** Different types of forces, gravitational, electrostatic, magnetic, electromagnetic, nuclear, mechanical forces like, centripetal, centrifugal, friction, tension, cohesive, adhesive forces	6
III	**Energy:** Different forms of energy, Conservation laws of momentum, energy, types of collisions, angular momentum, alternate energy sources, real life examples	6
IV	**Motion:** Types of motion, linear, projectile, circular, angular, simple harmonic motions, satellite motion, banking of a curved road, stream line and turbulent motions, wave motion, comparison of light and sound waves, Free, forced and damped oscillations	6
V	**Surface tension and Viscosity:** Surface tension, shape of liquid drop – angle of contact – viscosity – lubricants, capillary flow, diffusion, real life examples, properties and types of materials in daily use, conductors, insulators, thermal and electric	6
TOTAL		**30**

Self-study	Unit I : Units and dimensions Unit II : Friction Unit III : Comparison of light and sound waves Unit IV : Stream line and turbulent motions

Unit V : Conductors

Text Books

1. Mathur D.S. 2010, Elements of Properties of Matter, S.Chand & Co
2. BrijLal & N. Subrahmanyam. 2003, Properties of Matter, S.Chand & Co.

Reference Books

1. Gulati H.R, 1977, Fundamental of General Properties of Matter (Fifth edition), S.Chand & Co.

Web Resources:

1. https://www.physicsclassroom.com/class/newtlaws/Lesson-2/Types-of-Forces
2. http://hyperphysics.phy-astr.gsu.edu/hbase/permot2.htmlhttps://science.nasa.gov/ems/
3. https://eesc.columbia.edu/courses/ees/climate/lectures/radiation_hays/
4. https://testbook.com/physics/types-of-motion
5. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Physical_Properties_of_Matter/States_of_Matter/Properties_of_Liquids/Surface_Tension

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO S1	PO S2	PO S3	PO S4	PO S5	PO S6	PO S7	PO S1	POS 2	POS3	POS4	POS5
CO1	3	3	3	3	2	3	3	2.5	2.5	3	3	3
CO2	3	3	3	3	3	2	2	2.5	2.5	2	3	3
CO3	3	3	3	3	3	2	2	2.5	2.5	2	3	3
CO4	3	3	3	3	2	2	2	2.5	2.5	2	3	3
CO5	3	3	3	3	3	2	2	2.5	2.5	2	3	3
TOTAL	15	15	15	15	13	11	11	12.5	12.5	11	15	15
AVERAGE	3	3	3	3	2.6	2.2	2.2	2.5	2.5	2.2	3	3

3 – Strong, 2- Medium, 1- Low

SEMESTER – II

CORE COURSE -II: HEAT, THERMODYNAMICS AND STATISTICAL PHYSICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU232CC1	5	-	-	-	5	5	75	25	75	100

Pre-requisite:

Knowledge on Temperature in different Scales and Laws of thermodynamics

Learning Objectives:

1. To understand a basic in conversion of temperature in Celsius, Kelvin and Fahrenheit scales.
2. To Relate the laws of thermodynamics, entropy in everyday life and explore the knowledge of statistical mechanics and its relation

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	acquires knowledge on how to distinguish between temperature and heat, and explain practical measurements of high temperature as well as low temperature physics.	**K1 & K2**
2.	derive the efficiency of Carnot's engine and discuss the implications of the laws of Thermodynamics in diesel and petrol engines	**K1 & K3**
3.	analyze performance of thermodynamic systems viz efficiency by problems and gets an insight into thermodynamic properties like enthalpy, entropy	**K2 & K3**
4.	study the process of thermal conductivity and apply it to good and bad conductors.	**K2 & K3**
5.	interpret classical statistics concepts such as phase space, ensemble, Maxwell-Boltzmann distribution law, Bose-Einstein and Fermi-Dirac .	**K2 & K3**

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

Units	Contents	No. of Hours
I	**CALORIMETRY:** Specific heat capacity – specific heat capacity of gases C_P& C_V– Meyer's relation – Joly's method for determination of C_V – Regnault's method for determination of C_P **LOW TEMPERATURE PHYSICS:** Joule-Kelvin effect – porous plug experiment – Joule-Thomson effect –Boyle temperature – temperature of inversion – liquefaction of gas by Linde's Process – adiabatic demagnetisation.	15
II	**THERMODYNAMICS-I:** Zeroth law and first law of thermodynamics – P-V diagram – heat engine –efficiency of heat engine – Carnot's engine, construction, working and efficiency of petrol engine and diesel engines – comparison of engines.	15
III	**THERMODYNAMICS-II:** Second law of thermodynamics –entropy of an ideal gas – entropy change in reversible and irreversible processes – T-S diagram –thermodynamical scale of temperature – Maxwell's thermodynamical relations – Clasius-Clapeyron's equation (first latent heat equation) – third law of thermodynamics – unattainability of absolute zero – heat death.	15
IV	**HEAT TRANSFER:** Modes of heat transfer: conduction, convection and radiation. Conduction: thermal conductivity – determination of thermal conductivity of a good conductor by Forbe's method – determination of thermal conductivity of a bad conductor by Lee's disc method. Radiation: black body radiation (Ferry's method) – distribution of energy in black body radiation – Wien's law and Rayleigh Jean's law – Planck's law of radiation – Stefan's law – deduction of Newton's law of cooling from Stefan's law.	15
V	**STATISTICAL MECHANICS:** Definition of phase-space – micro and macro states – ensembles –different types of ensembles – classical and quantum Statistics – Maxwell Boltzmann statistics – expression for distribution function – Bose-Einstein statistics – expression for distribution function – Fermi-Dirac statistics – expression for distribution function – comparison of three statistics.	15
TOTAL		75

Self-study	Temperature of inversion ; Comparison of engines; Entropy of an ideal gas; Stefan's law; Comparison of three statistics.

Text Books

1. Brijlal , Subramaniam, N. Henne, P. S. 2008. Heat Thermodynamics and Statistical Physics, Revised Edition, S.Chand& Co., New Delhi.
2. Murugeshan, R. Kiruthiga Sivaprasath. 2013,Thermal Physics, 2nd edn., Sulthan Chand & Sons, New Delhi.

3. Jauaraman, D. Ilangovan. K. 2009, Thermal Physics and Statistical Mechanics, 1st edn., S. Viswanathan Publishers and Printers, Chennai.

Reference Books

1. Ubald Raj A. and Jose Robin G. 2001, Thermal Physics and Statistical Mechanics. 1st edn. Indirapublication.Marthandam, Tamil Nadu.
2. Mathur, D.S. 2014. Heat and Thermodynamics, 5th Edition, Sultan Chand & Sons, New Delhi.
3. Gupta, Kumar, Sharma, 2013. Statistical Mechanics (Twenty-Sixth Edition), S. Chand & Co. Ltd., New Delhi.
4. Sears, Zemansky, Hugh D. Young,Roger, Freedman,A. 2021. University Physics with Modern Physics (Fifteenth Edition), Pearson, New Jersey.
5. Ubald Raj A. and Jose Robin G. 2005, Mechanics and Thermal Physics. 1st edn. Indirapublication.Marthandam, Tamil Nadu.

Web Resources

1. https://www.youtube.com/watch?v=M_5KYncYNyc
2. https://www.youtube.com/watch?v=pQWwP7YYH6o
3. https://www.youtube.com/watch?v=LUoUb4hGMH8
4. https://ocw.mit.edu/courses/5-60-thermodynamics-kinetics-spring-2008/resources/lecture-2-work-heat-first-law/
5. https://ocw.mit.edu/courses/5-60-thermodynamics-kinetics-spring-2008/resources/lecture-13-gibbs-free-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	3	3	3	3	2	2	1	1
CO2	2	3	3	3	2	3	3	3	2	2	1	1
CO3	3	3	3	2	3	3	3	3	2	2	2	1
CO4	3	3	3	3	3	3	3	3	2	2	1	2
CO5	3	3	2	3	3	3	2	3	2	2	1	1
TOTAL	14	15	14	14	14	15	14	15	10	10	6	6
AVERAGE	2.8	3	2.8	2.8	2.8	3	2.8	3	2	2	1.6	1.6

3 – Strong, 2- Medium, 1- Low

SEMESTER – II

CORE LAB COURSE - II: GENERAL PHYSICS LAB II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU232CP1	-	-	3	-	3	3	45	25	75	100

Prerequisites: Types of Modulus, Knowledge on thermal conductivity and specific heat capacity

Learning Objectives:

1. To apply their knowledge gained about the concept of heat and sound waves, resonance.
2. To do error analysis and correlate results

Course Outcomes

On the successful completion of the course, students will able to:		
1.	understand the strength of materials using physical experiments.	**K2**
2.	acquire knowledge of thermal behaviour of the materials.	**K1**
3.	analyze the physical principle involved in the various instruments such as sonometer and Melde's String.	**K4**
4.	understand the scientific method and an ability to apply the scientific method in practice.	**K2**

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

Contents

(Any Eight Experiments)

1. Verification of Newton's law of cooling
2. Determination of specific heat by cooling – graphical method.
3. Determination of thermal conductivity of bad conductor by Lee's disc method.
4. Frequency of AC by using Sonometer.
5. To verify the laws of transverse vibration using sonometer.
6. Velocity of sound through a wire using Sonometer.
7. To verify the laws of transverse vibration using Melde's apparatus.
8. Determination of g using compound pendulum.
9. Determination of thermal conductivity of good conducto
10. r by Searle's method.
11. Determination of thermal conductivity of bad conductor by Charlaton's method.
12. Determination of specific heat capacity of solid.
13. Determination of specific heat of liquid by Joule's electrical heating method (applying radiation correction by Barton's correction/graphical method),
14. Determination of Latent heat of a vaporization of a liquid.
15. Verification of Stefan's-Boltzmans law.
16. Determination of thermal conductivity of rubber tube.
17. Helmholtz resonator.
18. Determination of velocity of sound using Kunds tube.
19. Determination of frequency of an electrically maintained tuning fork
20. To compare the mass per unit length of two strings using Melde's apparatus.
21. Determination of moment of inertia and g using Bifilar pendulum.

Reference Books

1. Manual prepared by the department
2. Ouseph, C, C., Rao, U, J. and Vijayendran, V. 2007. Practical Physics and Electronics. S. Viswanathan, Pvt., Ltd. Chennai.

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	3	3	3	3	3	3	3	2
CO2	2	3	2	3	2	3	3	3	2	2	3	2
CO3	3	3	2	2	3	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	3	3	2	2	2	2
TOTAL	11	12	8	11	11	12	12	12	9	9	10	8
AVERAGE	2.75	3	2	2.75	2.75	3	3	3	2.25	2.25	2.5	2

3 – Strong, 2- Medium, 1- Low

SEMESTER - II

ELECTIVE COURSE–II: ALLIED PHYSICS FOR MATHEMATICS – II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU232EC1	4		-		3	4	60	25	75	100

Prerequisites:

Knowledge on basic Physics

Learning Objectives:

1. To impart basic principles of Physics
2. To incorporate concepts of Physics in day to day life

Course Outcomes

On the successful completion of the course, student will be able to**:**		
CO1	explain the concepts of interference, diffraction and rephrase the concept of polarization	**K1 & K2**
CO2	outline the basic foundation of different atom models and relate the importance of theoretical models	**K1 & K2**
CO3	understand the properties of nuclei, nuclear forces, structure of atomic nucleus and nuclear models and interpret nuclear processes like fission and fusion.	**K2& K3**
CO4	describe the basic concepts of relativity like equivalence principle, inertial frames and Lorentz transformation.	**K3 & K4**
CO5	summarize the working of semiconductor devices like diodes, transistors, USB chargers and EV charging stations.	**K4& K5**

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

Unit	Contents	No. of Hours
I	**OPTICS** Interference – interference in thin films –colours of thin films – air wedge – determination of diameter of a thin wire by air wedge – diffraction – diffraction of light vs sound – normal incidence – experimental determination of wavelength using diffraction grating (no theory) – polarization – polarization by double refraction – Brewster's law – optical activity – application in sugar industries	**12**
II	**ATOMIC PHYSICS** Atom models – Bohr atom model – mass number – atomic number – nucleons – vector atom model – various quantum numbers – Pauli's exclusion principle – electronic configuration – periodic classification of elements – Bohr magneton – Stark effect –Zeeman effect (elementary ideas only) – photo electric effect – Einstein's photoelectric equation – applications of photoelectric effect: solar cells, solar panels, optoelectric devices	**12**

III	**NUCLEAR PHYSICS** Nuclear models – liquid drop model – magic numbers – shell model – nuclear energy – mass defect – binding energy – radioactivity – uses – half life – mean life - radio isotopes and uses –controlled and uncontrolled chain reaction – nuclear fission – energy released in fission – chain reaction – critical reaction – critical size- atom bomb – nuclear reactor – breeder reactor – importance of commissioning PFBR in our country – heavy water disposal, safety of reactors: seismic and floods –introduction to DAE, IAEA – nuclear fusion – thermonuclear reactions – differences between fission and fusion.	**12**
IV	**INTRODUCTION TO RELATIVITY AND GRAVITATIONALWAVES** Frame of reference – postulates of special theory of relativity – Galilean transformation equations – Lorentz transformation equations – derivation – length contraction – time dilation – twin paradox – mass-energy equivalence – introduction on gravitational waves, LIGO, ICTS opportunities at International Centre for Theoretical Sciences	**12**
V	**SEMICONDUCTOR PHYSICS** p-n junction diode – forward and reverse biasing – characteristic of diode – zener diode – characteristic of zener diode – voltage regulator – full wave bridge rectifier – construction and working – advantages (no mathematical treatment) – USB cell phone charger –introduction to e-vehicles and EV charging stations	**12**
TOTAL		**60**

Self-study	Application in sugar industries; Zeeman effect; nuclear fusion; ICTS opportunities at International Centre for Theoretical Sciences; USB cell phone charger

Textbooks

1. R.Murugesan (2001), Allied Physics,S. Chand &Co, New Delhi.
2. Ubald Raj, A. and Jose Robin, G. 2012. Allied Physics. Indira Publications. Marthandam.

Reference Books

1. Resnick Halliday and Walker (2018), Fundamentals of Physics, 11th Edn., John Willey and Sons, Asia Pvt .Ltd., Singapore.
2. K.Thangaraj and D. Jayaraman(2004), Allied Physics, Popular Book Depot, Chennai.
3. A.Beiser (2003), Concepts of Modern Physics, Tata McGraw Hill Publication, New Delhi.
4. R.Murugesan (2005), Modern Physics, S.Chand&Co, New Delhi.
5. A.Subramaniyam (2001), Applied Electronics, 2nd Edn., National Publishing Co., Chennai.

Web Resources

1. https://www.berkshire.com/learning-center/delta-p-facemask/
2. https://www.youtube.com/watch?v=QrhxU47gtj4
3. https://www.validyne.com/blog/leak-test-using-pressure-transducers/
4. https://www.atoptics.co.uk/atoptics/blsky.htm -
5. https://www.metoffice.gov.uk/weather/learn-about/weather/optical-effects
6. https://www.berkshire.com/learning-center/delta-pfacemask/https://www.youtube.com/watch?v=QrhxU47gtj4
7. https://www.youtube.com/watch?time_continue=318&v=D38BjgUdL5U&feature=emb_log

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOM

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	2	2	2	2
CO2	2	3	3	2	3	2	3	2	3	2
CO3	2	2	2	2	2	3	3	3	2	2
CO4	3	3	2	2	3	2	2	2	2	2
CO5	2	3	2	3	2	2	3	2	2	2
TOTAL	12	14	11	11	13	11	13	11	11	10
AVERAGE	2.4	2.8	2.2	2.2	2.6	2.2	2.6	2.2	2.2	2.0

3 – Strong, 2- Medium, 1- Low

SEMESTER – II

ELECTIVE LAB COURSE - II : ALLIED PHYSICS PRACTICAL FOR MATHEMATICS II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU232EP1	-	-	2	-	2	2	30	25	75	100

Prerequisites:

Basic Knowledge in physics experiments

Learning Objectives:

1. To apply various Physics concepts to understand concepts of Light, electricity and magnetism and waves, set up experimentation to verify theories, quantify and analyze,
1. To able to do error analysis and correlate results

On the successful completion of the course, students will able to:		
1.	understand the nature of monochromatic light and its diffraction and interference phenomenon.	**K2**
2.	able to design simple logic circuits	**K3**
3.	analyze the physical principle involved in the various instruments	**K4**
4.	understand the scientific method and an ability to apply the scientific method in practice.	**K2**

Course Outcomes

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

Contents

(Any Eight Experiments)

1. Radius of curvature of lens by forming Newton's rings
2. Thickness of a wire using air wedge
3. Wavelength of mercury lines using spectrometer and grating
4. Refractive index of material of the lens by minimum deviation
5. Refractive index of liquid using liquid prism
6. Thermal conductivity of poor conductor using Lee's disc
7. Determination of Earth's magnetic field using field along the axis of a coil
8. Determination of AC frequency using sonometer
9. Characterization of Zener diode
10. Construction of Zerner/IC regulated power supply
11. Construction of AND, OR, NOT gates using diodes and transistor
12. NOR gate as a universal building block

Reference Books

1. Ubald Raj, A. and Jose Robin, G. 2012. Allied Physics. Indira Publications. Marthandam.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	3	2	2	2	2	2	3
CO2	2	3	3	2	3	2	3	2	3	2	3
CO3	2	2	2	2	2	3	2	3	2	2	3
CO4	3	3	2	2	3	2	3	2	2	3	3
TOTAL	9	11	9	8	11	9	10	9	9	9	12
AVERAGE	2.25	2.75	2.25	2.0	2.75	2.25	2.5	2.25	2.25	2.25	3.0

3 – Strong, 2- Medium, 1- Low

SEMESTER – II

NON MAJOR ELECTIVE: NME II: PHYSICS OF MUSIC

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU232NM1	2	-	-	-	2	2	30	25	75	100

Pre-requisite:

Students should know about the basic knowledge regarding sound, vibrating systems and musical instruments.

Learning Objectives:

1. To educate and instruct students on the significance of physics in music.
2. To gain understanding of musical notes and instruments.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
1.	understand the principles and basic scientific concepts in sound waves	**K2**
2.	understand the various phenomena of simple vibrating systems.	**K1**
3.	comprehend the various musical notes and its production	**K2**
4.	apply the knowledge of recording music in day to day life activities.	**K3**
5.	know the scientific concepts of music	**K2**

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

Units	Contents	No. of Hours
I	**UNIT I: SCIENTIFIC STUDY OF MUSIC:** vibrations of atoms of matter– vibrations coupling to air – propagation of sound waves in air, other media, fluids & solids – velocity, frequency, wavelength, time period, intensity: definition and unit fs – classification of sound on frequency and velocity– human & animal sound perception– mechanism of ear and hearing – psychoacoustics	**6**
II	**UNIT II: SIMPLE VIBRATING SYSTEMS:** Simple harmonic motion – tuning fork– amplitude, phase, energy, energy loss/damping/ dissipation – power – travelling waves and standing waves– laws of vibration in stretched strings– one-dimensional medium – open and closed organ pipes – over tones, harmonics – quality of sound: pitch, timber, loudness – octaves, musical notes	**6**

III	**UNIT III: MUSICAL TONE:** pure/simple tones – sine/cosine waves– well-defined frequencies, wavelengths, amplitudes & phases– partial tones – assembly of pure tones– mix of different frequencies & amplitudes– complex tone – superposition of simple tones – complex waveform– periodic complex waveform – formants – resonances– sound envelope	**6**
IV	**UNIT IV: PRODUCTION OF MUSICAL SOUNDS:** human voice,mechanism of vocal sound production – larynx (sound box) – stringed Instruments:plucked&bowed, guitar, mandolin, violin, piano, etc. – wind instruments: whistles, flute, saxophone, pipe organ, bag pipes,etc – percussion instruments:plates, membranes,drums, cymbals, xylophone etc. – electronic instruments: keyboards, electric guitars, rhythm pads, etc. – analog and digital sound synthesizers,–MIDI instrument– computer generated music	**6**
V	**UNIT V: RECORDING OF MUSIC & SOUND** Edison phonograph – cylinder & disk records – magnetic wire and tape recorders – digital recording (e.g. to CD, DVD, etc.)– analog transducers, condenser, dynamic microphones, loudspeaker – complex sound fields – near & far fields of acoustic– spectral analysis techniques – continuous & discrete Fourier transforms, digital signal processing – digital filtering – specifications of recording studios	**6**
TOTAL		**30**

Self -Study	Simple tones, frequencies, wavelength, Musical Instruments

Text Books:

1. Harvey White, 2014, Physics and Music: The Science of Musical Sound. Dover Publications Inc, New York.
2. Barry Parker, 2009, Good Vibrations – The Physics of Music.John Hopkins University Press, Baltimore
3. Curt Sachs, 2006, The History of Musical Instruments. Dover Publications Inc, New York
4. Kinko Tsuji and Stefan C. Müller, 2021, Physics and Music: Essential Connections and Illuminating Excursions, Springer Nature, Switzerland.
5. Panos Photinos, 2017, Musical Sounds, Instruments and Equipment, Morgan Claypool Publishers, USA

Reference Books:

1. Gerardin Jayam. 2019. Physics in Everyday Life. Published by the Department of Physics, Holy Cross College (Autonomous), Nagercoil.
2. Ian Johnston, 2009, Measured Tones, 3rd edition, CRC Press, Taylor and Francis Group, New York.
3. Michael J Morovcsik, 2002, Musical Sound, A Solomon Press Book, Kluwer Academic/Plenum Publishers, Moscow.
4. Curt Sachs, 2022, The Rise of Music in the Ancient World: East And West, Gyan Publishing House, New Delhi

Panos Photinos, 2021, The Physics of Sound Waves: Music, Instruments, and Sound Equipment, 2 nd Edition, IOP Publishing Ltd, UK

Web Resources:

1. https://www.britannica.com/science/musical-sound
2. https://blog.landr.com/sound-recording/
3. https://www.britannica.com/topic/music-recording/The-development-of-musicalrecording
4. https://ccrma.stanford.edu/CCRMA/Courses/152/vibrating_systems.html

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	2	3	2	2	2	2
CO2	3	2	1	1	1	2	2	3	2	2	2	2
CO3	3	2	1	1	1	1	2	2	2	2	2	2
CO4	3	3	2	1	1	2	3	3	2	2	2	2
CO5	2	2	2	1	1	2	2	2	2	2	2	2
TOTAL	14	11	7	5	5	9	11	13	10	10	10	10
AVERAGE	2.8	2.2	1.4	1	1	1.8	2.2	2.6	2	2	2	2

3 – Strong, 2- Medium, 1- Low

SEMESTER – II

SKILL ENHANCEMENT COURSE SEC-I –
DIGITAL PHOTOGRAPHY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PU232SE1	2	-	-	-	2	2	30	25	75	100

Prerequisites:

Basic Knowledge in optics and imaging.

Learning Objectives:

1. To understand the principles of photography and image formation and the science and arts behind it.
2. To understand the essential components of conventional and digital cameras and also the different image processing techniques.

Course Outcomes

	On the successful completion of the course, student will be able to:	
1	describe the principle of image formation in Photography	**K2**
2	apply the parameters for controlling the images	**K3**
3	identify different types of camera	**K4**
4	explain the image formation in Digital Photography	**K2**
5	illustrate the digital image – postproduction procedures	**K3**

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

Units	Contents	No. of Hours
I	**PHOTOGRAPHY AND BASIC PRINCIPLE OF IMAGE FORMATION:** Principle –chemical route and digital route –light, wavelengths, colours – shadows – light intensity and distance – making light form images –pin-hole images – practical limitations to pin-hole images – lens instead of pin-hole – focal length and image size – imaging of closer subjects.	**6**
II	**LENSES – CONTROLLING THE IMAGES:** Photographic lens – focal length and angle of view (problems) – focusing movement – aperture and f-numbers (problems) – depth of field– depth of focus – image stabilization – lenses for digital cameras – lens and camera care	**6**
III	**CAMERA USING FILMS AND ITS TYPES:** Camera and its essential components– shutter – aperture – light measurement – film housing – camera types: view camera– view finder camera – Reflex camera– single lens reflex (SLR) camera	**6**
IV	**DIGITAL CAMERAS PRINCIPLE AND TYPES** Principle of digital image capturing –comparison of digital and analog picture information – megapixel – grain, noise and pixel density – optical and digital zooming – image stabilizer – bit depth – white balance – colour modes – file formats (TIFF, RAW & JPEG) – storage cards and types – digital cameras: camera phones – compact camera – hybrid camera – digital SLR.	**6**
V	**THE DIGITAL IMAGE – POSTPRODUCTION** Hardware: computer and its peripherals – software: saving digital file – basic editing: navigating the image – undo/redo/history – crop – rotate – brightness & contrast – colour balance – hue/saturation – dodge/burn – cloning & amp; retouching – removing an element in an image – advanced editing: histogram/levels – curves – selection tools: magic wand – printing digital images: inkjet printer – laser printer – dye sub printer – lambda/ light jet printers.	**6**
TOTAL		**30**

Self-study	Imaging of closer subjects; Lens and camera care; Camera and its essential components; Digital cameras: camera phones;Laser printer

Textbooks:

1. Michel J.Langford, Anna Fox & Richard Sawdon Smith, 2010, Basic Photography, 9th Edition, Focal press, London
2. Henry Carroll. 2014, Read this if you want to take great photographs of people, Laurence King PublishingHouse.

Reference Books:

1. Mark Galer (2006), Digital Photography in Available Light essential skills, Focal press, London
2. Paul Harcourt Davies (2005), The Photographer's practical handbook, UK Press

Web Resources:

1. https://www.accessengineeringlibrary.com/binary/mheaeworks/27573c8a4e04bc1a/1ae690cdd3d5711fdbe6463f02945caf923faf161b30f99e05e9d8f1d5932641/principles-of-photography-and-imaging.pdf?implicit-login=true&sigma-token=AibpD1dgOcmXs4X3fz1ok4_1xmSXEZEQOFzoGKqklE
2. https://www.masterclass.com/articles/basic-photography-101-understandingcamera-lenses
3. https://blog.magnasonic.com/different-film-types-formats-sizes/
4. https://av.jpn.support.panasonic.com/support/global/cs/dsc/knowhow/knowhow01.html
5. https://en.wikibooks.org/wiki/Digital_Photography/Post_Processing

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	2	3	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	2	3	3	3
TOTAL	14	14	15	14	15	15	15	14	14	15	15	15
AVER AGE	2.8	2.8	3	2.8	3	3	3	2.8	2.8	3	3	3

3 – Strong, 2- Medium, 1- Low

Local

National

Regional

Global

Holy Cross College (Autonomous), Nagercoil

Kanyakumari District, Tamil Nadu.
Accredited with A$^+$ by NAAC - IV cycle – CGPA 3.35

Affiliated to
ManonmaniamSundaranar University, Tirunelveli

Semester I& II

Guidelines & Syllabus

DEPARTMENT OF PHYSICS

2023-2026

(With effect from the academic year 2023-2024)

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.

PG 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

PG 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, social and ethical responsibilities leading to sustainable development.	PEO3

PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSO	Upon completion of M.Sc. Physics Degree Programme, the graduates of Physics will be able to:	Mapping with POs
PSO– 1	have well– defined knowledge on theoretical concepts and experimental methods of advanced physics.	PO1 & PO2
PSO– 2	acquire skills in performing advanced physics experiments and projects using modern technology and numerical simulations.	PO3, PO4 & PO5
PSO– 3	develop and communicate analytical skills ranging from nuclear to cosmology to progress in the expanding frontiers of physics.	PO6
PSO– 4	apply and interpret physics principles in various physical observations. Demonstrate proficiency in analyzing, applying and solving Scientific problems.	PO1, PO7
PSO– 5	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

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

PO-PSO mapping

POs	PSO1	PSO2	PSO3	PSO4	PSO5
PO 1	**S**	**S**	**M**	**S**	**M**
PO 2	**S**	**S**	**S**	**S**	**M**
PO 3	**S**	**S**	**S**	**M**	**S**
PO 4	**M**	**M**	**M**	**M**	**S**
PO 5	**S**	**S**	**M**	**M**	**S**
PO 6	**M**	**M**	**M**	**M**	**M**
PO 7	**S**	**S**	**M**	**M**	**S**

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	10x100	1000
Core Practical	4x100	400
Project	1x100	100
Elective courses	4x100	400
Total marks	**19x100**	**1900**

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) + 6 (5) +	85	63
Core Practical	6 (3)	6 (4)	6 (4)	6 (3)		
Elective Course	5 (3)	4 (3) 4 (3)	3(3)		16	12
Core Project				8 (7)	8	7
Skill Enhancement Course		4 (2)	3 (2)	4 (2)	11	6
Internship/ Industrial Activity			(2)		-	2
Extension Activity				(1)	-	1
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	(1)		(1)		2

Courses					
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.

Course Structure

SEMESTER I

Course Code	Title of the Course	Credits	Hours
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	3333 3	3 5
PP231EC2	Elective Course I: b) Crystal Growth and Thin Films		
PP231EC3	Elective Course I: c) Material Science		
Total		**20**	**30**

SEMESTER II

Course Code	Title of the Course	Credits	Hours
PP232CC1	Core Course IV: Statistical Mechanics	5	6
PP232CC2	Core Course V: Quantum Mechanics – I	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
PP233CC1	Core Course VI: Quantum Mechanics – II	5	6
PP233CC2	Core Course VII: Electro Magnet Theory	5	6
PP233CC3	Core Course VIII: Nuclear and Particle Physics	5	6
PP233CP3	Core Lab CourseIII : Numerical Methods and Computer Programming C++	4	6
PP233EC1	Elective Course IV: a)Physics of Nano Science and Technology	3	3
PP233EC2	Elective Course IV: b) Communication Electronics		
PP233EC3	Elective Course IV: c) Advanced Mathematical Physics		
PP233SE1	Skill Enhancement Course II - NME II Sewage and Waste Water Treatment and Reuse	2	3
PP233IS1	Internship/ Industrial Activity	2	-
Total		**26**	**30**

SEMESTER IV

Course Code	Title of the Course	Credits	Hours
PP234CC1	Core Course IX: Spectroscopy	5	6
PP234CC2	Core Course X: Numerical Methods and Computer Programming	5	6
PP234CP4	Core Lab Course IV: Microprocessor and Microcontroller	3	6
PP234PW1	Core Project	7	8
PP234SE1	Skill Enhancement Course III – Solid Waste Management	2	4
PP234EA1	Extension Activity	1	-
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 Course (CEC)	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	PG232V01- PG232V12/ PG234V01- PG234V12	Generic Value-added Course	1+1
		Total	**10**

Specific Value added Course

S. No.	Course code	Title of the course	Total hours
I	PP231V01	Computer Maintenance	30

Examination Pattern

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 3 x 4(Internal choice)	12	Part B 5 x 6 (Internal choice)	30
Part C 3 x 8 (Internal choice)	24	Part C 5 x 12 (Internal choice)	60
Total	**40**	**Total**	100

ii) 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	
Minor Practical / Spotters /Record	75
Total	**75**

iii) Skill Enhancement Course

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

Internal Components and Distribution of Marks

Components	**Marks**
Internal test (2)	10
Quiz (2)	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 5 (Open choice any **Five** out **of Eight**)	25
Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 8 (Open choice any **Five** out **of Eight**)	40
Total	**25**	**Total**	**75**

iv) Internship/ Industrial Activity

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

v) Core 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**

Co-Curricular Courses:

(i) Life Skill Training

Internal Component

Components		Marks
Life Skill Training -I	Album (20 pages)	30
	Group Song, Mime, Skit (Group of 5students)	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
Report & Viva-voce	50

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

Components	**Marks**
Internal	25
External	75

(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**

Outcome Based Education

(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		1	2	1	2	10
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

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.

iv. 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	AAssssssA	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	6	-	-	-	4	5	90	25	75	100

Prerequisites:

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

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

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.	**15**
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 and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders	**15**
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.	**15**
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.	**15**
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.	**15**
TOTAL		**75**

Self-Study	Unit-I- Isomorphism of vector space Unit-II-Harmonic Functions Unit-III -Rank of a Matrix Unit-IV-Vibration of an infinite string Unit-V- One dimensional Green's function

Reference Books:

1. George Arfken and 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. Joshi, A W, 2017, Matrices and Tensors in Physics, (4th Edition Paperback), New Age International Pvt. Ltd, India.
4. Gupta, B.D.2009, Mathematical Physics, (4th edition), Vikas Publishing House, New Delhi.
5. Dass, H. K. and Dr. Rama Verma. (2014). Mathematical Physics, (7th edition), S. Chand & Company Pvt. Ltd., New Delhi.

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	5	-	-	-	4	5	75	25	75	100

Prerequisites:

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:		
CO1	Understand the fundamentals of classical mechanics.	**K2**
CO2	Apply the principles of Lagrangian mechanics to solve the equations of motion of physical systems.	**K3**
CO3	Apply the principles of Hamiltonian mechanics to solve the equations of motion of physical systems.	**K3**
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	**K2, K4**
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	**K2, K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **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.	15
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.	15
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.	15
IV	**Small Oscillations:**Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.	15
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.	15
	Total	75

Self-study	Unit I: Principle of virtual work Unit II: Simple pendulum Unit III: One dimensional simple harmonic oscillator Unit IV: Linear triatomic molecule Unit V: Einstein's mass-energy relation

Reference Books:

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
6. K. R. Symon (1971), *Mechanics*, London: Addison Wesley.
7. S. N. Biswas (1999), *Classical Mechanics*, Kolkata: Books & Allied Ltd,
8. S.L. Gupta, V. Kumar and H.V. Sharma (1998), *Classical Mechanics*, Meerut: PragatiPrakashan Publications
9. Tom W.B. Kibble Frank and H. Berkshire (2004), *Classical Mechanics*, London: Imperial College press
10. 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

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	4	-	-	-	3	4	60	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**:**		
CO1	Remember the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	**K1 & K2**
CO2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	**K2 & K3**
CO3	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**
CO4	Analyzeabout various techniques to develop A/D and D/A converters.	**K4 & K5**
CO5	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.	**12**
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.	**12**

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 astable 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	**12**
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. **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.	**12**
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).	**12**
TOTAL		**60**

Self-study	Unit I: Basic information of Op-Amp 741 Unit II: Square waveform generators Unit III: Schmitt trigger Unit IV: Counter type ADC Unit V: Universal Shift Register

Reference Books:

1. Roy Choudhury, D., Shail Jain, B.2012. Linear Integrated Circuit, (Forth Edition). New Age International Pvt. Ltd., New Delhi, India.
2. Ramakant, A.,Gayakwad. 2012. OP-AMP and Linear Integrated Circuits, ForthEdition).Prentice Hall / Pearson Education, New Delhi, India.
3. Sergio Franco,. 1997, Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi, India.
4. Floyd,.Jain, A.2009. Digital Fundamentals, 8th edition, Pearson Education, New Delhi, India.
5. Vijayendran,V. 2008. Introduction to Integrated electronics (Digital & Analog), S. Viswanathan Printers & Publishers Private Ltd, 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

ELECTIVE 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:		
CO1	**To identify and understand the various forms of renewable and non-renewable energy sources**	**K1 & K2**
CO2	Understand the principle of utilizing the oceanic energy and apply it for practical applications	**K2** & **K3**
CO3	Discuss the working of a windmill and analyze the advantages of wind energy.	**K4**
CO4	Evaluate the aerobic digestion process from anaerobic digestion.	**K5**
CO5	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 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.	**15**
TOTAL		**75**
Self Study	Unit-I -Nuclear energy Unit-II -Energy conversion systems Unit-III - Applications of wind energy Unit-IV -Generation of gas- bio gas from waste fuel Unit-V -Solar cooking	

Reference Books:

1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi.
2. S. Rao and Dr. ParuLekar, Energy technology.
3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983).
4. Solar energy, principles of thermal collection and storage by S. P. Sukhatme, 2nd edition, Tata McGraw-Hill Publishing Co. Lt., New Delhi (1997).
5. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York.
6. Introduction to Non-Conventional Energy Resources -Raja et. al., Sci. Tech Publications

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

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

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 VAPOURGROWTH:**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**

Reference Books:

1. Markov. V, 2004, Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2nd edition)
2. Goswami, 2008, Thin Film Fundamentals, New Age, New Delhi.
3. Heinz K. Henish, 1973, "Crystal Growth in Gels", Cambridge University Press. USA.
4. J.C. Brice, 1986, Crystal Growth Process (John Wiley, New York, 1986)
5. Buckley, H.E, 1951, Crystal Growth, John Wiley and Sons, New York
6. 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 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

Pre requisites:

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:		
CO1	Acquire knowledge on optoelectronic materials	**K1**
CO2	Be able to prepare ceramic materials	**K3**
CO3	Be able to understand the processing and applications of polymeric materials	**K2& K3**
CO4	Be aware of the fabrication of composite materials	**K5**
CO5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	**K1**

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

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	15

	polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.	
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	Unit-I-Inter-band and intra-band transitions Unit-II-Electronic ceramics Unit-III -Viscoelasticity Unit-IV-Fiber reinforced composites Unit-V-Nanomaterials: classification

Reference Books:

1. Jasprit Singh, 2007, Electronic and optoelectronic properties of semiconductor structures. Cambridge University Press, Cambridge.
2. Mallick, P. K., 2008, Fiber-Reinforced Composites, CRC Press.
3. Raghavan, V, 2003, Materials Science and Engineering,(4th Edition), Prentice- Hall India, New Delhi. (For units 2,3,4 and 5)
4. Narula, G.K., Narula, K.S., and Gupta, V.K., 1988. Materials Science. Tata McGraw-Hill.
5. Arumugam, M, 2002, Materials Science, (3rd revised Edition), Anuratha Agencies.

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/
5. 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 – 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:		
CO1	examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	**K1 & K2**
CO2	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**
CO3	distinguish canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	**K3 & K4**
CO4	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**
CO5	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. o Hour
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

SText Books:

1. Sinha, S.K., 2005. Introduction to Statistical Mechanics. Narosa Publishing House, New Delhi, India.
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
   https://en.wikipedia.org/wiki/Ising_model

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**

Pre requisites:

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.

5.

Course Outcomes

On the successful completion of the course, student will be able to:		
CO1	understand the basic postulates of quantum mechanics which serve to formalize the rules of quantum mechanics.	**K1 & K2**
CO2	interpret and relate the Schrodinger equation to solve one dimensional problems and three dimensional problems.	**K2& K3**
CO3	apply and analyze various representations, space time symmetries and formulations of time evolution.	**K3 & K4**
CO4	construct and prioritize the approximation methods for various quantum mechanical problems.	**K4& K5**
CO5	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.

Text Books:

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, India.
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. NouredineZettili, 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.	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**
6.	analyze various parameters related to operational amplifiers.	**K4**
7.	understand the concepts involved in arithmatic and logical circuits using IC's	**K2**
8.	acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	**K3**
9.	analyze the applications of counters and registers	**K4**

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
CO6	2	3	3	2	1	3	1	3	3	1	3	1
CO7	2	3	3	2	1	3	1	3	3	1	3	1
CO8	2	3	3	2	1	3	1	3	3	1	3	1
CO9	2	3	3	2	1	3	1	3	3	1	3	1
TOTAL	18	27	27	18	9	27	9	27	27	9	27	9
AVERAGE	1	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**:**		
CO1	discuss the transverse character of light waves and different polarization phenomenon	**K1**
CO2	discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	**K2**
CO3	demonstrate the basic configuration of a fiber optic – communication system and advantages	**K3, K4**
CO4	identify the properties of nonlinear interactions of light and matter	**K4**
CO5	interpret the group of experiments which depend for their action on an applied magnetics and electric field	**K5**

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

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:		
CO1	gain knowledge about the available analytical and numerical methods to solve various nonlinear systems.	**K1 & K2**
CO2	understand the concepts of different types of coherent structures and their importance in science and technology.	**K2 & K3**
CO3	apply and analyze simple and complex bifurcations and the routes to chaos	**K3 & K4**
CO4	analyze and evaluate the various types of oscillators, chaos and fractals.	**K4 & K5**
CO5	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.

Text Books:

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. Jamshid Ghaboussi, 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 Text book.

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:		
CO1	understand the interconnection of Quantum Mechanics and Special Relativity	**K1**
CO2	enable the students to understand the method of quantization to various field	**K2**
CO3	employ the creation and annihilation operators for quantization	**K5**
CO4	summarizes the interacting field, in quantum domain, and gives a discussion on how perturbation theory is used here.	**K1 & K3**
CO5	understand the concept of Feynman diagram	**K2**

K1 - Remember; **K2** - Understand; **K3** - Apply; **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 Lagrangianand Hamiltonian, Noether's theorem and derivation of energy-momentum and angular momentum tensors as consequence of Poincarésymmetry, 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 –	12

	Hamiltonian and EM field Hamiltonian - Interation of EM fields with matter - Electric field in cavity - Zero point energy -quantization in 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

Text Books:

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**	**PSO 1**	**PSO 2**	**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	Credits	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:		
CO1	learn the fundamentals, production and applications of X-rays.	**K1 & K2**
CO2	understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	**K1 & K2**
CO3	apply knowledge on Radiation Physics	**K2 & K3**
CO4	analyze Radiological imaging and filters	**K3 & K5**
CO5	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

Text Books:

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:		
CO1	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**
CO2	align with the recent advances in semiconductor laser technology combined sensitive spectroscopic detection techniques.	**K2& K3**
CO3	understand principle behind Mossbauer spectroscopy and apply the concepts of isomer shift and quadrupole splitting to analyse molecules.	**K2& K3**
CO4	assimilate this XPES quantitative technique and the instrumentation associated with this, as applied in understanding surface of materials.	**K4& K5**
CO5	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

Text books:

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-XCWRu
5. 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**

Pre requisites:

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 collection, processing and analysis- Scanning tunneling microscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.	**12**
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

Text Books:

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.
4.

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:		
CO1	gained knowledge in fundamental aspects of solar energy utilization	**K1 & K2**
CO2	equipped to take up related job by gaining industry exposure	**K1 & K2**
CO3	develop entrepreneurial skills	**K2 & K3**
CO4	skilled to approach the needy society with different types of solar cells	**K3 & K5**
CO5	gained industrialist mindset by utilizing renewable source of energy	**K5 & K6**

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

Unit	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

	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

AND PROGRAMME SPECIFIC OUTCOMES

3 – Strong, 2- Medium, 1- Low

Local

National

Regional

Global