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.

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 Courses	(1)		(1)		2
Generic Value-Added Courses		(1)		(1)	2
MOOC		(1)		(1)	2
Community Engagement Activity (UBA)		(1)			1

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

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

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: Solar Energy Utilization	2	4
Total		**22**	**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	75
Minor Practical / Spotters /Record	
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	AAA	ABSENT

Overall Performance

CGPA	Grade	Classification of Final Results
9.5-10.0	O+	First Class – Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0and above but below 6.5	A	
5.5and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-appear

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

SEMESTER – I

CORE COURSE I: MATHEMATICAL PHYSICS

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

Pre-requisite:

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

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, student will be able to:		
CO1	understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them.	**K1, K2**
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; **K6**– Create

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

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

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

Text Books:

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

Reference Books:

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

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

CORE COURSE II: CLASSICAL MECHANICS AND RELATIVITY

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

Pre requisites:

Fundamentals of mechanics, Foundation in mathematical methods.

Learning Objectives:

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

Course Outcomes

Upon completion of this course the students will be able to:		
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.	**18**
II	**Lagrangian Formulation:** D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.	**18**
III	**Hamiltonian Formulation:** Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.	**18**
IV	**Small Oscillations:** Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.	**18**
V	**Relativity**: Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations.	**18**
	TOTAL	**90**

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

Text 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

Reference Books:

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

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

CORE COURSE III: LINEAR AND DIGITAL ICS AND APPLICATIONS

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

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

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, student will be able to:		
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	analyze about 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.	**18**
II	**Applications of OP-AMP**: **Linear applications of OP-AMP:** Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters. **Non-linear applications of OP-AMP:** Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.	**18**
III	**Active filters, Timer and Phase locked loops:** **Active filters:** Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. **Timer and Phase locked loops:** Introduction to IC 555 timer, description of functional diagram, monostable and 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	**18**
IV	**Voltage regulator: D to A and A to D converters:** **Voltage regulator:** Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator.	**18**

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

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

Text Books:

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

Reference Books:

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

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

ELECTIVE COURSE I: a) ENERGY PHYSICS

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

Prerequisites:

Knowledge of conventional energy resources

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, students will able to:		
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	Nuclear energy, Energy conversion systems, Applications of wind energy, Generation of gas- bio gas from waste fuel, Solar cooking

Text Books:

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

Reference Books:

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

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

ELECTIVE COURSE I: b) CRYSTAL GROWTH AND THIN FILMS

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

Pre-requisite:

Students should know the Fundamentals of Crystal Physics

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, student will be able to:		
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 VAPOUR GROWTH:** Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.	**15**
IV	**UNIT IV: THIN FILM DEPOSITION METHODS:** Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.	**15**

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

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

Text Books:

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

Reference Books:

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

Web Resources:

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

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong, 2- Medium, 1- Low

SEMESTER – I
ELECTIVE COURSE I: c) MATERIAL SCIENCE

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

Prerequisites:

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

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, students will able to:		
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 polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.	**15**
	NEW MATERIALS: Shape memory alloys: mechanisms of one-way and	

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

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

Text Books:

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

Reference Books:

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

Web Resources :

1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview
2. https://nptel.ac.in/courses/112104229
3. https://archive.nptel.ac.in/courses/113/105/113105081
4. https://nptel.ac.in/courses/113/105/113105025/
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 – I
CORE LAB COURSE I: ADVANCED PHYSICS LAB I

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

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

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, students will able to:		
CO1	understand the strength of material using Young's modulus.	**K2**
CO2	acquire knowledge of thermal behaviour of the matetials.	**K1**
CO3	understand theoretical principles of magnetism through the experiments.	**K2**
CO4	acquire knowledge about the applications of laser	**K1**
CO5	improve the analytical and observation ability in Physics experiments	**K4**
CO6	analyze various parameters related to operational amplifiers.	**K4**
CO7	understand the concepts involved in arithmatic and logical circuits using IC's	**K2**
CO8	acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	**K3**
CO9	analyze the applications of counters and registers	**K 4**

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

Contents

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of Compressibility of a liquid using Ultrasonics
3. Measurement of Conductivity - Four probe method.
4. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
5. Measurement of Susceptibility of liquid - Quincke's method
6. Determine the slit width of a Fraunhofer single, double slit grating.
7. Construction of Schmidt trigger circuit using IC 741
8. Construction of sine wave Triangular wave generator using IC 741
9. Study of Binary to Gray and Gray to Binary code conversion.
10. Study of R-S, clocked R-S and D-Flip flop using NAND gates
11. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
12. Study of Modulus Counter
13. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
14. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
15. Measurement of Coefficient of linear expansion- Air wedge Method

16. Measurement of Band gap energy- Thermistor
17. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
18. Study of J-K, D and T flip flops using IC 7476/7473
19. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
20. Study of Arithmetic logic unit using IC 74181.
21. Construction of Encoder and Decoder circuits using ICs.

Text 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. Kuriachan T.D and Syam Mohan,2010, Electronic lab manual Vol II, Ayodhya Publishing, India.

Reference Books:

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

SEMESTER I
SPECIFIC VALUE ADDED COURSE
COMPUTER MAINTENANCE

Course Code	Credits	Total Hours	Total Marks
PP231V01	**1**	**30**	**100**

Learning Objectives

(i). Students will be able to analyse problems associated with PC components and provide solutions to troubleshoot and isolate the problems.

(ii). Students will be able to identify early detection of issues

(iii) Students will be able to prevent Viruses and Malware and Speed up their Computer

COs	Upon completion of this course, students will be able to:	
CO- 1	understand the basic components of a computer	**K1**
CO- 2	install different types of operating systems	**K2**
CO- 3	to assemble and disassemble a personal computer	**K3**
CO- 4	to troubleshoot the problems	**K3**

Unit I: Computer Hardware

Introduction to Computer Hardware - Parts of Computer - Motherboard: Block Diagram- Types -Identification of Ports, Chip, Slot, Connector - Computer Assembling & Dissembling - How to Upgrade Computer.

Unit II: Computer Software

Introduction to windows, Identification of windows - Windows Installation (win 7, 8, & 10) without data loss - Driver Installation (offline / online) - Software Installation - Hard Disk Partition - Windows Backup & Restore

Unit III: Soldering and Desoldering

Removing component from motherboard - Fixing component from motherboard - Changing Port & Slot from motherboard - Removing& fixing all ICs from motherboard

Unit IV: Fault Finding and Repairing in External Hardware

Keyboard Problem - Mouse Problem- Battery Problem - Overheating Problem - Hard Disk Problem - USB Problem - LAN Problem - Monitor Problem - Display White Problem - Blue Screen Problem - Shorting Problem

Unit V: Fault Finding and Repairing ComputerInternal

Windows Problem - Software Problem - Network Problem - Virus Problem – Antivirus - RAM Problem - Slow Working Problem - Hang Problem – Restart Problem - Control Panel Setting- Data recovery -Password Breaking

Benefit and Outcome

Students would become capable to process and monitors the system's capability to deliver services, records problems for analysis, takes corrective, adaptive, perfective, and preventive actions, and confirms restored capability.

Reference Books

1.Upgrading and Repairing PCs 22nd Edition, First Edition (2017), Scott Muelle, McGraw Hill Education

2.Simple Practical Hacks to Optimize, Speed Up and Make Computer Faster (2019), Hack, Khanna Publishers

3.A Simple Guide to Computer Maintenance and Troubleshooting First Edition (2019),AdaneNegaTarekegn, AlemuKumilachewTegegne, McG

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. of Hours
I	**PHASE TRANSITIONS** Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications - Third law of Thermodynamics: Nernst Heat Theorem. Order parameters - Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis: Scaling Hypothesis - Universality of Critical Behaviour- Law of Corresponding states.	**18**
II	**STATISTICAL MECHANICS AND THERMODYNAMICS** Foundations of statistical mechanics - Specification of states of a system: Microscopic and Macroscopic States - Phase space – Liouville's theorem- Microcanonical ensemble: Isolated systems- Microcanonical distribution- Principle of Equal a Priori Probabilities - Entropy - Connection between statistics and thermodynamics - Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.	**18**
III	**CANONICAL AND GRAND CANONICAL ENSEMBLES** Canonical and grand canonical ensembles: Systems at fixed temperature- Systems with fixed chemical potential- Trajectories and density of states: Canonical and Grand Canonical distribution - Equipartition theorem –Quantum Canonical	**18**

	Partition function - Calculation of statistical quantities –Free energy of an ideal gas- Thermodynamic functions- Energy and density fluctuations.	
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

Text 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

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

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, student will be able to:		
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 II: 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	**12**

	Optical Computing- Photo-Refractive Materials and the Manakov Equation - Soliton Solutions and Shape Changing Collisions -Optical Soliton Based Computation.	
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. JamshidGhaboussi, Michael F Insana, 2017. Understanding Systems A Grand Challenge for 21st Century, World Scientific Publishing Co Pte Ltd, India.
2. Carla M.A. Pinto, 2022. Nonlinear Dynamics and Complexity Mathematical Modelling of Real-World Problems, Springer, Berlin ,Hieldelberg.
3. Albert C. J. Luo, 2019. Bifurcation &Stability in Nonlinear Dynamical Systems, Springer, Berlin , Hieldelberg.
4. PawełOlejnik, Jan Awrejcewicz and Michal Fečkan, 2017. Modeling, Analysis and Control of Dynamical Systems With Friction and Impacts, World Scientific Publishing Co Pte Ltd, India.
5. Amon, Axelle and Lefranc,Marc.,2023.Nonlinear Dynamics,Berlin, Boston: De Gruyter 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 Lagrangian and Hamiltonian, Noether's theorem and derivation of energy-momentum and angular momentum tensors as consequence of Poincaré symmetry, internal symmetry and the associated conserved current - Wilson's Approach to Field Theories – Renormalization Group Flow.	**12**
II	**Quantization Of Klein-Gordan Field** Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, definition of the vacuum and N-particle eigenstates of the Hamiltonian, vacuum expectation values, propagators, spin and statistics of the KG quantum - Particle creation by a classical source - The Casimir effect – Casimir force - Fields as operator-valued distributions.	**12**
III	**Quantization of Dirac Field** Review of Dirac equation and its quantization, use of anti-commutators, creation and destruction operators of particles and antiparticles, Dirac propagator, energy, momentum and angular momentum, spin and statistics of Dirac quanta - Dirac matrices - Dirac bilinear operators - Lorentz transformations for spin-½ particles and fields - Discrete symmetries of the Dirac field – Degrees of divergences – Cancellation of divergences.	**12**
IV	**Quantization of Electromagnetic Fields** Classical Electromagnetic field - Review of free Maxwell's equations – Normal modes – B field –Lagrangian -gauge transformation and gauge fixing –Hamiltonian and EM field Hamiltonian - Interation of EM fields	**12**

	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	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	1	3	3	2	2	3	2	2	1	3
CO2	3	1	2	1	1	2	3	1	3	3	2	1
CO3	2	3	2	3	3	3	2	3	2	2	2	3
CO4	2	3	2	3	3	2	3	3	2	3	1	3
CO5	2	3	3	3	3	3	2	3	2	2	2	3
TOTAL	11	13	10	13	13	12	12	13	11	12	8	13
AVERAGE	2.2	2.6	2	2.6	2.6	2.4	2.4	2.6	2.2	2.4	1.6	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER – II

ELECTIVE COURSE III: a) MEDICAL PHYSICS

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

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

Learning Objectives:

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

Course Outcomes

On the successful completion of the course, student will be able to:		
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-XCWRu5.https://serc.carleton.edu/research_education/geochemsheets/techniques/mossbauer.html.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong, 2- Medium, 1- Low

SEMESTER – II

ELECTIVE COURSE III: c) CHARACTERIZATION OF MATERIALS

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

Prerequisites:

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

Learning Objectives:

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

Course Outcomes

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

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

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

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 AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong, 2- Medium, 1- Low

SEMESTER – I & II
LIFE SKILL TRAINING – I ETHICS

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

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

Learning Objectives

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

Course Outcomes	On completion of this course the student will be able to	
CO1	understand deeper insight of the meaning of their existence.	K1
CO2	recognize the philosophy of life and individual qualities	K2
CO3	acquire the skills required for a successful personal and professional life.	K3
CO4	develop as socially responsible citizens.	K4
CO5	create a peaceful, communal community and embrace unity.	K3

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

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

Textbooks

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

Reference Books

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

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

Web Resources

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