M.Sc., PHYSICS

Syllabus

Program Code: PPH

2023-2024 onwards

MANNAR THIRUMALAI NAICKER COLLEGE

(AUTONOMOUS)

Re-accredited with "A" Grade by NAAC

PASUMALAI, MADURAI – 625 004

GUIDLINESS FOR OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM

(FOR PG PROGRAM FROM 2023 -2024 ONWARDS)

ELIGIBILITY CONDITION FOR ADMISSION

For admission to Post Graduate Programmers (P.G) a candidate should have passed the 3years degree course (under 10 + 2 + 3 pattern) recognized by the university as equivalent there to.

DURATION

Two years. Each year consists of 2 semesters. The duration of a semester is 90 working days.

ATTENDANCE

75% of the classes in each semester shortage of attendance can be condoned as per existing university rules.

EVALUATION PROCEDURE:

A mark Statement with CGPA = $\frac{\sum(MarksXcredits)}{\sum(Credits)}$

Where the summations are over all paper appeared up to the current semester.

Examinations: 3 hours duration.

Total marks 100 for all papers

External Internal ratio 75:25 with 2 Internal tests.

Subjects of Study

The courses offered under the PG programs belong to the following categories:

1. Core Subjects
2. Electives
3. Non Major Electives (NME)
4. Skill Enhancement course

CBCS COURSE STRUCTURE - PG COURSES

M.A. (Tamil) - M.A. (English) – M.Com. – M.Com (CA) – M.S.W. M.Sc. (Mathematics) - M.Sc. (CS) - M.Sc. (CS&IT)

Semester–I	**Credit**	**Semester-II**	**Credit**	**Semester-III**	**Credit**	**Semester–IV**	**Credit**
1.1. Core-I	4	2.1. Core-IV	4	3.1. Core-VII	4	4.1. Core-X	4
1.2 Core-II	4	2.2 Core-V	4	3.2 Core-VII	4	4.2 Core-XI	4
1.3 Core – III	4	2.3 Core – VI	4	3.3 Core – IX	4	4.3 Core – XII	4
1.4 Elective (Generic / Discipline Centric)- I	3	2.4 Elective (Generic / Discipline Centric) – III	3	3.4 Elective (Generic / Discipline Centric) – V	3	4.4 Elective (Generic / Discipline Centric) – VI	3
1.5 Elective (Generic / Discipline Centric)-II	3	2.5 Elective (Generic / Discipline Centric)-IV	3	3.5 Core Industry Module	3	4.5 Project with Viva-Voce	3
1.6Ability Enhancement Course- Soft Skill -1	2	2.6 Ability Enhancement Course - Soft Skill -2	2	3.6 Ability Enhancement Course- Soft Skill -3	2	4.6 Ability Enhancement Course- Soft Skill -4	2
Skill Enhancement Course SEC 1	2	2.7 Skill Enhancement Course SEC 2	2	3.7 Skill Enhancement Course – Term Paper and Seminar Presentation SEC 3	2	4.7 Skill Enhancement Course - Professional Competency Skill	2
				3.8 Internship/ Industrial Activity	2	4.8 Extension Activity	1
	22		**22**		**24**		**23**
						Total Credit Points	**91**

QUESTION PAPER PATTERN FOR THE CONTINUOUS INTERNAL ASSESSMENT

Note: Duration – 1 hour 30 minutes

The components for continuous internal assessment are:

Part –A

Four multiple choice questions (answer all)	4 x01= 04 Marks

Part –B

Two questions (‘either …. or ‘type)	2 x 05=10 Marks

Part –C

Two questions (‘either …. or ‘type)	2 x 08=16 Marks

Total	40 Marks

The components for continuous internal assessment are:

(40 Marks of two continuous internal assessments will be converted to 15 marks)

Two tests and their average	--15 marks
Seminar /Group discussion	--5 marks
Assignment	--5 marks

Total	25 Marks

OUTCOME BASED EDUCATION

1. Course is defined as a theory, practical or theory cum practical subject studied in a semester. For e.g. Computer Applications Management

2. Course Outcome (CO) Course outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Outcomes may be specified for each course based on its weightage.

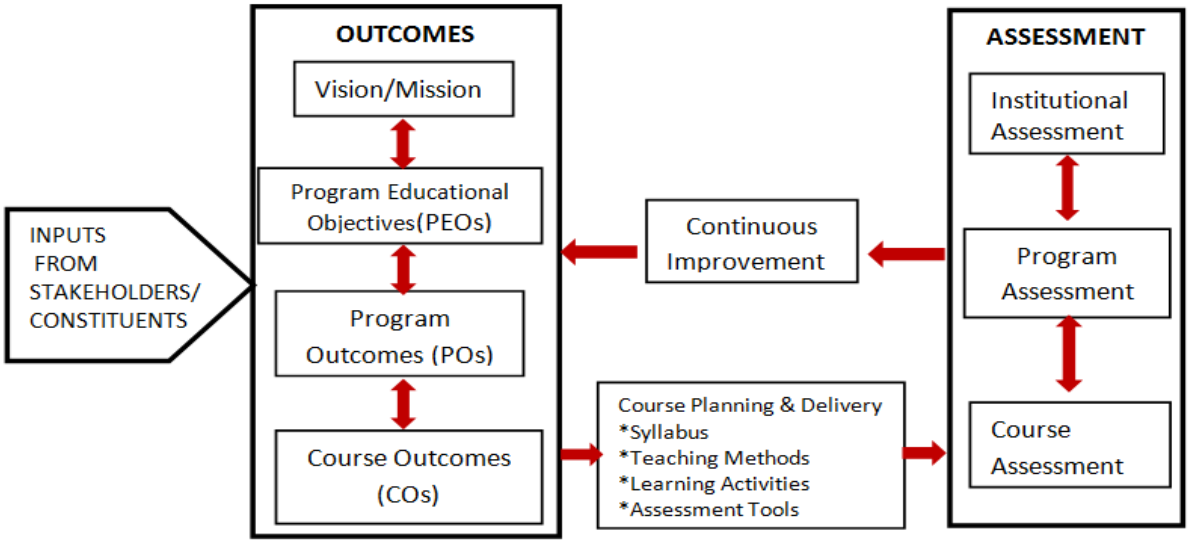
3. Program is defined as the specialization or discipline of a Degree. It is the interconnected arrangement of courses, co-curricular and extracurricular activities to accomplish predetermined objectives leading to the awarding of a degree.

4. Program Outcomes (POs) Program outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be Guidelines for Outcome Based Education System 4 aligned closely with Graduate Attributes.

5. Program Educational Objectives (PEOs) of a program are the statements that describe the expected achievements of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after graduation.

6. Program Specific Outcomes (PSO) are what the students should be able to do at the time of graduation with reference to a specific discipline. Usually there are two to four PSOs for a Program.

7. Graduate Attributes (GA): The graduation attributes, are exemplars of the attributes expected of a graduate from a Program



INSTITUTIONAL VISION

To Mould the learners into accomplished individuals by providing them with a stimulus for social change through character, confidence and competence.

INSTITUTIONAL MISSION

1. Enlightening the learners on the ethical and environmental issues.

2. Extending holistic training to shape the learners in to committed and competent citizens.

3. Equipping them with soft skills for facing the competitive world.

4. Enriching their employability through career oriented courses.

5. Ensuring accessibility and opportunity to make education affordable to the underprivileged.

Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising mathematical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced mathematical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Mathematics based problem solving skills are included as mandatory components in the ‘Training for Competitive Examinations’ course at the final semester, a first of its kind.

- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Industrial Statistics course is newly introduced in the fourth semester, to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest - Artificial Intelligence.

MANNAR THIRUMALAI NAICKER COLLEGE (AUTONOMOUS),
MADURAI – 625 004
M. SC PHYSICS CURRICULUM
(For the student admitted during the academic year 2023-2024 onwards)

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
FIRST SEMESTER						
Part – III	**Core Courses**					
23PPHCC11	MATHEMATICAL PHYSICS	6	5	25	75	100
23PPHCC12	CLASSICAL MECHANICS	6	5	25	75	100
23PPHCP11	PRACTICAL - I	6	4	25	75	100
Part – III	**Elective Courses**					
23PPHEC11	PHYSICS OF NANO SCIENCE AND TECHNOLOGY	6	3	25	75	100
23PPHEC12	LINEAR AND DIGITAL ICS AND APPLICATIONS	6	3	25	75	100
	Total	30	20	125	375	500
SECOND SEMESTER						
Part – III	**Core Courses**					
23PPHCC21	STATISTICAL MECHANICS	6	5	25	75	100
23PPHCC22	QUANTUM MECHANICS – I	6	5	25	75	100
23PPHCP21	PRACTICAL – II	6	4	25	75	100
Part – III	**Elective Courses**					
23PPHEC21	ADVANCED OPTICS	5	3	25	75	100
23PPHEC22	MEDICAL PHYSICS	5	3	25	75	100
Part – IV	**Skill Enhancement course**					
23PPHSC21	SOFT SKILL - I	2	2	25	75	100
	Total	30	22	150	450	600


FIRST SEMESTER

Course Name	MATHEMATICAL PHYSICS			
Course Code	23PPHCC11	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

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

UNIT - I LINEARVECTOR SPACE 17

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.

UNIT - II COMPLEXANALYSIS 19

Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable- Differentiability - Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders.

UNIT - III MATRICES 17

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.

UNIT - IV	FOURIERTRANSFORMS &LAPLACETRANSFORMS	19

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.

UNIT - V	DIFFERENTIAL EQUATIONS	18

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.

Total Lecture Hours	**90**

BOOKS FOR STUDY:

- George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
- P.K. Chattopadhyay, 2013, *Mathematical Physics* (2nd edition), New Age, New Delhi
- A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt. Ltd., India.
- B. D. Gupta, 2009, *Mathematical Physics* (4th edition), Vikas Publishing House, New Delhi.
- H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.

BOOKS FOR REFERENCES:

- E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,
- D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.
- S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York 3. E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.
- P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated East West, New Delhi
- C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York

WEB RESOURCES:

- **www.khanacademy.org**
- **https://youtu.be/LZnRlOA1_2I**
- **http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath**
- **https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qa**

❖ **https://archive.nptel.ac.in/courses/115/106/115106086/**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change	**60**	No Changes Made		New Course			
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**								

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students 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 to K5**
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.	**K1 to K5**
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	**K1 to K5**
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	**K1 to 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	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

3- STRONG **2 – MEDIUM** **1 - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	3	3	3	2	3	2
CO 2	2	3	3	3	3	3	3	2	2	2
CO 3	3	3	3	2	2	3	3	2	3	2

CO 4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**
CO 5	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**3**
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

UNIT	Mathematical Physics	HRS	PEDAGOGY
I	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	**17**	**Chalk &Talk, PPT, Seminar**
II	Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders	**19**	**Chalk &Talk, PPT**
III	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.	**17**	**Chalk &Talk, Assignment**
IV	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	**19**	**Chalk &Talk, Group discussion**

	functions - Application - Laplace equation: Potential problem in a semi - infinite strip.		
V	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.	**18**	**Seminar, PPT, Chalk &Talk**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K2, K2)
	CO2	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K3, K3)
CI AII	**CO3**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K3, K3)
	CO4	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.57	
	K2	2	10	16	28	50	
	K3		10	16	26	46.43	53.57
	K4						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.57	
	K2	2	10		12	21.43	
	K3		10	16	26	46.43	25
	K4			16	16	28.57	71.43
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K2, K2)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
3	CO3	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K3, K3)
4	CO4	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
5	CO5	K1 to K5	2	K1, K2	2 (K4, K4)	2 (K5, K5)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.57**	**-**
K2	**5**	**20**	**16**	**41**	**29.29**	
K3		**20**	**32**	**52**	**37.14**	**32.86**
K4		**10**	**16**	**26**	**18.57**	**70**
K5			**16**	**16**	**11.43**	**88.57**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions			**PART – A**	**(10 x 1 = 10 Marks)**	
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions **PART – B**				**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K4**	
		OR		
15. b)	**Unit - V**	**CO5**	**K4**	

Answer **ALL** the questions **PART – C(5 x 8 = 40 Marks)**				
16. a)	**Unit - I**	**CO1**	**K2**	
		OR		
16. b)	**Unit - I**	**CO1**	**K2**	
17. a)	**Unit - II**	**CO2**	**K3**	
		OR		
17. b)	**Unit - II**	**CO2**	**K3**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K5**	
		OR		
20. b)	**Unit - V**	**CO5**	**K5**	

Course Name	CLASSICAL MECHANICS			
Course Code	23PPHCC12	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

- To understand fundamentals of classical mechanics.
- To understand Lagrangian formulation of mechanics and apply it to solve equation of motion.
- To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion.
- To discuss the theory of small oscillations of a system.
- To learn the relativistic formulation of mechanics of a system.

UNIT - I PRINCIPLES OFCLASSICAL MECHANICS 17

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.

UNIT - II LAGRANGIAN FORMULATION 17

D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.

UNIT - III HAMILTONIAN FORMULATION 19

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.

UNIT - IV SMALL OSCILLATIONS 17

Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.

UNIT - V CANONICAL TRANSFORMATIONS 20

The equations of canonical transformation-Examples of canonical transformations-The harmonic oscillator-The simplistic approach to canonical transformations-Poisson brackets and other canonical invariants-Equation of motion, infinitesimal canonical transformations, and conservation theorems in the Poisson Bracket formulation- The angular momentum Poisson bracket relations, symmetry groups in mechanical systems-Liouville's theorem.

Total Lecture Hours 90

BOOKS FOR STUDY:

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

BOOKS FOR REFERENCES:

- K. R. Symon, 1971, Mechanics, Addison Wesley, London.
- S. N. Biswas, 1999, Classical Mechanics, Books & Allied, Kolkata.
- Gupta and Kumar, Classical Mechanics, KedarNath.
- T.W.B. Kibble, Classical Mechanics, ELBS.
- Greenwood, Classical Dynamics, PHI, New Delhi.

WEB RESOURCES:

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

Nature of Course	EMPLOYABILITY			SKILL ORIENTED	✓	ENTREPRENEURSHIP				
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓		
Changes Made in the Course	Percentage of Change	**60**		No Changes Made		New Course				

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the fundamentals of classical mechanics.	K1 to K5
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K1 to K5
CO3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	K1 to K5
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	K1 to K5
CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

3- STRONG 2 – MEDIUM 1 - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	3	3	3	2	3	2
CO 2	2	3	3	3	3	3	3	2	2	2
CO 3	3	3	3	2	2	3	3	2	3	2
CO 4	3	3	3	3	2	3	3	2	2	2
CO 5	3	2	3	3	2	3	3	2	2	2
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

UNIT	CLASSICAL MECHANICS	HRS	PEDAGOGY

I	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.	**17**	**Chalk &Talk, PPT, Seminar**
II	D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.	**17**	**Chalk &Talk, PPT**
III	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.	**19**	**Chalk &Talk, Assignment**
IV	Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.	**17**	**Chalk & Talk, Assignment**
V	The equations of canonical transformation-Examples of canonical transformations-The harmonic oscillator-The simplistic approach to canonical transformations-Poisson brackets and other canonical invariants-Equation of motion, infinitesimal canonical transformations, and conservation theorems in the Poisson Bracket formulation- The angular momentum Poisson bracket relations, symmetry groups in mechanical systems-Liouville's theorem.	**20**	**Seminar, PPT, Chalk &Talk**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	**CO1**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K2, K2)
	CO2	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K3, K3)
CI AII	**CO3**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K3, K3)
	CO4	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.57	
	K2	2	10	16	28	50	
	K3		10	16	26	46.43	53.57
	K4						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.57	
	K2	2	10		12	21.43	
	K3		10	16	26	46.43	25
	K4			16	16	28.57	71.43
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K2, K2)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
3	CO3	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
4	CO4	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K5, K5)
5	CO5	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K3, K3)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.57**	
K2	**5**	**20**	**16**	**41**	**29.29**	
K3		**30**	**32**	**62**	**44.28**	**32.86**
K4			**16**	**16**	**11.43**	**77.14**
K5			**16**	**16**	**11.43**	**88.57**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions **PART – B**				**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K3**	
		OR		
13. b)	**Unit - III**	**CO3**	**K3**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K2**	
		OR		
15. b)	**Unit - V**	**CO5**	**K2**	

Answer **ALL** the questions **PART – C(5 x 8 = 40 Marks)**				
16. a)	**Unit - I**	**CO1**	**K2**	
		OR		
16. b)	**Unit - I**	**CO1**	**K2**	
17. a)	**Unit - II**	**CO2**	**K3**	
		OR		
17. b)	**Unit - II**	**CO2**	**K3**	
18. a)	**Unit - III**	**CO3**	**K4**	
		OR		
18. b)	**Unit - III**	**CO3**	**K4**	
19. a)	**Unit - IV**	**CO4**	**K5**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K5**	
20. a)	**Unit - V**	**CO5**	**K3**	
		OR		
20. b)	**Unit - V**	**CO5**	**K3**	

Course Name	PRACTICAL - I			
Course Code	23PPHCP11	**L**	**P**	**C**
Category	CORE	-	6	4

COURSE OBJECTIVES:

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

Course Details

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of Viscosity of the given liquid – Meyer's disc
3. Measurement of Coefficient of linear expansion- Air wedge Method
4. B-H loop using Anchor ring.
5. Determination of Thickness of the enamel coating on a wire by diffraction
6. Determination of Rydberg's Constant - Hydrogen Spectrum
7. FP Etalon
8. Determination of Thickness of air film. - Solar spectrum – Hartmann's formula. Edser and Butler fringes.
9. Measurement of Band gap energy- Thermistor
10. Determination of Planck Constant – LED Method
11. Determination of Specific charge of an electron – Thomson's method.
12. Determination of Compressibility of a liquid using Ultrasonics
13. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer
14. GM counter – Characteristics, inverse square law and absorption coefficient.
15. Measurement of Conductivity - Four probe method.
16. Arc spectrum – Iron.
17. Molecular spectra – AlO band.
18. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.

19. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
20. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
21. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench
22. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient
23. Construction of relaxation oscillator using UJT
24. FET CS amplifier- Frequency response, input impedance, output impedance
25. Study of important electrical characteristics of IC741.
26. V- I Characteristics of different colours of LED.
27. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
28. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
29. Constructions of Schmidt trigger circuit using IC 741 for a given hysteresis- application as squarer.
30. Construction of square wave Triangular wave generator using IC 741
31. Construction of a quadrature wave using IC 324
32. Construction of pulse generator using the IC 741 – application as frequency divider
33. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
34. Study of Binary to Gray and Gray to Binary code conversion.
35. Study of R-S, clocked R-S and D-Flip flop using NAND gates
36. Study of J-K, D and T flip flops using IC 7476/7473
37. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
38. Study of Arithmetic logic unit using IC 74181.
39. Construction of Encoder and Decoder circuits using ICs.

BOOKS FOR STUDY:

- Practical Physics, Gupta and Kumar, PragatiPrakasan.
- Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences.
- Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi.
- Electronic lab manual Vol I, K ANavas, Rajath Publishing.
- Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition.

BOOKS FOR REFERENCES:

- Advanced Practical Physics, S.P Singh, PragatiPrakasan.
- An advanced course in Practical Physics, D. Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd
- Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
- A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd.
- Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.

WEB RESOURCES:

- **https://unacademy.com/content/upsc/study-material/physics/shapes-of-interference-fringes-in-youngs-double-slit-experiment/**
- **https://www.teachspin.com/diode-laser-spectroscopy**
- **https://vikramlearning.com/jntuh/notes/electronic-circuits-and-pulse-circuits-lab/ujt-relaxation-oscillator/280**
- **https://www.geeksforgeeks.org/4-bit-binary-adder-subtractor/**
- **https://he-coep.vlabs.ac.in/exp/decoders-encodersmultiplexer-demultiplexer/theory.html**

Nature of Course	EMPLOYABILITY		✓	SKILL ORIENTED			ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL			GLOBAL		✓
Changes Made in the Course	Percentage of Change		**90**	No Changes Made			New Course			
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**										

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the strength of material using Young's modulus.	K1 to K5
CO2	Acquire knowledge about arc spectrum and applications of laser	K1 to K5
CO3	Conduct experiments on applications of UJT and arithmetic and logical circuits using IC's	K1 to K5
CO4	Analyze various parameters related to operational amplifiers.	K1 to K5
CO5	Improve the analytical and observation ability in Physics Experiments	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2

3- STRONG 2 – MEDIUM 1 - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

Experiments	PRACTICAL - I	HRS	PEDAGOGY
1 to 4	Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.	30	Chalk & Talk, PPT

	Measurement of Conductivity - Four probe method. Construction of relaxation oscillator using UJT.		
5 to 8	Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp. Construction of square wave Triangular wave generator using IC 741. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type).	**30**	**Chalk & Talk, PPT**
9 to 12	Study of Binary to Gray and Gray to Binary code conversion. Study of R-S, clocked R-S and D-Flip flop using NAND gates. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction. Construction of Encoder and Decoder circuits using ICs.	**30**	**Chalk & Talk, PPT**

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total
25	75	100

Record Note and Attendance -10 mark
Model examination - 15 mark

Total CIA - 25 mark

Model examination should be conducted for 30 mark and it has to be converted to 15 mark

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)				
Internal	**Cos**	**K Level**	**No. of. Questions**	**K - Level**
CIA-I	**CO1 – CO5**	**K1 – K5**	**1 Question for Each Student**	**K1 – K5**
Question Pattern CIA - I		**No. of Questions to be asked**	**1 Question for Each Student**	
		No. of Questions to be answered	**1**	
		Marks for each question	**30**	
		Total Marks for each section	**30**	

Distribution of Marks with COs &K Level for Correction of CIA I					
	COs	**K - Level**	**Distribution of the work of the experiment**	**K - Level**	**MARKS**
CIA I	**CO1**	**K1 to K5**	Aim and apparatus	**K1**	**2.0**
	CO2	**K1 to K5**	Formula and Tabular Column	**K3**	**5.0**
	CO3	**K1 to K5**	Understanding and Observation	**K5**	**10.0**
	CO4	**K1 to K5**	Calculation and Graph	**K4**	**10.0**
	CO5	**K1 to K5**	Interpretation of result	**K2**	**3.0**
	Total Marks				**30**

Distribution of Marks with K Level CIA I					
	K Level	**Distribution of the work of the experiment**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	K1	Aim and apparatus	2	6.67	-
	K3	Formula and Tabular Column	5	16.67	
	K5	Understanding and Observation	10	33.33	**23.34**
	K4	Calculation and Graph	10	33.33	**56.67**
	K2	Interpretation of result	3	10.00	**90.00**
	Marks		**30**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

K5 – Evaluating, interpreting and concluding the results with accurate measurements**.**

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)			
COs	**K - Level**	**No. of Questions**	**K – Level**
CO1- CO5	**K1 – K5**	**1** Question for Each Student	**K1 – K5**
No. of Questions to be Asked		**1** Question for Each Student	
No. of Questions to be answered		**1**	
Marks for each question		**75**	
Total Marks for each section		**75**	

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)			
COs	**K - Level**	**No. of Questions**	**K – Level**
CO1- CO5	**K1 – K5**	**1** Question for Each Student	**K1 – K5**
No. of Questions to be Asked		**1** Question for Each Student	
No. of Questions to be answered		**1**	
Marks for each question		**75**	
Total Marks for each section		**75**	

Distribution of Marks with K Level				
K Level	**Parameters for K-Level**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**Aim and apparatus**	**10**	**13.33**	**13**
K3	**Formula and Tabular Column**	**15**	**20**	**20**
K5	**Understanding and Observation**	**30**	**40**	**40**
K4	**Calculation and Graph**	**15**	**20**	**20**
K2	**Interpretation of result**	**5**	**6.67**	**7**
Marks		**75**	**100**	**100**

Course Name	PHYSICS OF NANOSCIENCE AND TECHNOLOGY			
Course Code	23PPHEC11	**L**	**P**	**C**
Category	ELECTIVE	6	-	3

COURSE OBJECTIVES:

- Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale.
- To provide the basic knowledge about nanoscience and technology.
- To learn the structures and properties of nanomaterials.
- To acquire the knowledge about synthesis methods and characterization techniques and its applications.

UNIT – I FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY 17

Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.

UNIT - II PROPERTIES OF NANOMATERIALS 19

Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).

UNIT - III SYNTHESIS AND FABRICATION 17

Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography –Nanomanipulator.

UNIT - IV CHARACTERIZATION TECHNIQUES 18

Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

UNIT - V APPLICATIONS OF NANOMATERIALS 19

Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters –Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors-photovoltaics.

Total Lecture Hours 90

BOOKS FOR STUDY:

- A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).
- Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
- Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
- Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).
- Nanotechnology and Nanoelectronics, D.P. Kothari,V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt. Ltd, New Delhi. (2018).

BOOKS FOR REFERENCES:

- E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,
- D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.
- S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York 3. E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.
- P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated East West, New Delhi.
- C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York

WEB RESOURCES:

- **www.khanacademy.org**
- **https://youtu.be/LZnRlOA1_2I**
- **http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath**
- **https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qa**
- **https://archive.nptel.ac.in/courses/115/106/115106086/**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP		✓			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL			GLOBAL	✓			
Changes Made in the Course	Percentage of Change		**60**	No Changes Made			New Course					
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**												

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the basic of Nano science and explore the different types of nanomaterial's and should comprehend the surface effects of the nanomaterial's.	K1 to K5
CO2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterial's.	K1 to K5
CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterial's.	K1 to K5
CO4	Analyze the various characterizations of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	K1 to K5
CO5	Apply the concepts of Nano science and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

3- STRONG **2 – MEDIUM** **1 - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	2	1	1	3	3	3	3
CO 2	3	3	3	2	1	1	3	3	3	3
CO 3	3	3	2	2	1	1	3	3	3	3
CO 4	3	3	3	2	1	1	3	3	3	3
CO 5	3	3	2	2	1	1	3	3	3	3
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

UNIT	PHYSICS OF NANOSCIENCE AND TECHNOLOGY	HRS	PEDAGOGY
I	Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.	17	Chalk &Talk, PPT, Seminar

II	Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).	**19**	**Chalk &Talk, PPT**
III	Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nanomanipulator.	**17**	**Chalk &Talk, Assignment**
IV	Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.	**18**	**Chalk & Talk, Assignment**
V	Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.	**19**	**Chalk & Talk, Seminar**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K3, K3)
	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
CI AII	CO3	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K3, K3)
	CO4	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.57	-
	K2	2	10		12	21.43	
	K3		10	16	26	46.43	25
	K4			16	16	28.57	71.43
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.57	-
	K2	2	10		12	21.43	
	K3		10	16	26	46.43	25
	K4			16	16	28.57	71.43
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K – LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K3, K3)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
3	CO3	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K3, K3)
4	CO4	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
5	CO5	K1 to K5	2	K1, K2	2 (K4, K4)	2 (K5, K5)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.57**	**-**
K2	**5**	**20**		**25**	**17.86**	**-**
K3		**20**	**32**	**52**	**37.14**	**21.43**
K4		**10**	**32**	**42**	**30**	**58.57**
K5			**16**	**16**	**11.43**	**88.57**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions **PART – B**				**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K4**	
		OR		
15. b)	**Unit - V**	**CO5**	**K4**	

Answer **ALL** the questions **PART – C(5 x 8 = 40 Marks)**				
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K5**	
		OR		
20. b)	**Unit - V**	**CO5**	**K5**	

Course Name	LINEAR AND DIGITAL ICS AND APPLICATIONS			
Course Code	23PPHEC12	**L**	**P**	**C**
Category	ELECTIVE	6	-	3

COURSE OBJECTIVES:

- To introduce the basic building blocks of linear integrated circuits.
- To teach the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of PLL.
- To introduce the concepts of waveform generation and introduce one special function ICs.
- Exposure to digital IC‘s

UNIT - I INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER 16

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.

UNIT - II APPLICATIONS OF OP-AMP 18

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.

UNIT - III ACTIVE FILTERS &TIMER AND PHASE LOCKED LOOPS 19

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

UNIT - IV VOLTAGE REGULATOR & D to A AND A to D CONVERTERS 17

VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator.

D to A AND A to D CONVERTERS: Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

UNIT - V	CMOS LOGIC,COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs	20

CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. 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).

Total Lecture Hours **90**

BOOKS FOR STUDY:

- D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt. Ltd., New Delhi, India
- Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, New Delhi.
- B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co.
- V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition.
- V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog), S. Viswanathan Printers & Publishers Private Ltd, Reprint. V.

BOOKS FOR REFERENCES:

- Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi.
- Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi.
- Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi
- Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi.
- Integrated Electronics, Millman&Halkias, Tata McGraw Hill, 17th Reprint (2000).

WEB RESOURCES:

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

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change	**60**	No Changes Made		New Course			
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**								

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	**K1 to K5**
CO2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	**K1 to K5**
CO3	Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	**K1 to K5**
CO4	Learn about various techniques to develop A/D and D/A converters.	**K1 to K5**
CO5	Acquire the knowledge about the CMOS logic, combinational and sequential circuits	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

3- STRONG **2 – MEDIUM** **1 - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	2	2	3	3	3	2
CO 2	3	3	3	3	1	3	3	3	2	1
CO 3	3	3	3	3	1	3	3	3	2	1
CO 4	3	3	3	3	1	3	3	3	2	1
CO 5	3	3	3	2	1	1	2	3	2	1
WEIGTAGE										
WEIGHTED PERCENTAGE OF										

COURSE CONTRIBUTION TO POS										

LESSON PLAN:

UNIT	LINEAR AND DIGITAL ICs AND APPLICATIONS	HRS	PEDAGOGY
I	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.	16	Chalk &Talk, PPT, Seminar
II	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	Chalk &Talk, PPT
III	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	19	Chalk &Talk, Assignment
IV	VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator. D to A AND A to D CONVERTERS: Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.	17	Chalk & Talk, Assignment
V	CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. 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).	20	Seminar, PPT, Chalk &Talk

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K2, K2)
	CO2	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K3, K3)
CI AII	**CO3**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K3, K3)
	CO4	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.57**	
	K2	**2**	**10**	**16**	**28**	**50**	
	K3		**10**	**16**	**26**	**46.43**	**53.57**
	K4						
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.57**	
	K2	**2**	**10**		**12**	**21.43**	
	K3		**10**	**16**	**26**	**46.43**	**25**
	K4			**16**	**16**	**28.57**	**71.43**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K2, K2)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
3	CO3	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
4	CO4	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K4, K4)
5	CO5	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K5, K5)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.57	-
K2	5	20	16	41	29.29	-
K3		30	32	62	44.28	32.86
K4			16	16	11.43	77.14
K5			16	16	11.43	88.57
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions **PART – B**				**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K3**	
		OR		
13. b)	**Unit - III**	**CO3**	**K3**	
14. a)	**Unit - IV**	**CO4**	**K2**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K2**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions **PART – C(5 x 8 = 40 Marks)**				
16. a)	**Unit - I**	**CO1**	**K2**	
		OR		
16. b)	**Unit - I**	**CO1**	**K2**	
17. a)	**Unit - II**	**CO2**	**K3**	
		OR		
17. b)	**Unit - II**	**CO2**	**K3**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K5**	
		OR		
20. b)	**Unit - V**	**CO5**	**K5**	


SECOND SEMESTER

Course Name	STATISTICAL MECHANICS			
Course Code	23PPHCC21	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

- To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics
- To identify the relationship between statistic and thermodynamic quantities
- To comprehend the concept of partition function, canonical and grand canonical ensembles
- To grasp the fundamental knowledge about the three types of
- statistics
- To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties thatvary with time.

UNIT - I PHASE TRANSITIONS 18

Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications –Third law of Thermodynamics. Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

UNIT - II STATISTICAL MECHANICS AND THERMODYNAMICS 18

Foundations of statistical mechanics - Specification of states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.

UNIT - III CANONICAL AND GRAND CANONICAL ENSEMBLES 16

Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations.

UNIT - IV CLASSICAL AND QUANTUM STATISTICS 18

Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.

UNIT - V REAL GAS,ISING MODEL AND FLUCTUATIONS 20

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.

Total Lecture Hours 90

BOOKS FOR STUDY:

- S. K. Sinha, 1990, Statistical Mechanics, Tata McGraw Hill, New Delhi.
- B. K. Agarwal and M. Eisner, 1998, Statistical Mechanics, Second Edition New Age International, New Delhi.
- J. K. Bhattacharjee, 1996, Statistical Mechanics: An Introductory Text, Allied Publication, New Delhi.
- F. Reif, 1965, Fundamentals of Statistical and Thermal Physics, McGraw -Hill, New York.
- M. K. Zemansky, 1968, Heat and Thermodynamics, 5th edition, McGraw-Hill New York.

BOOKS FOR REFERENCES:

- R. K. Pathria, 1996, Statistical Mechanics, 2nd edition, Butter WorthHeinemann, New Delhi.
- L. D. Landau and E. M. Lifshitz, 1969, Statistical Physics, Pergamon Press, Oxford.
- K. Huang, 2002, Statistical Mechanics, Taylor and Francis, London
- W. Greiner, L. Neise and H. Stoecker, Thermodynamics and Statistical Mechanics, Springer Verlang, New York.
- A. B. Gupta, H. Roy, 2002, Thermal Physics, Books and Allied, Kolkata.

WEB RESOURCES:

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

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change	**70**	No Changes Made		New Course			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	K1 to K5
CO2	To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. Describe the peculiar behaviour of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	K1 to K5
CO3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	K1 to K5
CO4	To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	K1 to K5
CO5	To discuss and examine the thermodynamicalbehaviour of gases under fluctuation and also using Ising model	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

3- STRONG 2 – MEDIUM 1 - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	1	1	2	3	1	1	3
CO 2	3	3	3	1	1	2	3	1	1	3
CO 3	3	3	3	1	1	2	3	2	1	3
CO 4	3	3	3	1	1	2	3	2	1	3
CO 5	3	3	3	1	1	2	3	1	1	3
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:			
UNIT	**STATISTICAL MECHANICS**	**HRS**	**PEDAGOGY**
I	Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications –Third law of Thermodynamics. Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis.	**18**	**Chalk &Talk, PPT, Seminar**
II	Foundations of statistical mechanics - Specification of states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.	**18**	**Chalk &Talk, PPT**
III	Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations.	**16**	**Chalk &Talk, Assignment**
IV	Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.	**18**	**Chalk &Talk, Group discussion**
V	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	**20**	**Seminar, PPT, Chalk &Talk**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
	CO2	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
CI AII	**CO3**	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
	CO4	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.57**	
	K2	**2**			**2**	**3.57**	
	K3		**20**		**20**	**35.71**	**7.14**
	K4			**32**	**32**	**57.14**	**42.86**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.57**	
	K2	**2**			**2**	**3.57**	
	K3		**20**		**20**	**35.71**	**7.14**
	K4			**32**	**32**	**57.14**	**42.86**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
3	CO3	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
4	CO4	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K5, K5)
5	CO5	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.57	-
K2	5	10		15	10.71	3.57
K3		40	16	56	40.00	14.28
K4			48	48	34.29	54.28
K5			16	16	11.43	88.57
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions **PART – B**				**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K3**	
		OR		
11. b)	**Unit - I**	**CO1**	**K3**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K3**	
		OR		
13. b)	**Unit - III**	**CO3**	**K3**	
14. a)	**Unit - IV**	**CO4**	**K2**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K2**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions **PART – C(5 x 8 = 40 Marks)**				
16. a)	**Unit - I**	**CO1**	**K4**	
		OR		
16. b)	**Unit - I**	**CO1**	**K4**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K4**	
		OR		
18. b)	**Unit - III**	**CO3**	**K4**	
19. a)	**Unit - IV**	**CO4**	**K5**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K5**	
20. a)	**Unit - V**	**CO5**	**K3**	
		OR		
20. b)	**Unit - V**	**CO5**	**K3**	

Course Name	QUANTUM MECHANICS – I			
Course Code	23PPHCC22	**L**	**P**	**C**
Category	CORE	6	-	5

COURSE OBJECTIVES:

- To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
- To describe the propagation of a particle in a simple, one-dimensional potential.
- To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.
- To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
- To discuss the Approximation methods like perturbation theory, Variational and WKB methods fo solving the Schrödinger equation.

UNIT - I BASIC FORMALISM **18**

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

UNIT - II DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS **18**

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

UNIT - III GENERAL FORMALISM **17**

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal

UNIT - IV APPROXIMATION METHODS **18**

Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.

UNIT - V ANGULAR MOMENTUM **19**

Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.

Total Lecture Hours **90**

BOOKS FOR STUDY:

- P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition(37th Reprint),Tata McGraw-Hill, New Delhi, 2010.
- G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
- David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011.
- SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982.
- A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4thEdition, Macmillan, India, 1984.

BOOKS FOR REFERENCES:

- E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.
- V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
- L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976.
- S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.
- V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011.

WEB RESOURCES:

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

Nature of Course	EMPLOYABILITY			SKILL ORIENTED	✓		ENTREPRENEURSHIP					
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓				
Changes Made in the Course	Percentage of Change	**60**		No Changes Made			New Course					
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**												

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	K1 to K5
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	K1 to K5
CO3	Can discuss the various representations, space time symmetries and formulations of time evolution	K1 to K5
CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems	K1 to K5
CO5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

3- STRONG 2 – MEDIUM 1 - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	3	2	3	2	2	3
CO 2	3	3	3	3	3	S	3	2	2	3
CO 3	2	3	3	2	3	2	3	2	2	3
CO 4	3	3	3	3	3	2	3	3	2	3
CO 5	3	3	3	2	3	3	3	3	2	3
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

UNIT	QUANTUM MECHANICS – I	HRS	PEDAGOGY
I	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	18	Chalk &Talk, PPT, Seminar

	Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation		
II	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**	**Chalk &Talk, PPT**
III	Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal	**17**	**Chalk &Talk, Assignment**
IV	Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.	**18**	**Chalk & Talk, Assignment**
V	Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.	**19**	**Seminar, PPT, Chalk &Talk**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
	CO2	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
CI AII	**CO3**	**K1 to K5**	2	K1, K1	2 (K3, K3)	2 (K4, K4)
	CO4	**K1 to K5**	2	K2, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.57	
	K2	2			2	3.57	
	K3		20		20	35.71	7.14
	K4			32	32	57.14	42.86
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.57	
	K2	2			2	3.57	
	K3		20		20	35.71	7.14
	K4			32	32	57.14	42.86
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
3	CO3	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
4	CO4	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K5, K5)
5	CO5	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.57**	**-**
K2	**5**	**10**		**15**	**10.71**	**3.57**
K3		**40**	**16**	**56**	**40.00**	**14.28**
K4			**48**	**48**	**34.29**	**54.28**
K5			**16**	**16**	**11.43**	**88.57**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K3**	
		OR		
11. b)	**Unit - I**	**CO1**	**K3**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K3**	
		OR		
13. b)	**Unit - III**	**CO3**	**K3**	
14. a)	**Unit - IV**	**CO4**	**K2**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K2**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K4**	
		OR		
16. b)	**Unit - I**	**CO1**	**K4**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K5**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K5**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	PRACTICAL - II			
Course Code	23PPHCP21	**L**	**P**	**C**
Category	CORE	-	6	4

COURSE OBJECTIVES:

- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- To calculate the thermodynamic quantities and physical properties of materials.
- To analyze the optical and electrical properties of materials.
- To observe the applications of FET and UJT.
- To study the different applications of operational amplifier circuits.
- To learn about Combinational Logic Circuits and Sequential Logic Circuits

Course Details

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
2. Determination of Stefan's constant of radiation from a hot body
3. Measurement of Coefficient of linear expansion- Air wedge Method
4. Measurement of Susceptibility of liquid - Quincke's method
5. B-H curve using CRO
6. Measurement of Magnetic Susceptibility - Guoy's method
7. LG Plate
8. Arc spectrum: Copper
9. Determination of Solar constant
10. Determination of e/m - Millikan's method
11. Miscibility measurements using ultrasonic diffraction method
12. Determination of Thickness of thin film. - Michelson Interferometer
13. GM counter – Feather's analysis: Range of Beta rays
14. Iodine absorption spectra
15. Molecular spectra – CN bands
16. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser
17. Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.
18. Measurement of Dielectricity - Microwave test bench
19. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility

20. Interpretation of vibrational spectra of a given material.
21. Determination of I-V Characteristics and efficiency of solar cell.
22. IC 7490 as scalar and seven segment display using IC7447
23. Solving simultaneous equations – IC 741 / IC LM324
24. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter
25. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
26. Construction of second order butter worth multiple feedback narrow band pass filter
27. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193
28. Construction of square wave generator using IC 555 – Study of VCO
29. Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application as squarer
30. Construction of pulse generator using the IC 555 – Application as frequency divider
31. BCD to Excess- 3 and Excess 3 to BCD code conversion
32. Study of binary up / down counters - IC 7476 / IC7473
33. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474
34. Study of synchronous parallel 4-bit binary up/down counter using IC 74193
35. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493
36. Study of Modulus Counter
37. Construction of Multiplexer and Demultiplexer using ICs.

BOOKS FOR STUDY:

- Practical Physics, Gupta and Kumar, PragatiPrakasan
- Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences
- Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
- Electronic lab manual Vol I, K ANavas, Rajath Publishing
- Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition.

BOOKS FOR REFERENCES:

- An advanced course in Practical Physics, D. Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd
- Advanced Practical Physics, S.P Singh, PragatiPrakasan
- A course on experiment with He-Ne Laser, R. S. Sirohi, John Wiley & Sons (Asia) Pvt. ltd
- Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing
- Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi

WEB RESOURCES:

- https://www.niser.ac.in/sps/sites/default/files/basic_page/Young's%20modulus%20by%20Cornu's%20method.pdf
- https://www.mdpi.com/2075-1702/9/12/336
- https://www.electronics-tutorials.ws/filter/second-order-filters.html
- https://acschandwadcollege.com/up-images/downloads/FY_Asynchronous-Up-Down-counter.pdf
- https://www.engineersgarage.com/building-multiplexer-and-demultiplexer-using-sn-7400-series-ics-de-part-16/

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change	**90**	No Changes Made		New Course			
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**								

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Understand the strength of material using Young's modulus and Poisson's ratio by Elliptical fringes	**K1 to K5**
CO2	Acquire knowledge on Coefficient of linear expansion	**K1 to K5**
CO3	Understand theoretical principles of carrier concentration and carrier mobility of semiconducting material	**K1 to K5**
CO4	Solving simultaneous equations using OPAMP and ICs	**K1 to K5**
CO5	Improve the analytical and observation ability in Physics Experiments	**K1 to K5**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	S	S	2	2	2	3	3
CO2	2	2	S	S	S	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

3- STRONG **2 – MEDIUM** **1 - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3

CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

Experiments	PRACTICAL - II	HRS	PEDAGOGY
1 to 4	Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method. Measurement of Coefficient of linear expansion- Air wedge Method. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility.	**30**	**Demonstration & Video**
5 to 8	IC 7490 as scalar and seven segment display using IC7447. Solving simultaneous equations – IC 741 / IC LM324. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.	**30**	**Chalk & Talk, PPT**
9 to 12	Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193 Construction of square wave generator using IC 555 – Study of VCO Study of binary up / down counters - IC 7476 / IC7473 Construction of Multiplexer and Demultiplexer using ICs.	**30**	**Chalk & Talk, PPT**

METHOD OF EVALUATION:

Continuous Internal Assessment	End Semester Examination	Total
25	**75**	**100**

Record Note and Attendance -10 mark
Model examination - 15 mark
Total CIA - 25 mark

Model examination should be conducted for 30 mark and it has to be converted to 15 mark

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)				
Internal	**Cos**	**K Level**	**No. of. Questions**	**K - Level**
CIA-I	**CO1 – CO5**	**K1 – K5**	**1** Question for Each Student	**K1 – K5**
Question Pattern CIA - I		**No. of Questions to be asked**	**1** Question for Each Student	
		No. of Questions to be answered	**1**	
		Marks for each question	**30**	
		Total Marks for each section	**30**	

Distribution of Marks with COs &K Level for Correction of CIA I					
	COs	**K - Level**	**Distribution of the work of the experiment**	**K - Level**	**MARKS**
CIA I	**CO1**	**K1 to K5**	Aim and apparatus	**K1**	**2.0**
	CO2	**K1 to K5**	Formula and Tabular Column	**K3**	**5.0**
	CO3	**K1 to K5**	Understanding and Observation	**K5**	**10.0**
	CO4	**K1 to K5**	Calculation and Graph	**K4**	**10.0**
	CO5	**K1 to K5**	Interpretation of result	**K2**	**3.0**
	Total Marks				**30**

Distribution of Marks with K Level CIA I					
	K Level	**Distribution of the work of the experiment**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	K1	Aim and apparatus	2	6.67	-
	K3	Formula and Tabular Column	5	16.67	
	K5	Understanding and Observation	10	33.33	**23.34**
	K4	Calculation and Graph	10	33.33	**56.67**
	K2	Interpretation of result	3	10.00	**90.00**
	Marks		**30**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

K5 – Evaluating, interpreting and concluding the results with accurate measurements**.**

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)			
COs	**K - Level**	**No. of Questions**	**K – Level**
CO1- CO5	**K1 – K5**	**1** Question for Each Student	**K1 – K5**
No. of Questions to be Asked		**1** Question for Each Student	
No. of Questions to be answered		**1**	
Marks for each question		**75**	
Total Marks for each section		**75**	

Distribution of Marks with COs &K Level for Correction of the Summative Exam				
COs	**K - Level**	**Distribution of the work of the experiment**	**K - Level**	**MARKS**
CO1	**K1 to K5**	**Aim and apparatus**	**K1**	**10**
CO2	**K1 to K5**	**Formula and Tabular Column**	**K3**	**15**
CO3	**K1 to K5**	**Understanding and Observation**	**K5**	**30**
CO4	**K1 to K5**	**Calculation and Graph**	**K4**	**15**
CO5	**K1 to K5**	**Interpretation of result**	**K2**	**5**
Total Marks				**75**

Distribution of Marks with K Level				
K Level	**Parameters for K-Level**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**Aim and apparatus**	**10**	**13.33**	**13**
K3	**Formula and Tabular Column**	**15**	**20**	**20**
K5	**Understanding and Observation**	**30**	**40**	**40**
K4	**Calculation and Graph**	**15**	**20**	**20**
K2	**Interpretation of result**	**5**	**6.67**	**7**
Marks		**75**	**100**	**100**

Course Name	ADVANCED OPTICS			
Course Code	23PPHEC21	**L**	**P**	**C**
Category	Elective	5	-	3

COURSE OBJECTIVES:

- To know the concepts behind polarization and could pursue research work on application aspects of laser
- To impart an extensive understanding of fiber and non-linear optics
- To study the working of different types of LASERS
- To differentiate first and second harmonic generation
- Learn the principles of magneto-optic and electro-optic effects and its applications

UNIT - I POLARIZATION AND DOUBLE REFRACTION 20

Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity

UNIT - II LASERS 18

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 – CO2 laser – Chemical lasers – HCl laser – Semiconductor laser

UNIT - III FIBER OPTICS 18

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

UNIT - IV NON-LINEAR OPTICS 16

Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light

UNIT - V MAGNETO-OPTICS AND ELECTRO-OPTICS 18

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.

Total Lecture Hours 90

BOOKS FOR STUDY:

- B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd.
- AjoyGhatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd.
- William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York
- J. Peatros, Physics of Light and Optics, a good (and free!) electronic book
- B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley-Interscience,

BOOKS FOR REFERENCES:

- F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition.
- Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH.
- Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011.
- Y. B. Band, Light and Matter, Wiley and Sons (2006)
- R. Guenther, Modern Optics, Wiley and Sons (1990)

WEB RESOURCES:

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

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP		✓			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓				
Changes Made in the Course	Percentage of Change		**55**	No Changes Made			New Course					
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**												

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Discuss the transverse character of light waves and different polarization phenomenon	K1 to K5
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	K1 to K5
CO3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	K1 to K5
CO4	Identify the properties of nonlinear interactions of light and matter	K1 to K5
CO5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

3- STRONG 2 – MEDIUM 1 - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	2	3	3	3	3	3	3
CO 2	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	2	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

UNIT	ADVANCED OPTICS	HRS	PEDAGOGY
I	Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence –	20	Chalk &Talk, PPT, Seminar

	Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity		
II	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 – Semiconductor laser	**18**	**Chalk &Talk, PPT**
III	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	**18**	**Chalk &Talk, Assignment**
IV	Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light	**16**	**Chalk & Talk, Assignment**
V	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	**18**	**Seminar, PPT, Chalk &Talk**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K2, K2)
	CO2	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K3, K3)
CI AII	**CO3**	**K1 to K5**	2	K1, K2	2 (K2, K2)	2 (K3, K3)
	CO4	**K1 to K5**	2	K1, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.57	
	K2	2	10	16	28	50	
	K3		10	16	26	46.43	53.57
	K4						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.57	
	K2	2	10		12	21.43	
	K3		10	16	26	46.43	25
	K4			16	16	28.57	71.43
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K2, K2)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
3	CO3	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
4	CO4	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K4, K4)
5	CO5	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K5, K5)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.57**	**-**
K2	**5**	**20**	**16**	**41**	**29.29**	**3.57**
K3		**30**	**32**	**62**	**44.28**	**32.86**
K4			**16**	**16**	**11.43**	**77.14**
K5			**16**	**16**	**11.43**	**88.57**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions **PART – B**				**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K3**	
		OR		
13. b)	**Unit - III**	**CO3**	**K3**	
14. a)	**Unit - IV**	**CO4**	**K2**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K2**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions **PART – C(5 x 8 = 40 Marks)**				
16. a)	**Unit - I**	**CO1**	**K2**	
		OR		
16. b)	**Unit - I**	**CO1**	**K2**	
17. a)	**Unit - II**	**CO2**	**K3**	
		OR		
17. b)	**Unit - II**	**CO2**	**K3**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K5**	
		OR		
20. b)	**Unit - V**	**CO5**	**K5**	

Course Name	MEDICAL PHYSICS			
Course Code	23PPHEC22	**L**	**P**	**C**
Category	ELECTIVE	5	-	3

COURSE OBJECTIVES:

- To understand the major applications of Physics to Medicine
- To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.
- To outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical physics.
- To introduce the ideas of Radiography.
- To form a good base for further studies like research.

UNIT - I X-RAYS AND TRANSDUCERS 18

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer

UNIT - II BLOOD PRESSURE MEASUREMENTS 18

Introduction – sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

UNIT - III RADIATION PHYSICS 19

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.

UNIT - IV MEDICAL IMAGING PHYSICS 18

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)

UNIT - V RADIATION PROTECTION 17

Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter

Total Lecture Hours 90

BOOKS FOR STUDY:

- Dr. K. Thayalan , Basic Radiological Physics, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.
- Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology: -LippincotWilliams and Wilkins, 1990.
- FM Khan, Physics of Radiation Therapy, William and Wilkins, 3rd ed, 2003.
- D. J. Dewhurst, An Introduction to Biomedical Instrumentation, 1st ed, Elsevier Science, 2014.
- R.S. Khandpur, Hand Book of Biomedical Instrumentations, 1st ed, TMG, New Delhi, 2005.

BOOKS FOR REFERENCES:

- Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
- Daniel Jirák, FrantišekVítek, Basics of Medical Physics, 1st ed, Charles University, Karolinum Press, 2018
- Anders Brahme, Comprehensive Biomedical Physics, Volume 1, 1st ed, Elsevier Science, 2014.
- K. Venkata Ram, Bio-Medical Electronics and Instrumentation, 1st ed, Galgotia Publications, New Delhi, 2001.
- John R. Cameron and James G. Skofronick, 2009, Medical Physics, John Wiley Interscience Publication, Canada, 2nd edition.

WEB RESOURCES:

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

Nature of Course	EMPLOYABILITY		SKILL ORIENTED		ENTREPRENEURSHIP	✓		
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓		
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**								

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Learn the fundamentals, production and applications of X-rays.	K1 to K5
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	K1 to K5
CO3	Apply knowledge on Radiation Physics	K1 to K5
CO4	Analyse Radiological imaging and filters	K1 to K5
CO5	Assess the principles of radiation protection	K1 to K5

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3
CO5	3	3	3	1	1	2	3	3	1	3

3- STRONG 2 – MEDIUM 1 - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	1	1	2	3	3	1	3
CO 2	3	3	3	2	1	2	3	3	1	3
CO 3	3	3	3	2	1	2	3	3	1	3
CO 4	3	3	3	2	1	2	3	3	1	3
CO 5	3	3	3	1	1	2	3	3	1	3
WEIGTAGE										
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS										

LESSON PLAN:

UNIT	MEDICAL PHYSICS	HRS	PEDAGOGY
I	Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum – Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer	18	Chalk &Talk, PPT, Seminar

II	Introduction –sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).	**18**	**Chalk &Talk, PPT**
III	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	**19**	**Chalk &Talk, Assignment**
IV	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)	**18**	**Chalk & Talk, Assignment**
V	Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter	**17**	**Seminar, PPT, Chalk &Talk**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K2, K2)
	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
CI AII	CO3	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K3, K3)
	CO4	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K4, K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.57	
	K2	2	10	16	28	50	
	K3		10	16	26	46.43	53.57
	K4						
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.57	
	K2	2	10		12	21.43	
	K3		10	16	26	46.43	25
	K4			16	16	28.57	71.43
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K2, K2)
2	CO2	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
3	CO3	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K3, K3)
4	CO4	K1 to K5	2	K1, K2	2 (K2, K2)	2 (K4, K4)
5	CO5	K1 to K5	2	K1, K2	2 (K3, K3)	2 (K5, K5)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.57**	
K2	**5**	**20**	**16**	**41**	**29.29**	**3.57**
K3		**30**	**32**	**62**	**44.28**	**32.86**
K4			**16**	**16**	**11.43**	**77.14**
K5			**16**	**16**	**11.43**	**88.57**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions			**PART – A**	**(10 x 1 = 10 Marks)**	
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K3**	
		OR		
13. b)	**Unit - III**	**CO3**	**K3**	
14. a)	**Unit - IV**	**CO4**	**K2**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K2**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K2**	
		OR		
16. b)	**Unit - I**	**CO1**	**K2**	
17. a)	**Unit - II**	**CO2**	**K3**	
		OR		
17. b)	**Unit - II**	**CO2**	**K3**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K5**	
		OR		
20. b)	**Unit - V**	**CO5**	**K5**	