KAMARAJ COLLEGE

(AUTONOMOUS)

Accredited with A+ Grade by NAAC

Among Top 150 Colleges in India - NIRF Ranking 2025

இந்து நாடார் சங்கங்களால் 1966-ல் தொடங்கப்பட்ட கல்லூரி

(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

THOOTHUKUDI - 628 003.

B.Sc., Physics

Semester – I to VI

(for the students those who joined from the academic year 2025-2026)

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SYLLABUS

(for the students those who joined from the academic year 2025-2026)

Department Profile

Name of the Programme	**B.Sc., Physics**
Programme Code	**03012**
Year of Establishment	**1988**

Vision

To provide a strong foundation for students perusing physics for their excellence with well-behaved personality, academics and global vision.

Mission

- To produce nationally competent and quality graduate by educating the concept of Physics and Techniques
- To facilitate the students to work with recent tools and techniques
- To would the students by inculcating the spiral of ethical values contributing to the social ethic.

College Mail Id	**kamarajcoll@gmail.com**
College Website	**www.kamarajcollege.ac.in**

Undergraduate Degree Programme

1. Introduction

Programme Outcome, Programme Specific Outcomes and Course Outcomes Students completing this programme will be able to present their core under-graduate discipline clearly and precisely, make abstract ideas precise by formulating them in the language of the specific discipline, describe related ideas from multiple perspectives and explain fundamental concepts. Completion of this programme will also enable the learners to join teaching profession, enhance their employability for government jobs, jobs in various other public and private enterprises.

Eligibility: +2 course with Mathematics, Physics and Chemistry (Or) Physics, Chemistry and Biology

Learning Outcomes- Based Curriculum Framework Guidelines Based Regulations For Under Graduate Programme	
Programme:	B.Sc. (Physics)
Programme Code:	03012
Duration:	3 Years (UG)
Programme Outcomes:	
PO1:	**Disciplinary knowledge**: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study.
PO2:	**Communication Skills**: Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
PO3:	**Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.

PO4:	**Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.
PO5:	**Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
PO6:	**Research-related skills:** A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and- effect relationships; ability to plan, execute and report the results of an experiment or investigation
PO7:	**Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team
PO8:	**Scientific reasoning:** Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.

Programme Specific Outcomes

On successful completion of Bachelor of (chemistry) programme, the student should be able to:

PSO1	Disciplinary Knowledge
PSO2	Critical Thinking
PSO3	Problem Solving
PSO4	Analytical & Scientific Reasoning
PSO5	Research related skills

Methods of Assessment	
Recall (K1)	Simple definitions , MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate Between various ideas, Map knowledge
Evaluate (K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Methods of Evaluation		Marks	
Internal Evaluation	Continuous Internal Assessment Test	15	25
	Assignment (PPT) and Seminar	5	
	Group Discussion and Viva	5	
External Evaluation	End Semester Examination		75
Total			**100**

Extra Credits

Curricular Activities	Co-Curricular Activities	Extra-Curricular Activities
Paper Presentation	Cultural Competitions	NCC
Paper Publication	Domain Clubs	NSS
Placement Training		Sports
Quiz		YRC
Competitions		UBA
SWAYAM /NPTEL/MOOCs		

Level	Credit			
	Participation	III Prize	II Prize	I Prize
Intra college	1	2	3	4
Intercollegiate	2	3	4	5
District	3	4	5	6
University	4	5	6	7
State	5	6	7	8
National	6	7	8	9
International	7	8	9	10

****Paper Presentation for each paper: 1credit**

Total credits Under–Graduate Courses including Lab Hours – 2025 to 2026

Semester	Hours	Credits	Additional Credits
I	30	22	2
II	30	22	2
III	30	22	2
IV	30	23	2
V	30	27	3
VI	30	25	3
Total		**141**	**14**

**Extra Credit will be given on the basis of student's performances

Written Examination: Theory Paper (Bloom's Taxonomy based) Question paper Model Assessment Pattern

Continuous Internal Assessment (CIA) & End Semester Examination (ESE)

- CIA : 25
- ESE:75

Theory Course:

For theory courses there shall be two tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA).CIA is for 50 marks max and will be converted in to 15 marks. The duration of each test shall be 2 Hrs.

Continuous Internal Assessment (Writing)	15marks
Assignment (PPT) & Seminar	5marks
Viva & Group Discussion	5marks

For theory Papers:

- Part A (10×1=10) Marks-Answer all questions (Multiple choice)
- Part B (5×5=25) Marks-Choosing either(a) or (b)
- Part C (5×8=40) Marks-Choosing either (a) or (b)

Total =75marks

Laboratory Courses Assessment

- CIA-40marks
- ESE-60marks
- Mandatory Record submission, attendance and class participation.
- Two CIA for 40 marks max. The average of the best two can be taken as the Continuous Internal Assessment.
- The duration of each test shall be 3 hours. In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum. The S, M, L is based on the Course outcomes. The mapping is based on the revised Bloom's

Taxonomy Verbs used to describe your Course outcomes.

- Remember and Understanding–Lower level
- Apply and Analyze– Medium Level
- Evaluate and Create–Strong Level

Pedagogy:

- Technology Based Learning (PPT)
- Peer Teaching (Chalk & Talk)
- Virtual Lab
- Blended Learning (Online & Offline)
- Group Learning
- Self - Study
- Games Based Learning

Course Structure for Science Stream
First Year – Semester I
B.Sc., Physics
(With effect from the academic year 2025 to 2026 onwards)

Semester I	Course Code	Title of the Course	Hours / Week/ L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Part - I	25ULTL11	தமிழ் இலக்கிய வரலாறு - I	6	3	3	25	75	100
Part - II	25ULEN11	General English - I	6	3	3	25	75	100
Part - III Core - I	25UMPH11	Properties of Matter and Acoustics	5	5	3	25	75	100
Core Lab - I	25UMPHL1	Core Practical- I	3	2	3	40	60	100
EC - I Discipline /Generic	25UEMA11	Mathematics Paper I Algebra and Differential Equations	6	5	3	25	75	100
Part - IV SEC - I	25USPH11	Physics For Everyday Life	2	2	3	25	75	100
FC	25UFPH11	Introductory Physics	2	2	3	25	75	100
		Total	**30**	**22**				

**** SEC-Skill Enhancement Course** ****CIA- Continuous Internal Assessment**

****EC –Elective Course** **** ESE- End Semester Examination**

****FC - Foundation course**

Course Structure for Science Stream
First Year – Semester – II
B.Sc., Physics
(With effect from the academic year 2025 – 2026 onwards)

Semester II	Course Code	Title of the Course	Hours /Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Part - I	25ULTL21	தமிழ் இலக்கிய வரலாறு - II	6	3	3	25	75	100
Part - II	25ULEN21	General English – II	6	3	3	25	75	100
Part - III Core - II	25UMPH21	Heat, Thermodynamics and statistical Physics	5	5	3	25	75	100
Core Lab –II	25UMPHL2	Core Practical - II	3	2	3	40	60	100
EC - II Discipline /Generic	25UEMA21	Mathematics Paper-II Vector Calculus and Junior Series	6	5	3	25	75	100
Part - IV SEC - II	25USPH21	Astrophysics	2	2	3	25	75	100
Part - IV SEC - III	25USPH22	Energy Physics	2	2	3	25	75	100
		Total	**30**	**22**				

**** SEC-Skill Enhancement Course** **** CIA- Continuous Internal Assessment**

**** EC –Elective Course** **** ESE- End Semester Examination**

Course Structure for Science Stream
Second Year – III Semester
B.Sc., Physics
(With effect from the academic year 2025 to 2026 onwards)

Semester III	Course Code	Title of the Course	Hours / Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Part- I	25ULTL31	தமிழக வரலாறும் பண்பாடும்	6	3	3	25	75	100
Part- II	25ULEN31	General English - III	6	3	3	25	75	100
Part -III Core- III	25UMPH31	Mechanics	5	5	3	25	75	100
Core Lab – III	25UMPHL3	Core Practical III	3	2	3	40	60	100
EC -III Discipline /Generic	25UECH31	Allied Chemistry Paper – I	4	3	3	25	75	100
	25UECHL1	Allied Chemistry Practical-I	2	2	3	40	60	100
Part-IV SEC- IV	25USPH31	C Programming	2	2	3	25	75	100
Part –IV	25UYOG31	Yoga, Culture & Heritage	2	2	1.5	25	75	100
		Total	**30**	**22**				

**** SEC-Skill Enhancement Course** **** CIA- Continuous Internal Assessment**

**** EC –Elective Course** **** ESE- End Semester Examination**

Course Structure for Science Stream
Second Year – Semester – IV
B.Sc., Physics
(With effect from the academic year 2025 – 2026 onwards)

Semester IV	Course Code	Title of the Course	Hours /Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Part - I	25ULTL41	தமிழும் அறிவியலும்	6	3	3	25	75	100
Part - II	25ULEN41	General English – IV	6	3	3	25	75	100
Part - III Core - IV	25UMPH41	Optics and Laser Physics	5	5	3	25	75	100
Core Lab - IV	25UMPHL4	Core Practical IV	3	2	3	40	60	100
EC - IV Discipline /Generic	25UECH41	Allied Chemistry Paper – II	4	3	3	25	75	100
	25UECHL2	Allied Chemistry Practical-II	2	2	3	40	60	100
Part - IV SEC - V	25USPH41	Python Programming	2	2	3	25	75	100
Part - IV	25UEVS41	Environmental Studies	2	2	3	25	75	100
Part - V	25UEA41	NCC/ NSS/ YRC/ SPORTS	-	1	-	-	-	100
		Total	**30**	**23**				

**** SEC-Skill Enhancement Course** **** CIA- Continuous Internal Assessment**

**** EC –Elective Course** **** ESE- End Semester Examination**

Course Structure for Science Stream
Third Year – Semester – V
B.Sc., Physics
(With effect from the academic year 2025 – 2026 onwards)

Semester V	Course Code	Title of the Course	Hours /Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Core - V	25UMPH51	Quantum Mechanics and Relativity	5	5	3	25	75	100
Core - VI	25UMPH52	Atomic and Nuclear Physics	5	5	3	25	75	100
Core - VII	25UMPH53	Analog and communication electronics	5	4	3	25	75	100
Part - III Core - Lab - 5	25UMPHL5	Core Practical - V	3	2	3	40	60	100
Core - Lab - 6	25UMPHL6	Core Practical - VI	3	2	3	40	60	100
EC - V (Select any one)	25UEPH51 25UEPH52	1. Nano Science and Nano Technology 2. Digital Photography	5	3	3	25	75	100
Part - IV SEC - VI	25USPH51	Electrical Home Installation	2	2	3	25	75	100
Part - IV Training	25UINT51	*Internship	-	2	1.5	50	50	100
Part - V	25UPDT51	Personality development	2	2	3	25	75	100
		Total	**30**	**27**				

**** SEC-Skill Enhancement Course** **** CIA- Continuous Internal Assessment**
**** EC –Elective Course** **** ESE- End Semester Examination**

***Internship – course duration - 7 to14 days (Report should be submitted & Viva Voce will be conducted for the report which is equivalent to the project Viva – voce).**

Course Structure for Science Stream
Third Year – Semester – VI
UG Physics
(With effect from the academic year 2025 – 2026 onwards)

Semester VI	Course Code	Title of the Course	Hours /Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Core - VIII	25UMPH61	Solid State Physics	5	5	3	25	75	100
Core - IX	25UMPH62	Electricity, magnetism and Electromagnetism	5	5	3	25	75	100
Core - X	25UMPH63	Digital electronics and microprocessors 8085	5	4	3	25	75	100
Part - III Core – Lab - 7	25UMPHL7	Core Practical VII	3	2	3	40	60	100
Core – Lab - 8	25UMPHL8	Core Practical VIII	3	2	3	40	60	100
Project - 1	25UMPHP1	Project	2	2	3	50	50	100
EC - VI (Select any one)	25UEPH61 25UEPH62	1. Medical Instrumentation 2. Mathematical Physics & Numerical Methods	5	3	3	25	75	100
Part - IV SEC - VII	25USPH61	Maintenance of Electronic Appliances	2	2	3	25	75	100
		Total	**30**	**25**				

**** SEC-Skill Enhancement Course** **** CIA- Continuous Internal Assessment**
**** EC –Elective Course** **** ESE- End Semester Examination**

Semester - I

Properties of Matter and Acoustics

Title of the Course		**Properties of Matter and Acoustics**					
Course Type		**Core -I**					
Year	**I**	**Semester**	**I**	**Credits**	**5**	**Course Code**	**25UMPH11**
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**		**Total**	
		3	**2**	**--**		**5**	

Learning Objectives	
LO1	To learn the terms and relations between various terms associated with the nature of Elasticity that lead to understand the elastic properties which is critical in designing structures and materials that can withstand forces without permanently deforming.
LO2	To understand how loads affect the bending moment in a beam which is important for the design and construction of many structures, including buildings, bridges, and aircraft
LO3	To comprehend and predict the behaviour of fluids and the forces acting on them.
LO4	To explore the definition of oscillation, examine some examples of oscillations, and understand why they occur.
LO5	To gain a better understanding of how sound interacts with different materials and structures, which aid to realise the benefits like how to design a building to enhance the quality of sound. Also learn about Ultrasonic waves, production deduction and the range of benefits.

Unit	Contents
I	**Elasticity:** Hooke's law – stress-strain diagram – elastic constants –Poisson's ratio – relation between elastic constants and Poisson's ratio – work done in stretching a wire –Twisting couple on a cylinder – Rigidity modulus by torsion pendulum (with and without masses).
II	**Bending Of Beams:** Cantilever– expression for bending moment– expression for depression at the loaded end of the cantilever– oscillations of a cantilever – expression for time period – experiment to find Young's modulus by Koenig's method – uniform bending –expression for elevation – experiment to determine Young's modulus using microscope.
III	**Fluid Dynamics:** **Surface tension**: Definition –molecular forces -excess pressure over curved surface – application to spherical and cylindrical drops and bubbles. **Viscosity:** definition – streamline and turbulent flow – rate of flow of liquid in a capillary tube – Poiseuille's formula –terminal velocity and Stoke's formula.
IV	**Waves And Oscillations:** Simple Harmonic Motion (SHM) –Differential equation of SHM - composition of two SHM in a straight line and at right angles– Lissajous's figures- free, damped, forced vibrations –resonance and sharpness of resonance. Laws of transverse vibration in strings – sonometer –determination of AC frequency using sonometer– determination of frequency using Melde's string apparatus.
V	**Acoustics Of Buildings And Ultrasonics:** Intensity of sound – loudness of sound – decibel - reverberation – factors affecting the acoustics of buildings. **Field visit:** Focusing on unique acoustic features – Theatre/Recording Studio /Auditorium / Concert hall **Ultrasonic waves:** Production of ultrasonic waves – Piezoelectric crystal method – Detection of ultrasonic waves-application of ultrasonic waves.

Extended Professional Component (It is a part of the internal component only and is not to be included in the external examination question paper.)	Questions related to the above topics, from various competitive examinations UPSC/JAM/TNPSC and others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts:	1. D.S.Mathur, 2010, Elements of Properties of Matter, S.Chand & Co. 2. BrijLal & N. Subrahmanyam, 2013, Waves and oscillations, S.Chand & Co 3. R.Murugesan,2012, Properties of Matter, S.Chand& Co.
References Books:	1. J. Smith, 1960, General Properties of Matter, Orient Longman Publishers. 2. R. Gulati, 1977, Fundamental of General Properties of Matter, Fifth edition,R. Chand & Co. 3. A.P French, 1973, Vibration and Waves, MIT Introductory Physics, Arnold-Heinmann India.
Web Resources	1. https://www.biolinscientific.com/blog/what-are-surfactants-and-how-do- they-work 2. http://hyperphysics.phy-astr.gsu.edu/hbase/permot2.html 3. https://www.youtube.com/watch?v=gT8Nth9NWPM 4. https://www.youtube.com/watch?v=m4u-SuaSu1s&t=3s 5. https://www.biolinscientific.com/blog/what-are-surfactants-and-how-do-they-work 6. https://learningtechnologyofficial.com/category/fluid-mechanics-lab/ 7. http://www.sound-physics.com/ 8. http://nptel.ac.in/courses/112104026/

Course outcomes	On completion of this course, students will be able to:
CO1	Relate elastic behavior in terms of three modulii of elasticity and working of torsion pendulum
CO2	Able to appreciate concept of bending of beams and analyze the expression, quantify and understand nature of materials
CO3	Explain the surface tension and viscosity of fluid and support the interesting phenomena associated with liquid surface, soap films provide an analogue solution to many engineering problems.
CO4	Analyze simple harmonic motions mathematically and apply them. Understand the concept of resonance and use it to evaluate the frequency of vibration. Set up experiment to evaluate frequency of ac mains
CO5	Understand the concept of acoustics, importance of constructing buildings with good acoustics. Able to apply their knowledge of ultrasonics in real life, especially in medical field and assimilate different methods of production of ultrasonic waves ultrasonic waves

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Basic Physics Practicals – 1

Title of the Course		**Basic Physics Practicals – 1**					
Course Type		**Core - Practicals-I**					
Year	**I**	**Semester**	**I**	**Credits**	**2**	**Course Code**	**25UMPHL1**
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**		**Total**	
		-	**-**	**3**		**3**	

Experiments

(Minimum of Eight Experiments from the list)

1. Verification of Hooke's law by stretching of wire method.
2. Determination of rigidity modulus without mass using Torsional pendulum.
3. Determination of rigidity modulus with masses using Torsional pendulum.
4. Determination of Young's modulus by uniform bending – load depression graph.
5. Determination of Young's modulus by non-uniform bending – scale and telescope.
6. Determination of Young's modulus by cantilever – load depression graph.
7. Determination of Young's modulus by Koenig's method – (or unknown load)
8. Determination of surface tension and interfacial surface tension by drop weight method.
9. Determination of co-efficient of viscosity by Stokes' method – terminal velocity.
10. Determination of viscosity by Poiseullie's flow method.
11. Determination of g using compound pendulum.
12. Determination of Y, N and K by Searles double bar method.

Physics for Everyday Life

Title of the Course		**Physics For Everyday Life**					
Course Type		**Skill Enhancement Course - I**					
Year	**I**	**Semester**	**I**	**Credits**	**2**	**Course Code**	**25USPH11**
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**		**Total**	
		2	**-**	**--**		**2**	

Learning Objectives: After studying this topic, students should be able to	
LO1	Know the physics principles have been put to use in mechanical objects
LO2	Recognize the principles underlying optical instruments
LO3	Gain a deeper comprehension of the principles pertaining to household appliances
LO4	Know about solar energy its applications with better understanding.
LO5	Know about Indian scientists who have made significant contributions to Physics.

Unit	Contents
I	**Mechanical Objects:** Spring scales–bouncing balls–roller coasters – bicycles –rockets
II	**Optical Instruments And Laser:** Vision corrective lenses– polaroid glasses – UV protective glass – polaroid camera – colour photography – holography and laser.
III	**Physics Of Home Appliances:** Bulb–fan–hair drier– television – air conditioners – microwave ovens.
IV	**Solar Energy:** Solar constant–General applications of solar energy –Solar water heaters– Solar Photo–voltaic cells–General applications of solar cells
V	**Indian Physicist And Their Contributions:** C.V.Raman, Homi Jehangir Bhabha, Vikram Sarabhai, Subrahmanyan Chandrasekhar, Venkatraman Ramakrishnan, Dr. APJ Abdul Kalam and their contribution to science and technology.

Extended Professional Component (It is a part of the internal component only and is not to be included in the external examination question paper.)	Principles of physics in daily life will be discussed
Skills acquired from this Course	Proficiency, Knowledge and Transferable Skills
Recommended Texts:	1. The Physics in our Daily Lives, Umme Ammara, Gugucool Publishing, Hyderabad, 2019. 2. For the love of physics, Walter Lawin, Free Press, NewYork, 2011.
References Books:	1. Halliday, D.,Resnick,R. and Walker,J.(2014) Fundamental of Physics.10th
Web Resources	1. https://www.youtube.com/watch?v=QqsieD5BEw8 2. https://www.youtube.com/watch?v=R8QFOBam5gE

Course outcomes	On completion of this course, students will be able to:
CO1	Acquire knowledge about the properties of the mechanical objects
CO2	Understand the fundamentals of optics and significant optical devices
CO3	Learn the principles and functions of household appliances
CO4	Examine the significance of solar energy and its uses
CO5	Learn the contributions made by the Indian physicist

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Introductory Physics

Title of the Course		**Introductory Physics**					
Course Type		**Fundamental Course**					
Year	**I**	**Semester**	**I**	**Credits**	**2**	**Course Code**	**25UFPH11**
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**		**Total**	
		2	**-**	**--**		**2**	

Learning Objectives: After studying this topic, students should be able to	
LO1	Differentiate between scalar and vector quantities, perform vector operations and resolution, determine resultant vectors, and understand units, dimensions, and standard physics constants.
LO2	Understand natural forces—gravitational, electrostatic, magnetic, electromagnetic, and nuclear—and apply these concepts to real-world scenarios.
LO3	Understand the various types of energy and the principles of energy, momentum, and angular momentum conservation in physical systems.
LO4	Analyze different types of motion—linear, projectile, circular, angular, and simple harmonic—and concepts like curved road banking, fluid flow, wave motion, and the comparison of light and sound waves.
LO5	Understand the physics of sound—velocity, intensity, Doppler effect, and sonic boom—along with material properties like conductors, semiconductors, and insulators, focusing on their thermal and electrical characteristics.

Unit	Contents
I	**Vectors & Scalars :** Examples for scalars and vectors from physical quantities – addition, subtraction of vectors – resolution and resultant of vectors – Physical quantities - units and dimensions – standard physics constants
II	**Different types of forces:** Gravitational, Electrostatic, Magnetic, Electromagnetic, Nuclear forces – Mechanical Forces: centripetal, centrifugal forces, cohesive and adhesive forces.
III	**Types of Energy and Conservation Laws:** Different types of energy: Mechanical, chemical, electrical, heat, light and sound energy – conservation of energy and momentum - conservation laws of angular momentum.
IV	**Types of motion :** Linear, Projectile, Circular, Angular, Simple Harmonic motions – banking of a curved road - stream line and turbulent motions – wave motion – comparison of light and sound waves.
V	**Physics of sound:** Velocity of sound in different medium – Sound intensity level – Doppler effect – Sonic boom. **Properties and types of materials:** Conductors, Semi-Conductors and Insulators – Thermal And Electric Properties.

Extended Professional Component (It is a part of the internal component only and is not to be included in the external examination question paper.)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts:	1. D.S.Mathur, 2010, Elements of Properties of Matter, S.Chand & Co 2. BrijLal & N. Subrahmanyam, 2003, Properties of Matter, S.Chand & Co. 3. H.C. Verma, Concepts of Physics, Bharati Bhawan Publishers
References Books:	1. H.R. Gulati, 1977, Fundamental of General Properties of Matter, Fifth edition, S.Chand & Co.
Web Resources	1. http://hyperphysics.phyastr.gsu.edu/hbase/permot2.html 2. https://science.nasa.gov/ems/ 3. https://eesc.columbia.edu/courses/ees/climate/lectures/radiation_hays/

Course outcomes	On completion of this course, students will be able to:
CO1	Apply concept of vectors to understand concepts of Physics and solve problems
CO2	Appreciate different forces present in Nature while learning about phenomena related to these different forces.
CO3	Analyze and apply the concepts of various energy forms, as well as the conservation laws of energy, momentum, and angular momentum in physical systems.
CO4	Apply principles of different types of motion, analyze fluid dynamics, and compare wave behaviors, including light and sound waves, in various physical contexts.
CO5	Explain the physics of sound, including its velocity, intensity, Doppler effect, and sonic boom, while also differentiating between conductors, semiconductors, and insulators based on their thermal and electrical properties.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	3	3
CO2	2	3	3	3	2
CO3	2	2	3	2	3
CO4	3	3	3	3	3
CO5	3	3	2	3	3

Allied Physics – I

(for I - Mathematics, II - Chemistry)

Title of the Course		Allied Physics – I					
Course Type		Elective - I					
Year	I	Semester	I	Credits	2	Course Code	25UEPH11
Instructional Hours per week		Lecture	Tutorial	Lab Practice		Total	
		3	1	-		4	

Learning Objectives: After studying this topic, students should be able to	
LO1	To introduce the basics of waves, oscillation and ultrasonics.
LO2	To enable the students to gain the knowledge of properties of matter.
LO3	To make the students to understand the concept of thermodynamics.
LO4	Equipping the students to be successfully understand the basic ideas of electricity and magnetism.
LO5	To motivate the students towards the digital India with the help of digital electronics.

Unit	Contents
I	**Waves, Oscillations And Ultrasonics:** simple harmonic motion (SHM) – Lissajous figures – uses – laws of transverse vibrations of strings – determination of AC frequency using sonometer (steel and brass wires) – ultrasound – production – piezoelectric method – application of ultrasonics: medical field.
II	**Properties Of Matter:** Elasticity: elastic constants – bending of beam – theory of non- uniform bending – determination of Young's modulus by non-uniform bending – energy stored in a stretched wire – torsion of a wire – determination of rigidity modulus by torsional pendulum. **Viscosity:** streamline and turbulent motion – critical velocity – coefficient of viscosity – Poiseuille's formula - Surface tension: definition – droplets formation–shape, size and lifetime.
III	**Heat And Thermodynamics:** Joule-Kelvin effect – JouleThomson porous plug experiment – temperature of inversion – thermodynamic system – thermodynamic equilibrium – laws of thermodynamics – heat engine – Carnot's cycle – efficiency – entropy – change of entropy in reversible and irreversible process
IV	**Electricity And Magnetism:** potentiometer – principle – measurement of thermo emf using potentiometer –magnetic field due to a current carrying conductor – Biot-Savart's law – peak, average and RMS values of ac current and voltage – power factor and current values in an AC circuit – fuses and circuit breakers in houses.
V	**Digital Electronics:** logic gates, OR, AND, NOT, NAND, NOR , EXOR logic gates – universal building blocks – Boolean algebra – De Morgan's theorem – verification. **Number System:** Introduction to number system – Number base system (Decimal, Binary) – its conversions – Binary addition - Binary Subtraction by 1's and 2's complement

Extended Professional Component (It is a part of the internal component only and is not to be included in the external examination question paper.)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts:	1. R.Murugesan (2001), Allied Physics, S. Chand and Co,New Delhi.
References Books:	1. Resnick Halliday and Walker (2018). Fundamentals of Physics (11thedition), John Willey and Sons, Asia Pvt.Ltd., Singapore. 2. V.R.Khanna and R.S.Bedi (1998), Textbook of Sound1stEdn. Kedharnaath Publish and Co, Meerut. 3. V.K.Metha (2004). Principles of electronics 6th Edn. S.Chand and company. 4. Brijlal and N.Subramanyam, (1994), Waves and Oscillations, Vikas Publishing House, New Delhi. 5. Brijlal and N.Subramaniam (1994), Properties of Matter, S.Chand and Co., New Delhi.
Web Resources	1. https://youtu.be/M_5KYncYNyc 2. https://youtu.be/ljJLJgIvaHY 3. https://youtu.be/7mGqd9HQ_AU 4. https://youtu.be/h5jOAw57OXM

Course outcomes	On completion of this course, students will be able to:
CO1	This course is framed to provide in depth knowledge of waves, oscillations, ultrasonic and their applications in physical world.
CO2	The students will be able understand the fundamental concepts of properties of matter and viscosity.
CO3	Gain knowledge on the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy, the thermodynamic potentials and their physical interpretations. Understand the working of Carnot's ideal heat engine, Carnot cycle and its efficiency.
CO4	Understand electricity and magnetism on a level that uses standard mathematical tools.
CO5	Understand the operation of basic logic gates and universal gates and their truth tables.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	1	1
CO2	1	3	1	2	3
CO3	2	3	2	1	3
CO4	2	3	2	3	3
CO5	3	3	3	2	2

Allied Practicals – I

(for I - Mathematics, II - Chemistry)

Title of The Course		**Allied Practicals – I**					
Course Type		**Elective - I**					
Year	**I**	**Semester**	**I**	**Credits**	**2**	**Course Code**	**25UEPHL1**
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**		**Total**	
		-	**-**	**3**		**3**	

Experiments **(Minimum of EIGHT Experiments from the list)**
1. Young's modulus by non-uniform bending using pin and microscope.
2. Young's modulus by uniform bending using optic lever, scale and telescope.
3. Rigidity modulus by torsional oscillations without mass.
4. Verification of Newton's Law of Cooling.
5. Co-efficient of viscosity - Stoke's method.
6. Surface tension and interfacial Surface tension – drop weight method.
7. Verification of laws of transverse vibrations using sonometer.
8. Calibration of low range voltmeter using potentiometer.
9. Calibration of low range ammeter using potentiometer.
10. Thermoemf using potentiometer.
11. Thickness of a wire using air wedge.
12. Construction of AND, OR, NOT gates using IC's.

Semester - II

Heat, Thermodynamics and Statistical Physics

Title of the Course		Heat, Thermodynamics and Statistical Physics					
Course Type		Core - II					
Year	I	Semester	II	Credits	5	Course Code	25UMPH21
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		4	1		--	5	

Learning Objectives	
LO1	To learn about calorimetry, which involves the measurement of heat changes in chemical reactions or physical processes. Understand how to calculate heat changes using calorimetric equations. To get an overview of the principles of low temperature production and the thermodynamics behind it.
LO2	Make the students to understand the key thermodynamic concepts of zeroth law and first law of thermodynamics and hence understand the theorical performance of cycles and heat engines.
LO3	To a quire the thermodynamic concepts of second law i.e. the concept of entropy and the direction of spontaneous processes.
LO4	To gain basic concept of heat transfer
LO5	Create a bridge between theory of the micro world (theory of individual molecules and their interactions) and theory of macroscopic phenomena thermodynamic quantities and derivations and also understand the laws of thermodynamics from the laws of quantum mechanics

Unit	Contents
I	**Calorimetry:** specific heat capacity – specific heat capacity of gases C_P & C_V– Meyer's relation – Joly's method for determination of C_V. **Low Temperature Physics:** Joule-Kelvin effect – porous plug experiment – Boyle temperature – temperature of inversion – liquefaction of gas by Linde's Process- adiabatic demagnetization.
II	**Thermodynamics-I:** zeroth law and first law of thermodynamics– heat engine – efficiency of heat engine – Carnot's engine, construction, working and efficiency of petrol engine and diesel engines.
III	**Thermodynamics-II:** second law of thermodynamics –entropy of an ideal gas – entropy change in reversible and irreversible processes – T-S diagram – Maxwell's thermodynamical relations –Clasius- Clapeyron's equation (first latent heat equation) – third law of thermodynamics.
IV	**Heat Transfer:** modes of heat transfer: conduction, convection and radiation. Conduction: thermal conductivity – determination of thermal conductivity of a bad conductor by Lee's disc method. Radiation: black body radiation (Ferry's method) – distribution of energy in black body radiation – Wien's law and Rayleigh Jean's law –Planck's law of radiation – Stefan's law.
V	**Statistical Mechanics:** definition of phase-space – micro and macro states – ensembles –different types of ensembles – classical and quantum Statistics – Maxwell-Boltzmann statistics – expression for distribution function – Bose – Einstein Statistics- Fermi-Dirac statistics –Comparison.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Texts	1. Brijlaland N. Subramaniam, 2000, Heat and Thermodynamics, S.Chand and Co. 2. Narayanamoorthy and KrishnaRao, 1969, Heat,Triveni Publishers, Chennai. 3. R.Murugeshan and Kiruthiga Sivaprasath, Thermal Physics, S.Chand and Co.
Reference books:	1. J.B.Rajam and C.L.Arora, 1976, Heat and Thermodynamics, 8th edition, S.Chand and Co. Ltd. 2. Gupta, Kumar, Sharma, 2013, Statistical Mechanics, 26th Edition, S. Chand and Co. 3. D.S.Mathur, Heat and Thermodynamics, Sultan Chand and Sons. 4. Resnick, Halliday and Walker, 2010, Fundamentals of Physics, 6th Edition.
Web Resources	1. https://youtu.be/M_5KYncYNyc 2. https://www.youtube.com/watch?v=4M72kQulGKk&vl=en

Course outcomes CO	**On completion of this course, students will be able to**
CO1	Acquires knowledge on how to distinguish between temperature and heat. Introduce him/her to the field of thermometry and explain practical measurements of high temperature as well as low temperature physics. Student identifies the relationship between heat capacity, specific heat capacity. The study of Low temperature Physics sets the basis for the students to understand cryogenics, superconductivity, super fluidity and Condensed Matter Physics
CO2	Derive the efficiency of Carnot's engine. Discuss the implications of the laws of Thermodynamics in diesel and petrol engines
CO3	Able to analyze performance of thermodynamic systems viz efficiency by problems. Gets an insight into thermodynamic properties like enthalpy, entropy
CO4	Study the process of thermal conductivity and apply it to good and bad conductors. Quantify different parameters related to heat, relate them with various physical parameters and analyse Them
CO5	Interpret classical statistics concepts such as phase space, ensemble, Max well-Boltzmann distribution law. Develop the statistical interpretation of Bose-Einstein and Fermi-Dirac. Apply to quantum particles such as photon and electron

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2
CO2	3	3	2	2	2
CO3	3	3	2	3	2
CO4	3	3	2	2	2
CO5	3	2	2	3	2

Core Practicals – II

Title of the Course	Core Practicals – II						
Course Type	Core – Lab - II						
Year	I	Semester	II	Credits	2	Course Code	25UMPHL2
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		-		--	3	3	

Experiments
(Minimum of Eight Experiments from the list)

1. Determination of specific heat capacity of liquid by cooling method.
2. Determination of thermal conductivity of bad conductor by Lee's disc method.
3. Determination of specific heat capacity of solid using method of mixture.
4. Verification of Newton's law of cooling.
5. Determination of Latent heat of a vaporization of a liquid.
6. Determination of Stefan's constant for Black body radiation.
7. Verification of Stefan's-Boltzmans law.
8. Velocity of sound through a wire using Sonometer.
9. Determination of frequency of an electrically maintained tuning fork
10. Verification of the laws of transverse vibration using sonometer.
11. Verification of the laws of transverse vibration using Melde's apparatus.
12. Frequency of AC by using sonometer.

Astrophysics

Title of the Course	Astrophysics						
Course Type	Skill Enhancement Course - II						
Year	I	Semester	II	Credits	2	Course Code	25USPH21
Instructional Hours per week	Lecture	Tutorial		Lab Practice	Total		
	2	-		-	2		

Learning Objectives:	
LO1	To introduce the principles of astrophysics.
LO2	To describe the science of formation and evolution of stars.
LO3	To interpret the various heavenly phenomena.
LO4	To provide an understanding of the physical nature of celestial bodies.
LO5	To provide the instrumentation and techniques used in astronomical research.

Unit	Contents
I	**Telescopes:** Optical telescopes – magnifying power, brightness, resolving power and f/a ratio – types of reflecting and refracting telescopes – detectors and image processing – radio telescopes – Hubble space telescope.
II	**Solar System:** Bode's law of planetary distances – meteors, meteorites, comets, asteroids – Kuiper belt – Oort cloud – detection of gravitational waves – recent advances in astrophysics.
III	**Eclipses:** types of eclipses – solar eclipse – total and partial solar eclipse – lunar eclipse – total and partial lunar eclipse – transits. **The Sun:** physical and orbital data – solar atmosphere – photosphere – chromosphere – solar corona – prominences – sunspots – 11year solar cycle – solar flares.
IV	**Stellar Evolution:** H-R diagram – birth & death of low mass, intermediate mass and massive stars – Chandrasekar limit – white dwarfs – neutron stars – pulsars – black holes – supernovae. **Galaxies:** classification of galaxies – galaxy clusters –interactions of galaxies, dark matter and super clusters – evolving universe.

V	**Activities In Astrophysics:** (i) Basic construction of telescope. (ii) Develop models to demonstrate eclipses/planetary motion (iii) Night sky observation. (iv) Conduct case study pertaining to any topic in this paper. (v) Visit to any one of the National Observatories Any three activities to be done compulsorily.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. Baidyanath Basu, (2001). An introduction to Astrophysics, Second printing, Prentice – Hall of India (P) Ltd, New Delhi 2. K.S.Krishnaswamy, (2002), Astrophysics – a modern perspective, New Age International (P) Ltd, New Delhi. 3. Shylaja, B.S. & Madhusudan, H.R.,(1999), Eclipse: A Celestial Shadow Play, Orient Black Swan,
Reference books:	Jean Dufay, Introduction to Astrophysics: The Stars, Dover Publications, 2012
Web Resources	https://www.youtube.com/watch?v=_yB56tgILUM

Course outcomes: CO	On completion of this course, the students will be able to:
CO1	Know the functions of telescopes and their applications.
CO2	Understand the principles and recent advances in Astrophysics.
CO3	Analyse the solar cycle.
CO4	Understand the universe's fundamental processes.
CO5	Expand astrophysics-related activities.

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	2	2	2	2
CO3	3	2	3	3	2
CO4	2	2	3	2	2
CO5	3	3	3	3	3

Energy Physics

Title of the Course		Energy Physics					
Course Type		Skill Enhancement Course - III					
Year	I	Semester	II	Credits	2	Course Code	25USPH22

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	2		-	2

Learning Objectives	
LO1	To differentiate between conventional and non-conventional energy sources, as well as renewable and non-renewable energy sources. Also to evaluate the merits and demerits of various energy sources through comparative analysis
LO2	To gain an understanding of solar energy, including solar radiation at the Earth's surface and methods for measuring solar radiation and to explore various applications of solar energy and photovoltaic cells.
LO3	To understand the basic principles and evaluate the advantages, disadvantages, and applications of wind energy and tidal energy conversion system in energy generation
LO4	To learn about biomass and biogas generation, factors influencing it, and the classification of biogas plants, along with their advantages and disadvantages.
LO5	To understand the importance of energy storage and the role of batteries in energy systems. Also to learn about fuel cells, their types, and the advantages and disadvantages of their usage.

Unit	Contents
I	**Introduction To Energy Sources:** Introduction to energy reserve – world energy sources reserve and their availability – conventional and non- conventional energy sources – renewable and non- renewable energy sources – comparison – merits and demerits.
II	**Solar Energy:** Solar energy: Introduction – solar radiation at the Earth's surface – Solar radiation measurements – Applications: solar pond – solar cooker (Box type) – solar water heater – solar greenhouse – solar crop dryer - Photovoltaic cell and its principle – Applications: PV powered fan and area lighting system.

III	**Wind And Tidal Energy:** Introduction – basic principle of wind energy conversion – basic components and working of Wind Energy Conversion Systems (WECS) – advantages and disadvantages of WECS – applications – Tidal energy – advantages and limitations.
IV	**BIOMASS ENERGY:** Introduction – classification of biomass – biomass conversion technologies – biogas generation – factors affecting biogas generation - classification of biogas plants – advantages and disadvantages – Thermal gasification of biomass and its classification.
V	**ENERGY STORAGE:** Importance of energy storage - batteries - lead acid battery - nickel-cadmium battery – fuel cells – types of fuel cells – advantages and disadvantages of fuel cells – applications of fuel cells.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. G.D. Rai, Non-Conventional Sources of Energy, Khanna Publishers, 2009, 4th Edn. 2. S.P.Sukhstme, J.K.Nayak, Solar Energy, Principles of Thermal Collection and Storage, McGraw Hill, 2008, 3rdEdn. 3. D.P.Kothari, K.P.Singal, Rakesh Rajan, PHI Learning Pvt Ltd, 2011, 2nd Edn.
Reference books:	1. John Twidell and, Tony Weir, Renewable Energy Resources, Taylor and Francis, 2005, 2ndEdn. 2. S.A. Abbasi and Nasema Abbasi, Renewable Energy sources and their environmental impact, PHI Learning Pvt. Ltd, 2008. 3. M. P. Agarwal, Solar Energy, S. Chand and Co. Ltd., New Delhi,1982 4. H. C. Jain, Non-Conventional Sources of Energy, Sterling Publishers, 1986.
Web Resources	1. https://landgreen.github.io/physics/notes/energy/energy/ 2. https://www.un.org/en/climatechange/what-is-renewable-energy 3. https://www.edfenergy.com/energywise/renewable-energy-sources

Course outcomes: CO	On completion of this course, the students will be able to:
CO1	Analyze global energy reserves, their availability, and the comparison of conventional, non-conventional, renewable, and non-renewable energy sources with their merits and demerits.
CO2	Understand solar energy principles, radiation measurement, and applications, including photovoltaic systems and solar- based devices for heating, lighting, and drying.
CO3	Comprehend the principles, components, and applications of Wind Energy Conversion Systems (WECS) and tidal energy, along with their advantages and limitations.
CO4	Understand biomass energy, its classification, conversion technologies, biogas generation processes, and thermal gasification methods, including their advantages and limitations.
CO5	Gain knowledge of energy storage systems, including batteries and fuel cells, their types, advantages, limitations, and practical applications.

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2
CO2	3	3	2	3	3
CO3	3	3	2	3	3
CO4	3	3	2	3	3
CO5	3	3	2	3	3

Allied Physics – II

(for I - Mathematics, II - Chemistry)

Title of the Course	Allied Physics – II						
Course Type	Elective - IV						
Year	I	Semester	II	Credits	3	Course Code	25UEPH21

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	3	1	-	4

Learning Objectives:

LO1	To introduce the basics of optics.
LO2	To enable the students to gain the knowledge of atomic physics.
LO3	To make the students to understand the concept of nuclear physics.
LO4	Equipping the students to be successfully understand the basic ideas of relativity.
LO5	To motivate the students towards the applications of semiconductor devices.

Unit	Contents
I	**Optics:** Interference – interference in thin films – colors of thin films – air wedge – determination of diameter of a thin wire by air wedge – diffraction – normal incidence – experimental determination of wavelength using diffraction grating (no theory) – polarization – polarization by double reflection – Brewster's law – optical activity – application in sugar industries.
II	**Atomic Physics:** Atom models – Bohr atom model – mass number – atomic number – nucleons – vector atom model – Pauli's exclusion principle – periodic classification of elements – photo electric effect – Einstein's photoelectric equation – applications of photoelectric effect: solar cells.
III	**Nuclear Physics:** Nuclear models – liquid drop model – nuclear energy – mass defect – binding energy – radioactivity – uses – half life – mean life - radio isotopes and uses -nuclear fission – energy released in fission - nuclear fusion – differences between fission and fusion.
IV	**Special theory of relativity:** Frame of reference – postulates of special theory of relativity – Galilean transformation equations – Lorentz transformation equations – derivation – length contraction – time dilation.
V	**Semiconductor Physics:** p-n junction diode – forward and reverse biasing – zener diode – characteristic of zener diode – full wave bridge rectifier – construction and working – advantages (no mathematical treatment) - Transistor- PNP-NPN – working.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. R.Murugesan (2005), Allied Physics, S.Chand and Co, New Delhi. 2. K.Thangaraj and D.Jayaraman (2004), Allied Physics, Popular Book Depot, Chennai.
Reference books:	1. Resnick Halliday and Walker (2018), Fundamentals of Physics, 11th Edn. John Willey and Sons, Asia Pvt.Ltd., Singapore. 2. D.R.Khanna and H.R. Gulati (1979).Optics, S.Chand and Co. 3. A.Beiser (1997), Concepts of Modern Physics, Tata Mc GrawHill Publication, New Delhi. 4. V.K.Metha (2004), Principles of electronics, 6th Edn. S.Chand and Company, New Delhi.
Web Resources	1. https://www.youtube.com/watch?v=JrRrp5F-Qu4 2. https://www.atoptics.co.uk/atoptics/blsky.htm

Course outcomes: CO	**On completion of this course, the students will be able to:**
CO1	Explain the concepts of interference diffraction using principles of superposition of waves and rephrase the concept of polarization based on wave patterns
CO2	Outline the basic foundation of different atom models and various experiments establishing quantum concepts. Relate the importance of interpreting improving theoretical models based on observation. Appreciate inter disciplinary nature of science and in solar energy related applications
CO3	Summarize the properties of nuclei, nuclear forces structure of atomic nucleus and nuclear models. Solve problems on delay rate half-life and mean-life. Interpret nuclear processes like fission and fusion. Understand the importance of nuclear energy, safety measures carried and get our Govt. agencies like DAE guiding the country in the nuclear field.
CO4	To describe the basic concepts of relativity like equivalence principle, inertial frames and Lorentz transformation. Extend their knowledge on concepts of relativity and vice versa. Relate this with current research in this field and get an overview of research projects of National and International importance,
CO5	Summarize the working of semiconductor devices like junction diode, Zener diode, transistors and practical devices we daily use like USB chargers.

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	1	1
CO2	1	3	1	2	3
CO3	2	3	2	1	3
CO4	2	3	2	3	3
CO5	3	3	3	2	2

Allied Practicals - II
(for I - Mathematics, II - Chemistry)

Title of the Course	**Allied Practicals – II**						
Course Type	**Elective - IV – Lab - 2**						
Year	**I**	**Semester**	**II**	**Credits**	**2**	**Course Code**	**25UEPHL2**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		-	**--**		**2**	**2**	

Experiments

(Minimum of EIGHT Experiments from the list)

1. Radius of curvature of lens by forming Newton's rings.
2. Wavelength of mercury lines using spectrometer and grating.
3. Refractive index of material of the prism by minimum deviation.
4. Deflection magnetometer (Tan A).
5. Determination of AC frequency using sonometer.
6. Specific resistance of a wire using PO box.
7. Thermal conductivity of poor conductor using Lee's disc.
8. Determination of figure of merit table galvanometer.
9. Determination of Earth's magnetic field using field along the axis of a coil.
10. Characterization of Zener diode.
11. Bridge Rectifier.
12. NOR gate as a universal building block.

Semester - III

Mechanics

Title of the Course		Mechanics					
Course Type		Core III					
Year	II	Semester	III	Credits	5	Course Code	25UMPH31
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		4	1		--	5	

Learning Objectives	
LO 1	To understand the laws and principles of mechanics
LO 2	To apply the concepts of forces existing in the system
LO 3	To understand the forces of physics in everyday life
LO 4	To visualize conservation laws
LO 5	To apply Lagrangian equation to solve complex problems

Unit	Contents
I	**Laws Of Motion:** Newton's Laws– forces – equations of motion – frictional force – motion of a particle in a uniform gravitational field. ***Gravitation*:** Kepler's laws, Newton's law of gravitation – Determination of G by Boy's method – Earth-moon system – weightlessness – earth satellites –earth density – mass of the Sun – gravitational potential – velocity of escape – satellite potential and kinetic energy.
II	**Conservation Laws Of Linear And Angular Momentum: c**onservation of linear and angular momentum – Internal forces and momentum conservation – center of mass – general elastic collision of particles of different masses – system with variable mass – conservation of angular momentum – torque due to internal forces – torque due to gravity – angular momentum about center of mass.
III	**Conservation Laws Of Energy:** Introduction – significance of conservation laws – law of conservation of energy - concepts of work- power – energy – conservative forces – potential energy and conservation of energy in gravitational field – non - conservative forces – general law of conservation of energy.

IV	**Rigid Body Dynamics: t**ranslational and rotational motion – angular momentum – moment of inertia – parallel and perpendicular axis theorem – rotation about fixed axis – kinetic energy of rotation – examples – body rolling along a plane surface – body rolling down an inclined plane.
V	**Lagrangian Mechanics:** generalized coordinates –degrees of freedom – constraints - principle of virtual work and D' Alembert's Principle – Lagrange's equation from D' Alembert's principle – application –simple pendulum – Atwood's machine.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Texts	1. J. C. Upadhyaya, 2019, Classical Mechanics, Himalaya Publishing house, Mumbai. 2. P. Durai Pandian, Laxmi Durai Pandian, Muthamizh Jaya pragasam, 2005, Mechanics, 6th revised edition, S.Chand& Co. 3. D. S. Mathur & P. S. Hemne, 2000, Mechanics, Revised Edition, S.Chand& Co.
Reference books	1. Goldstein Herbert, 1980, Classical Mechanics. U.S.A: Addison and Wesely. 2. Halliday, David Robert Resnick and Walker Jearl, 2001, Fundamentals of Physics, John Wiley, New Delhi
Web Resources	1. https://youtu.be/X4_K-XLUIB4 2. https://nptel.ac.in/courses/115103115 3. https://www.youtube.com/watch?v=p075LPq3Eas 4. https://www.youtube.com/watch?v=mH_pS6fruyg 5. https://onlinecourses.nptel.ac.in/noc22_me96/preview 6. https://www.youtube.com/watch?v=tdkFc88Fw-M 7. https://onlinecourses.nptel.ac.in/noc21_me70/preview

Course outcomes CO	On completion of this course, students will be able to
CO1	Understand the Newton's Law of motion, understand general theory of relativity, Kepler's laws and Realize the basic principles behind planetary motion
CO2	Acquire the knowledge on the conservation laws
CO3	Apply conservation law and calculate energy of various systems, understand and differentiate conservative and non-conservative forces
CO4	Gain knowledge on rigid body dynamics and solve problems based on this concept
CO5	Apply D'Alembert's principle and understand the Lagrangian system of mechanics.

Mapping With Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	2	S	3	3	2
CO2	3	3	3	2	S	2	3	3
CO3	3	3	3	2	S	3	2	3
CO4	2	3	3	3	M	3	3	2
CO5	3	3	2	3	S	2	3	3

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	3	3	2	3	3
CO2	3	3	2	3	2
CO3	3	3	3	3	3
CO4	2	3	3	2	3
CO5	3	2	3	3	2

Core Practicals – III

Title of the Course	Core Practicals – III						
Course Type	Core - Practicals-III						
Year	II	Semester	III	Credits	2	Course Code	25UMPHL3
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		-		--	3	3	

Experiments
(Minimum of Eight Experiments from the list)

1. Determination of the 'g' using Simple pendulum.
2. Determination of the spring constant using various load method.
3. Verification of parallel axes theorem on moment of inertia.
4. Verification of perpendicular axes theorem on moment of inertia.
5. Determination of the rigidity modulus by static torsion method.
6. Determination of the Young's modulus by cantilever – oscillation method.
7. Determination of the moment of inertia of an irregular body.
8. Write a C program to find the type (alphabet, numeric, special) of given character.
9. Write a C program to find the sum of series $x = 1^2 + 2^2 + 3^2 + \ldots\ldots\ldots + n^2$.
10. Write a C program to find the sum of series $x = 1 + 3 + 5 + \ldots\ldots\ldots + n$.
11. Write a C program to find the factorial of the given number.
12. Write a C program to perform the basic arithmetic operations.

C Programming

Title of the Course	C Programming						
Course Type	Skill Enhancement Course - IV						
Year	II	Semester	III	Credits	2	Course Code	25USPH31
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		2		-	-	2	

Learning Objectives:	
LO 1	To introduce the key features and implementation of C.
LO 2	To explain the basic operator's mathematical functions and data input and output, rules of compiling and execution of C programming.
LO 3	To teach the student to write programs in C and to solve the problems.
LO 4	To understand the concept of function in the C Programming.
LO 5	To teach the students how to define the array. To train the students to write the programme using arrays.

Unit	Contents
I	**Introduction to C:-** Basic structure of C programs –Character set – C tokens –keyword and identifiers – Constants: Integer – Unsigned and long integer – Character – string - Variables – Data types – Declaring variables – Initializing variables – conversion rules for type conversion.
II	**Operators, Expressions & I/O Functions:-** Types of operators – Arithmetic operators - Relational, logical, and assignment operators - Increment and decrement operators – Conditional operators – arithmetic expressions – Mathematical functions – priority of operators - Data input and output – getchar( ), putchar( ) , gets( ) , puts( ) - scanf( ), printf( ) - escape sequence.
III	**Control Statements:-** Simple IF statement – Simple IF- ELSE statement – looping operation using while statement – for statement – Break statement – Switch statement – Go to statement – Simple programs : To find the solution of quadratic equation - Fibonacci series – To find the biggest of three no's, factorial of a no, 5odd or even number.
IV	**Functions: -** Defining a function – Accessing a function – Category of function – Recursion - Library function. Programs using functions: Binomial coefficient, Generating Sin series, summing the numbers 1 to using recursion method.
V	**Arrays: -** Defining an Array – Processing an array – one, two dimensional arrays – Simple programs using arrays: addition of two matrices - subtraction of two matrices – Multiplication of two matrices ascending and descending order.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. Theory and problems of programming with C – By Byron Gottfried Second edition – Tata Megraw Hill, 2004. 2. Programming in C – Pradip Dey and Manas Ghosh, Oxford University Press, Second Edition.
Reference books	1. Programming in C – By E. Balagurusamy – Third Edition – Tata Megraw Hill, 2004. 2. Programming in C by S. Ramasamy and P. Radhaganesan, Scitech Publications (India) Private Limited, Chennai and Hyderabad, 2006.

Course outcomes: CO	**On completion of this course, the students will be able to:**
CO1	Acquire the knowledge of basic structure of C programme, constants, and variables in c programming.
CO2	Understand the concepts of operators and mathematical functions.
CO3	Able to write the programme using If statement and go to condition.
CO4	Gain the knowledge of function and recursion.
CO5	Able to write the simple programme using arrays such as addition and subtraction of two matrices and multiplications of two matrices.

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	2	2	3	3	2
CO3	2	3	2	2	2
CO4	2	3	2	2	3
CO5	2	3	2	3	3

Semester - IV

Optics and Laser Physics

Title of the Course		Optics and Laser Physics					
Course Type		Core - IV					
Year	II	Semester	IV	Credits	5	Course Code	25UMPH41
Instructional Hours Per week		Lecture	Tutorial		Lab Practice	Total	
		4	1		--	5	
Learning Objectives							
LO1		To provide an in-depth understanding of the basics of various phenomena in Geometrical and wave optics.					
LO2		To explain the behavior of light in different mediums.					
LO3		To understand the differences in the important phenomena namely interference, Diffraction and Polarization and apply the knowledge in day today life.					
LO4		To understand the design of optical systems and methods to minims aberrations.					
LO5		To understand the working and applications of laser.					

Unit	Contents
I	**Lens And Prisms:** Lens: Lenses and its types – Equivalent focal length of two thin lenses in contact and separated by a distance – power of a lens. Aberrations: Spherical aberration, Methods of minimizing Spherical Aberration and chromatic aberrations. Prism: Dispersion by a prism, Angular dispersion and Dispersive power, Achromatic combination of prisms- Deviation without dispersion and Dispersion without deviation. Eyepieces: Huygen‘s and Ramsden‘s eyepieces, construction and working – comparison.
II	**Interference:** – Conditions – Theory of Interference - Fresnel‘s biprism – Experimental determination of the wavelength of light - Colours of thin films - Production of colours in thin films – Air wedge – Newton‘s rings. Interferometers : Michelson’s interferometer – applications, (i) determination of the wavelength of a monochromatic source of light, (ii) determination of the wavelength and separation D_1 and D_2 lines of sodium light, (iii) determination of a thickness of a mica sheet.

III	**Diffraction:** Fresnel and Fraunhofer diffraction - Fresnel's explanation of Rectilinear propagation of light - zone plate – action of zone plate for an incident spherical wave front – differences between a zone plate and a convex lens – diffraction pattern due to a straight edge – plane transmission diffraction grating– experiment to determine wavelengths.
IV	**Polarisation:** Polarisation of light -double refraction – Nicol prism – Plane, circularly and elliptically polarized light –quarter wave plate – half wave plate – production and detection of circularly and elliptically polarized lights – Optical activity - Fresnel's explanation – Laurent half shade polarimeter – experiment to determine specific rotatory power.
V	**Lasers:** general principles of lasers – properties of lasers action – spontaneous and stimulated emission – population inversion–optical pumping–He-Ne laser (principle and working) – CO_2 laser (principle and working) – laser applications – Introduction to holography.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC/CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Texts	1. Subramaniam N & Brijlal, 2014, Optics, 25thedition, S. Chand & Co. 2. Murugeshan. R and Kiruthiga Sivaprasath, 2014, Optics and Spectroscopy, 9th Edition,S.Chandand Co.
Reference books	1. Sathyaprakash, 1990, Optics,VII edition, Ratan Prakashan Mandhir, New Delhi. 2. Ajoy Ghatak, 2009, Optics, 4thedition, PHIPvt Ltd, New Delhi. 3. Jenkins A. Francis & White, 2011, Fundamentals of Optics, 4thedition, Mc Graw Hill Inc., New Delhi.

Web Resources	1. https://science.nasa.gov/ems/ 2. https://imagine.gsfc.nasa.gov/educators/gammarraybursts/imagine/index. html 3. http://www.thephysicsmill.com/2014/03/23/sky-blue-lord-rayleigh-sir- raman-scattering/

Course outcomes CO	On completion of this course, students will be able to
CO1	Outline basic knowledge of methods of rectifying different defects in lenses, articulate technological applications of eyepieces
CO2	Discuss the principle of superposition of wave, use these ideas to understand the wave nature of light through working of Interferometer
CO3	Extend the knowledge about nature of light through diffraction techniques; apply mathematical principles to analyse the optical instruments
CO4	Interpret basic formulation of polarization and gain knowledge about polarimeter, appraise its usage in industries
CO5	Relate the principles of optics to various fields of IR, Raman and UV spectroscopy and understand their instrumentation and Application in industries.

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	3	3	2	3	2
CO2	2	2	3	2	3
CO3	3	3	3	3	2
CO4	3	3	2	2	3
CO5	3	3	2	3	3

Core Practicals – IV

Title of the Course	**Core Practicals - IV**						
Course Type	**Core - Lab - 4**						
Year	**II**	**Semester**	**IV**	**Credits**	**2**	**Course Code**	**25UMPHL4**
Instructional Hours Per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		-	**--**		**3**	**3**	

Experiments
(Minimum of Eight Experiments from the list)

1. Determination of the refractive index of the material of the given small angled prism using spectrometer by normal incidence method.
2. Determination of the angle of deviation of a prism for various angle of incidences to draw i-d curve -Spectrometer
3. Determination of the angle of emergence i' for various angle of incidence i and to draw the i- i' curve - spectrometer
4. Determination of the wavelength of mercury spectral lines by keeping grating in minimum deviation.
5. Determination of the diameter of a thin wire using air wedge method.
6. Determination of the radius of curvature of a plano-convex lens using Newton's rings
7. Determination of refractive index using Laser.
8. Particle size determination using laser.
9. Wavelength determination using laser.
10. Measuring numerical aperture using Fiber optics.
11. Determination of the focal length of a concave mirror.
12. Determination of the focal length of converging lens.

Python Programming

Title of the Course	Python Programming						
Course Type	Skill Enhancement Course - V						
Year	II	Semester	IV	Credits	2	Course Code	25USPH41
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		2		-	-	2	

Learning Objectives	
LO1	To understand the features and history of python. To develop algorithms and design logical flow charts for solving problems and to solve simple formula based problems on computer using Python.
LO2	To understand the conditional and unconditional Statements, Decision Control Statements and to implement programs using python control Structure
LO3	To understand need for functions, variables and to use various operators in concatenating, appending, and multiplying strings. To develop programs using built-in string methods and functions.
LO4	To demonstrate creating, accessing elements in a tuples and lists and to develop programs using lists and tuples.
LO5	To understand various file types and file paths. To understand various operations on files and to implement programs on Files.

Unit	Contents
I	**Basics of Python programming** Introduction - Writing and Executing Python Program - Literal Constants - Variables and identifiers - Data types - Input operation – Reserved words - Operators and Expression. Write a python program: to calculate area of a triangle using Heron's formula - to compute distance between two points taking input from the user (use Pythagorean Theorem) – to calculate area of a circle – to convert Fahrenheit to degree Celsius.
II	**Decision Control and Looping Statements** Conditional Branching: if – if-else – nested if – if-elif-else. Iterative statements: while loop – for loop – range ( ) – Nested loop – break statement – continue statement. Write a python program: to calculate root of a quadratic equation – to convert binary number to decimal number – to print reverse of a number - to find the factorial of a given number.
III	**Functions and Strings** Functions **-** functions definition - function call and return –arguments: required, keyword and default - Lambda function – Good programming practices – Concatenating, appending and multiplying string - Built-in string methods and functions Write a program: to convert time into minutes – to find sum of sin series – to compute polynomial function (P(n,r)) - to calculate GCD using recursive function.
IV	**Tuples and Lists** Tuples: creating - accessing values – updating and deleting elements in a tuples - Basic Tuple operations - Lists: accessing - updating values in Lists – nested list – cloning list - basic List operations. Write a program: to swap two values using tuple assignment - to remove all duplicates from a list – to add two matrices using nested lists – to find the median of a list of numbers
V	**File Handling** Introduction – File path - Types of files – Opening and Closing files: open( ), close( ) – File position - Reading and writing files: write( ), write lines( ), append( ), read( ), read lines( ), splitting words – Renaming and deleting files. Write a program: to count the number of times a character appears in a file – to read a file and calculate percentage of vowels and consonants in a file - to copy contents of one file into another file - to compute the number of characters, words and lines in a file.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGCCSIR/GATE/TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. Reema Thareja, "Python Programming using problem solving approach", First Edition, 2017, Oxford University Press
Reference books	1. Fundamental of Pythons – First program by Kenneth A. Lambert 2. Python Programming – A modular approach by Pearson-Sheetal Taneja 3. Vamsi Kurama, "Python Programming: A Modern Approach", Pearson Education.
Web Resources	https://www.programiz.com/python-programming https://www.guru99.com/python-tutorials.html https://youtu.be/eWRfhZUzrAc https://www.learnpython.org/ https://www.tutorialspoint.com/python/index.htm

Course outcomes: CO	**On completion of this course, the students will be able to:**
CO1	Demonstrate the basic elements of Python
CO2	Implement programs using Python Control Structures.
CO3	Design functions in Python to solve the problems.
CO4	Apply strings, lists and tuples in developing Python programs.
CO5	Develop python programs by using files.

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	2	2	3	3	3

Allied Physics – IV

(for I - Mathematics, II - Chemistry)

Title of the Course	Allied Physics – IV						
Course Type	Elective - IV						
Year	II	Semester	IV	Credits	3	Course Code	25UEPH41

Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total
	3	1	-	4

Learning Objectives:	
LO1	To introduce the basics of optics.
LO2	To enable the students to gain the knowledge of atomic physics.
LO3	To make the students to understand the concept of nuclear physics.
LO4	Equipping the students to be successfully understand the basic ideas of relativity.
LO5	To motivate the students towards the applications of semiconductor devices.

Unit	Contents
I	**Optics:** Interference – interference in thin films – colors of thin films – air wedge – determination of diameter of a thin wire by air wedge – diffraction – normal incidence – experimental determination of wavelength using diffraction grating (no theory) – polarization – polarization by double reflection – Brewster's law – optical activity – application in sugar industries.
II	**Atomic Physics:** Atom models – Bohr atom model – mass number – atomic number – nucleons – vector atom model – Pauli's exclusion principle – periodic classification of elements – photo electric effect – Einstein's photoelectric equation – applications of photoelectric effect: solar cells.
III	**Nuclear Physics:** Nuclear models – liquid drop model – nuclear energy – mass defect – binding energy – radioactivity – uses – half life – mean life - radio isotopes and uses -nuclear fission – energy released in fission - nuclear fusion – differences between fission and fusion.
IV	**Special theory of relativity:** Frame of reference – postulates of special theory of relativity – Galilean transformation equations – Lorentz transformation equations – derivation – length contraction – time dilation.
V	**Semiconductor Physics:** p-n junction diode – forward and reverse biasing – zener diode – characteristic of zener diode – full wave bridge rectifier – construction and working – advantages (no mathematical treatment) - Transistor-PNP-NPN – working.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. R.Murugesan (2005), Allied Physics, S.Chand and Co, New Delhi. 2. K.Thangaraj and D.Jayaraman (2004), Allied Physics, Popular Book Depot, Chennai.
Reference books:	1. Resnick Halliday and Walker (2018), Fundamentals of Physics, 11th Edn. John Willey and Sons, Asia Pvt.Ltd., Singapore. 2. D.R.Khanna and H.R. Gulati (1979).Optics, S.Chand and Co. 3. A.Beiser (1997), Concepts of Modern Physics, Tata Mc GrawHill Publication, New Delhi. 4. V.K.Metha (2004), Principles of electronics, 6th Edn. S.Chand and Company, New Delhi.
Web Resources	1. https://www.youtube.com/watch?v=JrRrp5F-Qu4 2. https://www.atoptics.co.uk/atoptics/blsky.htm

Course outcomes: CO	**On completion of this course, the students will be able to:**
CO1	Explain the concepts of interference diffraction using principles of superposition of waves and rephrase the concept of polarization based on wave patterns
CO2	Outline the basic foundation of different atom models and various experiments establishing quantum concepts. Relate the importance of interpreting improving theoretical models based on observation. Appreciate inter disciplinary nature of science and in solar energy related applications
CO3	Summarize the properties of nuclei, nuclear forces structure of atomic nucleus and nuclear models. Solve problems on delay rate half-life and mean-life. Interpret nuclear processes like fission and fusion. Understand the importance of nuclear energy, safety measures carried and get our Govt. agencies like DAE guiding the country in the nuclear field.
CO4	To describe the basic concepts of relativity like equivalence principle, inertial frames and Lorentz transformation. Extend their knowledge on concepts of relativity and vice versa. Relate this with current research in this field and get an overview of research projects of National and International importance,
CO5	Summarize the working of semiconductor devices like junction diode, Zener diode, transistors and practical devices we daily use like USB chargers.

Mapping With Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	1	1
CO2	1	3	1	2	3
CO3	2	3	2	1	3
CO4	2	3	2	3	3
CO5	3	3	3	2	2

Allied Practicals – IV
(for I - Mathematics, II - Chemistry)

Title of the Course	**Allied Practicals – IV**						
Course Type	**Elective - IV – Lab - 2**						
Year	**II**	**Semester**	**IV**	**Credits**	**2**	**Course Code**	**25UEPHL2**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		-	**--**		**2**	**2**	

Experiments

(Minimum of EIGHT Experiments from the list)

1. Radius of curvature of lens by forming Newton's rings.
2. Wavelength of mercury lines using spectrometer and grating.
3. Refractive index of material of the prism by minimum deviation.
4. Deflection magnetometer (Tan A).
5. Determination of AC frequency using sono meter.
6. Specific resistance of a wire using PO box.
7. Thermal conductivity of poor conductor using Lee's disc.
8. Determination of figure of merit table galvanometer.
9. Determination of Earth's magnetic field using field along the axis of a coil.
10. Characterization of Zener diode.
11. Bridge Rectifier.
12. NOR gate as a universal building block.

Semester - V

Quantum Mechanics and Relativity

Title of the Course		**Quantum Mechanics And Relativity**					
Course Type		**CORE - V**					
Year	**III**	**Semester**	**V**	**Credits**	**5**	**Course Code**	**25UMPH51**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	**2**		**--**	**5**	
Learning Objectives							
LO1	To give the basic concept of quantum mechanics and compare the classical mechanics and their drawbacks.						
LO2	To solve Schrodinger's wave equation for simple problems and analyse to understand the solutions.						
LO3	To explain the concept of an operator in quantum mechanics and how it differs from a regular function.						
LO4	To solve Schrodinger's equation for simple problem such as particle in 1D box, and free particles.						
LO5	To understand the theory of relativity, its postulates and the consequences and be able to apply these concepts to explain phenomena like time dilation and Length contraction in different inertial reference frames.						

UNIT	CONTENTS
I	**INTRODUCTION TO QUANTUM MECHANICS:** Inadequacies of classical physics and origin of quantum theory – black body radiation – Planck's law – Einstein's photoelectric equation – Compton effect - De Broglie waves – Davisson and Germer's experiment – Uncertainty principle – consequences – illustration of Gamma ray microscope.
II	**SCHRODINGER EQUATION:** Postulates of quantum mechanics – Wave function and its interpretation – Schrodinger's equation - Schrodinger's wave equation in time dependent and independent form – Steady state Schrodinger's wave equation – extension to three dimensions.

III	**OPERATORS IN QUANTUM MECHANICS:** linear operators – Eigen value – Hermitian operator – properties of Hermitian operator – operators for position, linear Momentum – commutator algebra – expectation values of position and momentum.
IV	**SOLVING SCHRODINGER EQUATION FOR SIMPLE PROBLEMS:** One-dimensional problems: Free particle - particle in a box –potential step - barrier penetration problem – quantum mechanical tunneling - linear harmonic oscillator.
V	**THEORY OF RELATIVITY:** Experimental evidences for General theory of Relativity - Michelson-Morley experiment–frames of reference – postulates of special theory of relativity –Galilean transformation - Lorentz transformation – consequences – time dilation – length contraction–variation of mass with velocity – Einstein's mass-energy relation– relativistic momentum – energy relation.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. Modern Physics, R. Murugeshan, Kiruthiga Sivaprasath,S. Chand and Co.,17th Revised Edition, 2014. 2. Quantum mechanics – Satyaprakash and Swati Saluja. Kedar Nath Ram Nathand Co.
Reference books	1. Quantum Mechanics, V. Devanathan, Narosa Pub. House, Chennai, 2005. 2. Quantum Mechanics, V.K. Thangappan, New Age International, New Delhi. 3. A Text Book of Quantum Mechanics, Mathews and Venkatesan, Tata McGraw Hill, New Delhi. 4. Special Theory of Relativity,S. P.Puri, Pearson Education, India, 2013. 5. Quantum Mechanics, Ghatak and Loganathan, Macmillan Publications.
Web Resources	1. http://hyperphysics.phy-astr.gsu.edu/hbase/qapp.html 2. https://swayam.gov.in/nd2_arp19_ap83/preview 3. https://swayam.gov.in/nd1_noc20_ph05/preview

Course outcomes CO	On completion of this course, students will be able to
CO1	Understand the basic concept of quantum mechanics.
CO2	Derive Schrodinger equation and realize the wave nature of matter.
CO3	Understand the concept of an operator in quantum mechanics.
CO4	Apply Schrodinger equation to simple problems.
CO5	Understand various postulates of special theory of relativity. Appreciate the importance of transformation equations and also the general theory of relativity.

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	3	3	2	3	2
CO2	3	3	3	3	3	3	1	2
CO3	2	3	3	3	3	3	2	3
CO4	2	3	3	3	1	3	3	3
CO5	2	3	3	3	3	3	3	2

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	2	3	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	3	3
CO4	2	3	3	3	3
CO5	2	3	3	3	3

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

Atomic and Nuclear Physics

Title of the Course		**Atomic And Nuclear Physics**					
Course Type		**CORE - VI**					
Year	**III**	**Semester**	**V**	**Credits**	**5**	**Course Code**	**25UMPH52**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		4	**1**		**--**		**5**

Learning Objectives	
LO1	To make the students to understand the knowledge atom model and its key parameters.
LO2	To enable the students to gain the knowledge of atomic spectra and nuclear models
LO3	To make the students to understand the concept of radioactivity.
LO4	Equipping the students to successfully understand the basic ideas of nuclear reactions and reactors.
LO5	To motivate the students to get a deep knowledge about elementary particles.

UNIT	**CONTENTS**
I	**VECTOR ATOM MODEL:** Introduction to atom model – vector atom model– electron spin–spatial quantization– quantum numbers associated with vector atom model – L-S and J-J coupling – Pauli's exclusion principle – magnetic dipole moment due to orbital motion and spin motion of the electron–Bohr magnetron – Stern-Gerlach experiment.
II	**ATOMIC SPECTRA AND NUCLEAR MODELS**: Spectral terms and notations – fine structure of sodium D-lines – Zeeman effect – Larmor's theorem – quantum mechanical explanation of normal Zeeman effect – Paschen-Back effect – Stark effect – General properties of nucleus – mass defect – Binding energy - BE curve – nuclear structure – nuclear properties - Liquid drop model.
III	**RADIOACTIVITY:** Discovery of radioactivity – natural and artificial radio activity – Exponential decay law - Half life – Mean life - properties of alpha rays, beta rays and gamma rays – Geiger Nuttal law – Gamow's theory of alpha decay (qualitative study) – Radio isotopes – Application of Radio isotopes.

IV	**NUCLEAR REACTOR:** Nuclear fission – Energy released in fission – Bohr and Wheeler theory of nuclear fission – Chain reaction – critical size for maintenance of chain reaction – Atom bomb – Nuclear reactor: Construction and working – types of nuclear reactor – Nuclear fusion – sources of stellar energy – Hydrogen bomb.
V	**ELEMENTARY PARTICLES:** Classification of elementary particles – fundamental interactions – elementary particle quantum numbers: baryon, lepton, hypercharge, isospin and strangeness quantum number – Conservation laws and symmetry–quarks–quark model (elementary ideas only).

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. R. Murugesan, Modern Physics, S. Chand and Co. (All units)
Reference books	1. Brijlal and N. Subrahmanyam, Atomic and Nuclear Physics, S.Chand and Co. 2. Sehgal and Chopra, Modern Physics, Sultan Chand, New Delhi 3. Irving Kaplan (1962), Nuclear Physics, Second Edition, Oxford and IBH Publish and Co, New Delhi. 4. Roy and Nigam, – Nuclear Physics (1967) First edition, Wiley Eastern Limited, New Delhi.
Web Resources	1. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html 2. https://makingphysicsfun.files.wordpress.com/2015/01/photoelectric-effect.pptx 3. https://www.khanacademy.org/science/physics/quantumphysics/in-nuclei/v/types-of-decay

Course outcomes CO	On completion of this course, students will be able to
CO1	Understand vector atom model, quantum numbers, coupling, Pauli principle, magnetism, Stern–Gerlach experiment.
CO2	Analyze spectral terms, fine structure, Zeeman and Stark effects, nuclear models, experimental evidence.
CO3	Understand radioactivity, decay laws, particle properties, alpha theory, radioisotope applications in science, industry, medicine.
CO4	Understand nuclear fission, chain reactions, reactor principles, energy release, bombs, stellar energy production.
CO5	Classify elementary particles, apply forces, quantum numbers, conservation laws, quarks, cosmic rays origin significance.

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	3	2	3	3	3
CO2	2	2	3	2	1	3	2	3
CO3	2	2	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3
CO5	2	2	3	2	2	3	3	3

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	2	2	3	2	2
CO2	3	2	3	2	1
CO3	3	2	3	3	2
CO4	2	2	3	3	3
CO5	3	3	2	2	2

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

Analog and Communication Electronics

Title of the Course		Analog And Communication Electronics					
Course Type		CORE - VII					
Year	III	Semester	V	Credits	4	Course Code	25UMPH53
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total
		4	1		--		5

Learning Objectives	
LO1	To study the design, working and applications of semiconducting devices.
LO2	To construct various electronic circuits and to study them in details.
LO3	To understand feedback amplifier and oscillators.
LO4	To analyse the operational amplifiers and its applications.
LO5	To study the basics of modulation and demodulation.

UNIT	CONTENTS
I	**DIODES:** Diode characteristics –half wave rectifier, center tapped and bridge full wave rectifiers, calculation of efficiency and ripple factor - clipper circuits, clamping circuits. DC power supply: Block diagram of a power supply, Zener diode as voltage regulator.
II	**TRANSISTOR AMPLIFIERS:** Transistor configurations: CB, CE and CC modes – I-V characteristics and hybrid parameters – DC load line– Q point self-bias - RC coupled CE amplifier–power amplifiers–push pull amplifiers– tuned amplifiers.
III	**TRANSISTOR OSCILLATORS:** feedback amplifier – principle of feedback, positive and negative feedback- voltage and current gain - advantages of negative feedback - Barkhausen's criterion – Transistor oscillators: Hartley, Colpitts, and Phase shift oscillators.
IV	**OPERATIONAL AMPLIFIERS AND 555 TIMER:** Differential amplifiers **–** OP-AMP characteristics – IC 741 pin configuration **–** Common Mode Rejection Ratio (CMRR) – Slew Rate - inverting and non-inverting amplifiers – summing and difference amplifiers – differentiator and integrator–555 timer pin configuration- astable multivibrator (square wave generator)–monostable multivibrator
V	**MODULATION AND DEMODULATION:** Theory of amplitude modulation - frequency modulation – comparison of AM and FM – phase modulation – AM and FM transmitter – D**e**modulation**:** AM and FM detection.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. V.K.Mehta – Principles of Electronics, S.Chand and Co. Ltd., 2019.
Reference books	1. Malvino- Electronic Principles, Tata McGraw Hill. 2. V.Vijayendran –Integrated Electronics, S.Vishwanathan Publishers, Chennai. 3. B.L.Theraja – A Text Book of Electrical Technology. 4. JohnD.Ryder – Electronic fundamentals and Applications. 5. Millman and Halkias – Integrated Electronics - Tata McGraw Hill.
Web Resources	1. https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/ 2. https://ocw.mit.edu/courses/6-101-introductory-analog-electronics-laboratory- spring-2007/ 3. https://www.elprocus.com/semiconductor-devices-types-and-applications/

Course outcomes CO	**On completion of this course, students will be able to**
CO1	Understand the basic concepts of diodes and its applications.
CO2	Classify the basic principles of biasing and transistor amplifiers.
CO3	Acquire the fundamental concepts of oscillators.
CO4	Analyze how the feedback affects the performance of an operational amplifier.
CO5	Learn and understand the concept of modulation and demodulation techniques used in communication systems.

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	3	2
CO2	3	3	2	3	2	2	3	2
CO3	2	2	3	2	3	3	2	3
CO4	2	3	3	3	3	3	3	2
CO5	3	2	3	3	2	2	3	2

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	2	3	2	2
CO3	3	3	2	3	2
CO4	3	3	3	2	3
CO5	3	2	3	3	2

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

Core Practicals - 5

<table>
<tr><td>Title of the Course</td><td colspan="7">Core Practicals - 5</td></tr>
<tr><td>Course Type</td><td colspan="7">CORE – V – Lab - 5</td></tr>
<tr><td>Year</td><td>III</td><td>Semester</td><td>V</td><td>Credits</td><td>2</td><td>Course Code</td><td>25UMPHL5</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td colspan="2">-</td><td>3</td><td colspan="2">3</td></tr>
<tr><td colspan="8">Experiments
(Minimum of EIGHT Experiments from the list)</td></tr>
<tr><td colspan="8">1. Young’s Modulus of a material – Elliptical fringes.
2. Dispersive power of plane diffraction grating.
3. Diffraction at a wire.
4. Diffraction at a straight edge.
5. Determination of Planck’s constant.
6. Spot Galvanometer: Figure of Merit.
7. Spectrometer – Cauchy’s Constant.
8. Spectrometer – Oblique incidence.
9. Spectrometer – Hartmann’s constant.
10. Spectrometer – Normal incidence.
11. Thevanin’s and Nortan’s theorem –verification.
12. Desauty’s Bridge- Determination of C, C1 and C2 in series and parallel.</td></tr>
<tr><td colspan="2">Reference Book</td><td colspan="6">C.C.Ouseph, U.J. Rao and V. Vijayendran - Practical Physics and Electronics – S. Viswanathan Pvt. Ltd (2007)</td></tr>
</table>

Core Practicals - 6

Title of the Course	**Core Practicals - 6**						
Course Type	**CORE – VI – Lab - 6**						
Year	**III**	**Semester**	**V**	**Credits**	**2**	**Course Code**	**25UMPHL6**

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	-	**--**	**3**	**3**

Experiments
(Minimum of EIGHT Experiments from the list)

1. VI Characteristics of Junction diode and Zener diode.
2. Bride rectifier using diodes.
3. Zener diode– voltage regulations.
4. Dual power supply using IC.
5. Characteristics of a transistor – CE mode.
6. Colpitt's oscillator-transistor.
7. Astable multivibrator using 555 timer.
8. Monostable multivibrator using 555 timer.
9. OPAMP – Low pass and High pass.
10. OPAMP – Adder and Subtractor.
11. OPAMP - differentiator and integrator.
12. AM Modulation.

Reference Book	C.C.Ouseph, U.J. Rao and V. Vijayendran - Practical Physics and Electronics – S. Viswanathan Pvt. Ltd (2007)

Nano science and Nano Technology

Title of the Course	**Nano science and Nano Technology**						
Course Type	**Elective - V**						
Year	**III**	**Semester**	**V**	**Credits**	**3**	**Course Code**	**25UEPH51**
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		**1**	**-**	**5**	

Learning Objectives	
LO1	To learn what a nanometer is and the size range considered "nanoscale." And understand the influence of size, shape, and surface morphology on nanomaterial properties**.**
LO2	To learn the properties of materials at nanoscale.
LO3	To Learn various methods of synthesis of nanomaterials.
LO4	To Learn the various characterization techniques to know the properties of Nanomaterials.
LO5	To learn the applications of nanomaterials.

UNIT	**CONTENTS**
I	**NANOSCIENCE AND NANOTECHNOLOGY:** Introduction-Nanoscale – nature and nanostructures – nanostructures: 0D, 1D, 2D – surface to volume ratio – size effect – excitons – metal based nanoparticles (metal and metal oxide) – nanocomposites (non- polymer based) – carbon nanostructures – fullerene – SWCNT and MWCNT.
II	**PROPERTIES OF NANOMATERIALS:** Mechanical behavior –elastic properties – hardness and strength – ductility and toughness – optical properties – electrical properties – dielectric materials and properties – magnetic properties – super paramagnetism – electrochemical properties – properties of CNTs.
III	**FABRICATION METHODS AND VACUUM TECHNIQUES:** Top-down and Bottom-up approaches – ball milling – chemical vapour depositions (CVD) – electrochemical method – sol-gel method - plasma arc discharge (qualitative only) – sputtering – thermal evaporation – pulsed laser deposition.

IV	**CHARACTERIZATION TECHNIQUES:** Scanning Electron Microscopy – Atomic Force Microscopy – Transmission Electron Microscopy. Powder XRD method: Determination of structure and grain size analysis – Fourier Transform Infrared Spectroscopy - UV-visible and photoluminescence spectroscopy.
V	**APPLICATIONS OF NANOMATERIALS:** Energy storing devices: fuel cells – rechargeable batteries – super capacitors. photovoltaic sensors: nano- sensors based on optical and physical properties. Nano electronics: CNTFET – display screens – GMR read/write heads – nanorobots. Medicine: drug delivery – photodynamic therapy.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / C S I R - NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. K.K.Chattopadhyay and A.N.Banerjee, (2012), Introduction to Nanoscience and Nanotechnology, PHI Learning Pvt. Ltd., 2. M.A. Shah, Tokeer Ahmad (2010), Principles of Nanoscience and Nanotechnology, Narosa Publishing House Pvt Ltd. 3. Mick Wilson, et al (2005) Nanotechnology, Overseas Press
Reference books	1. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA 2. J.H.Fendler (2007) Nano particles and nano structured films; Preparation, Characterization and Applications, John Wiley and Sons 3. B.S.Murty, et al (2012) Textbook of Nano science and Nanotechnology, Universities Press.
Web Resources	1. https://youtu.be/tlzlNg6xC5E 2. https://youtu.be/E29ksYotSLI

Course outcomes: CO	On completion of this course, the students will be able to:
CO1	Understand the basic idea of nanoscience and nanotechnology including the ability to explain the fundamental concept and properties of nanomaterials.
CO2	The unique properties of materials at the nanoscale and how they differ from bulk materials. Explain the principles of top-down and bottom-up fabrication.
CO3	They will be familiar with different techniques used to fabricate nonmaterial.
CO4	Analyze the size, shape and structure of nanomaterials using microscopy techniques like SEM, TEM, AFM etc.
CO5	Identify potential applications of nanomaterials in fields like electronics, carbon nanotubes and Nano robots.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	1	1	1
CO2	3	3	1	3	3
CO3	2	3	3	2	1
CO4	3	2	2	3	3
CO5	1	1		2	2

Digital Photography

Title of the Course		**Digital Photography**					
Course Type		**Elective -V**					
Year	**III**	**Semester**	**V**	**Credits**	**3**	**Course Code**	**25UEPH52**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	**1**		**-**	**5**	
Learning Objectives							
LO1	To understand the principles of photography and image formation and the science and arts behind it.						
LO2	To know how to control the image using lenses for digital cameras.						
LO3	To understand the essential components of conventional cameras						
LO4	To understand the principle of digital cameras and their types.						
LO5	To gain the knowledge of different image processing techniques.						

UNIT	CONTENTS
I	**PHOTOGRAPHY AND BASIC PRINCIPLE OF IMAGE FORMATION:** principle – chemical route and digital route –light, wavelengths, colours – shadows – light intensity and distance – making light form images – pin -hole images – practical limitations to pin-hole images – lens instead of pin - hole – focal length and image size – imaging of closer subjects.
II	**LENSES – CONTROLLING THE IMAGES:** photographic lens – focal length and angle of view **(***problems***)** – focusing movement – aperture and f- numbers **(***problems***)** – depth of field– depth of focus – image stabilization – lenses for digital cameras – lens and camera care
III	**CAMERA USING FILMS AND ITS TYPES:** camera and its essential components– shutter – aperture – light measurement – film housing – camera types: view camera– view finder camera – Reflex camera– single lens reflex (SLR) camera
IV	**DIGITAL CAMERAS PRINCIPLE AND TYPES:** principle of digital image capturing – comparison of digital and analog picture information – megapixel – grain, noise and pixel density – optical and digital zooming – image stabilizer – bit depth – white balance – colour modes – file formats (TIFF, RAW & JPEG) – storage cards and types.
V	**THE DIGITAL IMAGE – POSTPRODUCTION:** hardware: computer and its peripherals – software: saving digital file – basic editing: navigating the image – undo/redo/history – crop – rotate – brightness &contrast – colour balance – hue/saturation – dodge/burn – cloning &retouching – removing an element in an image –selection tools: magic wand – printing digital images: inkjet printer – laser printer.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Texts	1. Michel J. Langford , Anna Fox & Richard Sawdon Smith, Basic photography, 9th Edition, , 2010-NL, Focal press, London 2. Henry Carroll, Read this if you want to take great photographs of people, Laurence King Publishing
Reference books	1. Mark Galer, Digital Photography in Available Light essential skills, 2006, Focal press, London 2. Paul Harcourt Davies, The Photographer's practical handbook, 2005, UK PRESS
Web Resources	1. https://www.artdex.com/best-free-resources-for-photographers/ 2. https://openoregon.pressbooks.pub/understandingnewmediaarts /chapter/digital-photography/ 3. https://edis.ifas.ufl.edu/publication/WC094
Course outcomes: CO	**On completion of this course, the students will be able to:**
CO1	Understand the Fundamentals of Image Formation
CO2	Gain knowledge of controlling the images by changing the focus
CO3	Describe the essential components of conventional cameras.
CO4	Compare the digital and analog picture information and identify the file formats.
CO5	Gain knowledge to navigate file systems and to print digital images.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2
CO2	3	3	2	3	3
CO3	3	3	2	3	3
CO4	3	3	2	3	3
CO5	3	3	2	3	3

Home Electrical Installation

Title of the Course	**Home Electrical Installation**						
Course Type	**Skill Enhancement Course - VI**						
Year	**III**	**Semester**	**V**	**Credits**	**2**	**Course Code**	**25USPH51**

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	2	**-**	**-**	**2**

Learning Objectives	
LO1	Understand fundamental principles of charge, current, potential difference, resistance, Ohm's law, DC, AC, electromagnetic induction.
LO2	Understand electricity generation, transmission, distribution, grids, circuits, transformers, junctions, loops, transmission losses impact.
LO3	Identify and install switches, sockets, meters, bells, wiring, appliances, inverters, ensuring safe electrical installations.
LO4	Understand energy conversion, appliance power ratings, consumption, calculate bills, conduct audits, implement savings measures.
LO5	Identify insulation, color codes, fuses, and breakers, earthen; prevent shorts, shocks, apply fire safety.

UNIT	**CONTENTS**
I	**INTRODUCTION TO ELECTRICAL COMPONENTS:** Charge, Current, potential difference, resistance – DC ammeter, voltmeter, ohmmeter – Ohm's law – difference between DC and AC – advantages of AC over DC – AC ammeter - voltmeter – symbols and nomenclature
II	**TRANSMISSION OF ELECTRICITY:** Production and transmission of electricity – concept of power grid – Series and parallel connections – roles of step-up and step-down transformers– characteristics of single and multicore wires - gauge specifications of wires for various needs
III	**ELECTRICAL WIRING:** Different types of switches – Installation of basic switch board - installation of two way switch, electrical bell – fixing of tube lights and fans – fixing heavy equipment like AC, fridge, oven, geyser, jet pumps – installing provisions for inverter.

IV	**POWER RATING AND POWER DELIVERED:** Joule's law of heating – power rating of electrical appliances – energy consumption – electrical energy unit in kWh – calculation of EB bill – single and three phase connections – Measures to save electrical energy.
V	**SAFETY MEASURES:** Insulation for wires – Color specification for main (live) , return (neutral) and earth – fuse – circuit breakers – types of circuit breakers: MCB, ELCB, RCCB – purpose of earth line – lighting arrestors – short circuiting and over loading – tips to avoid electrical shock – first aid for electrical shock.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / C S I R - NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. Study Material prepared by the Department of Physics, Kamaraj College, Thoothukudi
Reference books	1. Black & Decker, The Complete Guide of wiring, Quarto Publishing Group USA Inc. 2. Rex Caudwell, Wiring a house, Taunton Pr; 5th edition. 3. National Electrical Code (NEC) Handbook, by NFPA (National Fire Protection Association).
Web Resources	1. https://www.electrical-installation.org/enwiki/Residential_electrical_installation 2. https://electrical-engineering-portal.com/download-center/books-and-guides/electricalengineering/electrical- wiring-home 3. https://www.electricaltechnology.org/2013/09/electrical-wiring.html?utm_source=chatgpt.com#google_vignette

Course outcomes: CO	On completion of this course, the students will be able to:
CO1	Understand electrical principles, operate DC/AC instruments, and use symbols correctly in circuits.
CO2	Understand electricity production, transmission, losses, and wire characteristics with gauge specifications practically.
CO3	Identify, install switches and appliances, and gain hands-on experience fixing basic electrical fixtures.
CO4	Analyze electrical energy conversion, appliance power ratings, compute bills, and implement energy-saving measures.
CO5	Understand wiring, color codes, fuses, breakers, earthing, ensuring electrical and fire safety measures.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	2	2
CO5	3	3	2	2	2

Personality Development

Title of the Course	**Personality Development**						
Course Type	**Indian Knowledge System (IKS)**						
Year	**III**	**Semester**	**V**	**Credits**	**2**	**Course Code**	**25UPDT51**

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	1	**1**	**-**	**2**

UNIT	CONTENTS
I	Personality - Definition – Determinants – Personality Traits –Theories of Personality – Importance of Personality Development. Self-Awareness – Meaning – Benefits of Self – Awareness – Developing Self – Awareness. Swot – Meaning – Importance-Application – Components. Goal Setting Meaning- Importance – Effective goal setting – Principles of goal setting – Goal setting at the Right level.
II	Self-Monitoring – Meaning – High self – monitor versus low self-monitor – Advantages and Disadvantages self-monitor- Self –monitoring and job performance. Perception- Definition- Factor influencing perception- Perception process –Errors in perception – Avoiding perceptual errors. Attitude – Meaning- Formation of attitude – Types of attitude - Measurement of Attitudes – Barriers to attitude change – Methods to attitude change. Assertiveness - Meaning – Assertiveness in Communication – Assertiveness Techniques – Benefits of being Assertive – Improving Assertiveness.
III	Team Building – Meaning – Types of teams – Importance of Team building- Creating Effective Team. Leadership – Definition – Leadership style- Theories of leadership – Qualities of an Effect leader. Negotiation Skills – Meaning – Principles of Negotiation – Types of Negotiation – The Negotiation Process – Common mistakes in Negotiation process. Conflict Management – Definition- Types of Conflict- Levels of Conflict – Conflict Resolution – Conflict management.

IV	Communication – Definition – Importance of communication – Process of communication - Communication Symbols – Communication network – Barriers in communication – Overcoming Communication Barriers. Transactional Analysis – Meaning – Ego States – Types of Transactions – Johari Window- Life Positions. Emotional Intelligence- Meaning – Components of Emotional Intelligence- Significance of managing Emotional intelligence – How to develop Emotional Quotient. Stress Management – Meaning – Sources of Stress – Symptoms of Stress – Consequences of Stress – Managing Stress
V	Social Graces – Meaning – Social Grace at Work – Acquiring Social Graces. Table Manners – Meaning – Table Etiquettes in Multicultural Environment- Do's and Don'ts of Table Etiquettes. Dress Code – Meaning- Dress Code for selected Occasions – Dress Code for an Interview. Group Discussion – Meaning – Personality traits required for Group Discussion- Process of Group Discussion- Group Discussion Topics. Interview – Definition- Types of skills – Employer Expectations –Planning for the Interview – Interview Questions- Critical Interview Questions.

Reference Books	1. Dr.S. Narayana Rajan, Dr. B. Rajasekaran, G. Venkadasalapthi, V. Vijuresh Nayaham and Herald M.Dhas, **Personality Development**, Publication Division, Manonmaniam Sundaranar University, Tirunelveli 2. Stephan P.Robbins, **Organisational Behaviour**, Tenth Edition, Prentice Hall of India Private Limited, New Delhi,2008 3. Jit S. Chandan, **Oragnisational Behaviour**, Third Edition, Vikas Publishing House Private Limited, 2008 4. Dr.K.K. Ramachandran and Dr.K.K. Karthick, **From Campus to Corporate**, Macmillan Publishers India Limited, New Delhi, 2010

Semester – VI

Solid State Physics

Title of the Course		**Solid State Physics**					
Course Type		**CORE - VIII**					
Year	**III**	**Semester**	**VI**	**Credits**	**5**	**Course Code**	**25UMPH61**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	**1**		**--**	**5**	

Learning Objectives	
LO1	To learn the fundamental concepts of crystal structure and to study the types of bonding and their benefits in the crystal structure.
LO2	To understand the properties of dielectric materials.
LO3	To acquire knowledge on the basics of magnetic phenomena on materials and various types of magnetization materials.
LO4	To learn the fundamental concepts of ferroelectric materials and their properties.
LO5	To understand the concept of superconducting properties of materials.

UNIT	**CONTENTS**
I	**CRYSTAL STRUCTURE, BONDING IN SOLIDS:** Introduction-Crystal lattice – Lattice with basis – Unit cell – Bravais lattices – Miller indices – procedure for finding them – Atomic packing factor of SC, BCC and FCC structures – structure of NaCl crystal. Types of bonding: ionic bonding – bond energy of NaCl molecule – covalent bonding – Vander-Waals bonding.
II	**DIELECTRIC PROPERTIES OF MATERIALS:** Basic definitions-polarization and electric susceptibility - dielectric constant and polarisability – polarization processes: electronic polarization– calculation of polarisability – ionic, orientational and space charge polarization –internal field – Clausius - Mosotti relation – frequency dependence of dielectric constant –dielectric loss.
III	**MAGNETIC PROPERTIES OF SOLIDS:** permeability, susceptibility, relation between them – classification of magnetic materials – properties of dia, para, ferro, ferri and antiferro magnetism –Langevin's theory of diamagnetism – Weiss theory of paramagnetism – Curie-Weiss law – domain theory of ferro magnetism – hysteresis and energy loss – soft and hard magnets.

IV	**FERROELECTRIC PROPERTIES OF MATERIALS:** Ferroelectric effect: Curie- Weiss Law – ferroelectric domains– elementary band theory: band gap (no derivation) – Hall effect – measurement of conductivity (four probe method) - Hall coefficient.
V	**SUPERCONDUCTING PROPERTIES OF MATERIALS:** Superconductivity – General properties of superconductivity-critical temperature – Critical magnetic field – Meissner effect – Isotope effect - Type-I and Type-II superconductors – London's equation and penetration depth.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / C S I R - NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	Solid state Physics, Palanisamy,P.K, Scitech Publication(India) Pvt.Ltd., Chennai.
Reference books	1. Puri & Babber – Solid State Physics – S.Chand & Co. New Delhi. 2. Kittel - Introduction to solid state physics, Wiley and Sons, 7th edition. 3. Raghavan - Materials science and Engineering, PHI 4. S. O. Pillai - Solid State Physics, Narosa publication 5. Solid State Physics, K. Ilangovan, 1st Edition, MJP Publishers, 2021.
Web Resources	1. https://nptel.ac.in/courses/115105099/ 2. https://nptel.ac.in/courses/115106061/

Course outcomes CO	**On completion of this course, students will be able to**
CO1	Helps as pre-requisite for understanding materials science, nano science, etc. Understand the different types of crystal structure, lattice dynamics and different types of bonding in solid substances.
CO2	Know the basic ideas of dielectric materials and their properties. Understand the BH curve and the energy loss.
CO3	Understand the magnetic properties of crystalline structures. Explain different types of magnetism (diamagnetic, paramagnetic, ferro magnetic). Understand polarization, dielectric constants, and ferroelectric materials
CO4	Describe the origin of spontaneous polarization. Explain dielectric constant, losses, and piezoelectric/pyroelectric effects.
CO5	Understand the importance of superconducting materials in engineering applications.

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	2	3	3	3
CO2	3	2	2	2	2	3	3	3
CO3	3	2	3	2	2	3	3	3
CO4	2	2	2	2	3	3	3	3
CO5	3	2	3	2	3	3	3	3

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	2	2	3	2	2
CO2	2	3	3	2	2
CO3	3	2	3	3	2
CO4	3	3	2	2	2
CO5	2	3	3	2	2

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

Electricity, Magnetism and Electromagnetism

Title of the Course		**Electricity, Magnetism And Electromagnetism**					
Course Type		**CORE - IX**					
Year	**III**	**Semester**	**VI**	**Credits**	**5**	**Course Code**	**25UMPH62**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		4	**1**		**--**		**5**

Learning Objectives	
LO1	To understand the principle and calculations of capacitance in different capacitor configurations and laws of thermo emf and thermo electric diagram.
LO2	To learn the principles of magnetism, including Biot-Savart's law and Ampere's circuital law, to analyze magnetic fields in different configurations.
LO3	To understand the concepts of magnetic induction, magnetization, and their relationships with field parameters.
LO4	To provide the basic ideas of transient response of RL, RC, and LCR circuits during growth and decay of current or charge.
LO5	To understand Maxwell's equations and their physical significance in describing electromagnetic fields and wave propagation.

UNIT	**CONTENTS**
I	**CAPACITORS AND THERMO ELECTRICITY:** Capacitor –principle – capacitance of a parallel plate capacitor (with and without dielectric slab) – effect of dielectric – Carey Foster bridge – temperature coefficient of resistance – Seebeck effect – laws of thermo emf – Peltier effect – Thomson effect – Thermo electric diagram - thermodynamics of thermo couple.
II	**MAGNETIC EFFECTS OF CURRENT:** Biot and Savart's law – magnetic induction due to circular coil – magnetic induction due to solenoid –force on a current element by magnetic field – force between two infinitely long conductors – torque on a current loop in a field - moving coil galvanometer – damping correction – Ampere's circuital law – differential form – divergence of magnetic field – magnetic induction due to toroid.

III	**MAGNETISM AND ELCTROMAGNETIC INDUCTION:** Magnetic induction (B) – magnetization (M) - relation between B, H and M – magnetic susceptibility – magnetic permeability – experiment to draw B-H curve – energy loss due to hysteresis - Importance of hysteresis curves – Faraday and Lenz laws - self-induction – coefficient of self-inductance of solenoid –mutual induction – coefficient of mutual inductance between two coaxial solenoids – coefficient of coupling.
IV	**TRANSIENT AND ALTERNATING CURRENTS:** Growth and decay of current in a circuit containing resistance and inductance – growth and decay of charge in a circuit containing resistance and capacitor – growth and decay of charge in an LCR circuit (expressions for charge only) – peak, average and rms values of ac – LCR series and parallel circuits – resonance condition – Q factor – power factor.
V	**MAXWELLS EQUATIONS AND ELECTROMAGNETIC WAVES:** Maxwell's equations in vacuum, material media– physical significance of Maxwell's equations –displacement current – plane electromagnetic waves in free space – velocity of light – Poynting vector–electromagnetic waves in a linear homogenous media.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Texts	1. Murugeshan. R., - Electricity and Magnetism, 8th Edn, 2006, S.Chand and Co, New Delhi.
Reference books	1. Brijlal and Subramanian, Electricity and Magnetism, 6th Edn.,Ratanand Prakash, Agra. 2. M.Narayanamurthy and N.Nagarathnam, Electricity and Magnetism, 4th Edition, National Publishing Co., Meerut. 3. David J. Griffiths, Introduction to Electrodynamics, 2nd Edn. 1997, Prentice Hall of India Pvt. Ltd., New Delhi 4. D. Halliday, R. Resnik and J. Walker - Fundamentals of Physics, 6th Edn. Wiley, NY, 2001.
Web Resources	1. https://www.edx.org/course/electricity 2. https://www.udemy.com/courses/electricity 3. https://www.edx.org/course/magnetism 4. http://www.hajim.rochester.edu/optics/undergraduate/courses.ht_ml

Course outcomes CO	On completion of this course, students will be able to
CO1	Analyze and compute capacitance for various capacitor configurations and understand the impact of dielectrics.
CO2	Apply Biot-Savart's law and Ampere's circuital law to determine magnetic fields in various configurations.
CO3	Analyze the relationships between magnetic induction, magnetization, and field parameters, as well as understand hysteresis and its significance.
CO4	Analyze the transient behavior of electrical circuits involving resistance, inductance, and capacitance.
CO5	Apply Maxwell's equations to describe electromagnetic fields in vacuum and material media, understanding their physical significance.

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	2	2	3	2
CO2	3	3	2	3	2	2	3	2
CO3	3	3	2	3	2	2	3	2
CO4	3	3	3	3	2	2	3	3
CO5	3	3	2	3	2	2	3	2

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	2	3	2	2
CO3	3	2	3	2	2
CO4	3	3	3	3	2
CO5	3	2	3	2	2

Digital Electronics and Microprocessor 8085

Title of the Course		**Digital Electronics And Microprocessor 8085**					
Course Type		**CORE – X**					
Year	**III**	**Semester**	**VI**	**Credits**	**4**	**Course Code**	**25UMPH63**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**
		4	**1**		**--**		**5**

Learning Objectives	
LO1	To learn all types of number systems.
LO2	To learn Boolean Algebra and Identities
LO3	To understand digital circuits for addition and subtraction, multiplexers and Demultiplexers.
LO4	To learn all types of flip-flops, registers, counters.
LO5	To get the knowledge on fundamentals of 8085 architecture, instruction sets and Simple programs.

UNIT	**CONTENTS**
I	**BINARY ARITHMETIC:** Decimal, binary, octal, hexadecimal numbers systems and their conversions – codes: BCD, gray and excess-3 codes –code conversions –– binary addition, binary subtraction using 1's & 2's complement methods
II	**MINIMIZATION TECHNIQUES:** Boolean laws – De-Morgan's theorem–basic logic gates- universal logic gates (NAND &NOR) - Standard representation of logic functions (SOP & POS) – Karnaugh map: 2, 3, 4 variables.
III	**COMBINATIONAL LOGIC:** Adders: half & full adder – subtractors: half & full subtractor – parallel binary adder – magnitude comparator - multiplexers (4:1) & demultiplexers (1:4), encoder (8-line-to-3-line) and decoder (3-line-to- 8-line), BCD to seven segment decoder.
IV	**FLIP FLOPS AND COUNTERS:** R-S Flip-flop – Clocked R-S flip flop - J-K Flip-flop - T and D type flip-flops - master-slave flip-flop - Shift registers:- serial in serial out, serial in parallel out, parallel in serial out and parallel in parallel out – counters asynchronous:- mod- 5, mod-10, synchronous – 4-bit and ring counter.

V	**8085 MICROPROCESSOR:** Introduction to microprocessor – pin configuration of 8085 – Flags – Registers (General and special purpose) – interrupts and its priority – instruction set of 8085 – addressing modes of 8085 - Assembly language programming using 8085: programs for addition, subtraction, multiplication and division (8-Bit only).

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. M.Morris Mano, "Digital Design "3rd Edition, PHI, New Delhi. 2. Microprocessor Architecture, Programming and Applications with the 8085 – Penram International Publishing, Mumbai - Ramesh S. Gaonakar (Unit V).
Reference books	1. RonaldJ. Tocci. "Digital Systems-Principles and Applications"6/e. PHI. New Delhi. 1999. 2. S.K.Bose. "Digital Systems".2/e. New Age International.1992. 3. Malvino and Leach. "Digital Principles and Applications". TMG Hill Edition.
Web Resources	1. https://youtu.be/-paFaxtTCkI 2. https://youtu.be/s1DSZEaCX_g 3. https://www.geeksforgeeks.org/digital-logic/digital-electronics-logic-design-tutorials/ 4. https://8085.netlify.app/

Course outcomes CO	On completion of this course, students will be able to
CO1	Understand the number systems, Boolean algebra, logical operation and logic gates.
CO2	Learn about the working of adder, subractors, multiplexers and demultiplexers.
CO3	Construct the arithmetic and logic circuits as well as to analyse and design the combinational circuits
CO4	Get knowledge on flip-flops, registers and counters.
CO5	Develop programs on 8085 microprocessor.

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	3	3	3	2
CO2	2	3	2	3	2	2	3	2
CO3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	2	3	2	2
CO5	3	2	2	3	3	2	3	2

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

CO/PSO	PSO1	PS02	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	2	3	2	2
CO3	3	3	2	3	2
CO4	3	3	3	2	3
CO5	3	2	3	3	2

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

Core Practicals - 7

Title of the Course	Core Practicals - 7						
Course Type	CORE –VII – Lab 7						
Year	III	Semester	VI	Credits	2	Course Code	25UMPHL7
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		-		--	3	3	

EXPERIMENTS
(Minimum of EIGHT Experiments from the list)

1. LCR: Series Resonance circuit- L and Q.
2. LCR: Dielectric constant.
3. Mirror Galvanometer - current and voltage sensitivity.
4. Spot Galvanometer: Determination of mutual inductance.
5. Determination of B_H and M using Field along the axis of the circular coil.
6. Moment of Magnet-Tan A, B and C position.
7. Conversion of Galvanometer in to Voltmeter and Ammeter.
8. Potentiometer – E.M. F of a thermocouple.
9. Potentiometer – high range voltmeter.
10. Potentiometer – Ammeter.
11. Anderson's Bridge: Self Inductance.
12. Rayleigh's Bridge: Self Inductance.

Reference Book	C.C.Ouseph, U.J. Rao and V. Vijayendran - Practical Physics and Electronics – S. Viswanathan Pvt. Ltd (2007)

Core Practicals - 8

<table>
<tr><td>Title of the Course</td><td colspan="7">Core Practicals – 8</td></tr>
<tr><td>Course Type</td><td colspan="7">CORE – VIII – Lab 8</td></tr>
<tr><td>Year</td><td>III</td><td>Semester</td><td>VI</td><td>Credits</td><td>2</td><td>Course Code</td><td>25UMPHL8</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2">-</td><td colspan="2">--</td><td>3</td><td colspan="2">3</td></tr>
<tr><td colspan="8">EXPERIMENTS
(Minimum of EIGHT Experiments from the list)</td></tr>
<tr><td colspan="8">1. Study of gate ICs - NOT,OR, AND, NOR, NAND, XOR
2. Verification of DeMorgan's theorem using ICs - NOT, OR, AND
3. NAND as universal building block.
4. NOR as universal building block.
5. Half adder & Full adder using basic logic gate ICs
6. Half subtractor & Full subtractor using basic logic gate ICs
7. Karnaugh map(K-map) to solve Boolean Expressions
8. Verification of Boolean Algebra (any five)
9. Seven Segment Display using IC 7490 and IC 7447
10. Microprocessor 8085 –addition & Multiplication (8bitonly)
11. Microprocessor 8085 –subtraction & Division (8bitonly)
12. Microprocessor 8085–smallest and biggest of two numbers(8bit only)</td></tr>
<tr><td>Reference Book</td><td colspan="7">1. C. C. Ouseph, U.J. Rao and V. Vijayendran - Practical Physics and Electronics – S. Viswanathan Pvt. Ltd (2007).
2. B. Ram - Fundamentals of Microprocessors and Microcontrollers – Danpat Rai Publications.</td></tr>
</table>

Medical Instrumentation

Title of the Course	**Medical Instrumentation**						
Course Type	**Elective - VI**						
Year	**III**	**Semester**	**VI**	**Credits**	**3**	**Course Code**	**25UEPH61**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	**1**		**-**	**5**	

Learning Objectives	
LO1	To understand the principles of bio-potentials, ion transport, and electrode function in biomedical instrumentation.
LO2	To understand the origin of cardiac action potentials and their role in electrocardiography (ECG) and principles of electroencephalography (EEG).
LO3	To understand the principles of nuclear imaging and computed tomography (CT), including their applications in medical diagnostics.
LO4	To understand the principles of ultrasonic imaging, MRI instrumentation, and transducer construction.
LO5	To learn the applications of lasers in medicine, including laser-tissue interactions, endoscopy types, and their operational principles.

UNIT	**CONTENTS**
I	**BIO-POTENTIALS AND ELECTRODES:** Transport of ions through cell membrane- resting and action potential - bio-electric potential – design of medical instruments – components of bio-medical instrumentation – electrodes – half cell potential – types of surface electrode – the pH electrode.
II	**BIO-POTENTIAL BASED INSTRUMENTATION:** Electrocardiography (ECG) – origin of cardiac action potential - ECG lead configuration – block diagram of ECG recording set up (qualitative) - Electroencephalography (EEG) – origin of EEG – brain waves – block diagram of modern EEG set up – Analysis of EEG.

III	**RADIATION SAFETY:** Units of radiation - pocket dosimeter – pocket type radiation alarm – thermo- luminescence dosimeter. **MEDICAL IMAGING I:** Nuclear imaging technique –computer tomography (CT) – principle – mathematical basis of image construction –block diagram of CT scanning.
IV	**MEDICAL IMAGING II:** Ultrasonic imaging systems – construction of transducer – display modes – MRI principle and instrumentation – X-ray in radiography – applications of X- ray examination.
V	**LASER IN MEDICINE & ENDOSCOPES:** Laser interactions with bio-molecules – advantages of laser surgery – Endoscopy – types of endoscopes with their operation (qualitative).

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. Medical Instrumentation, M. Arumugam, Anuradha Publications, Chennai.
Reference books	1. Biomedical Instrumentation and measurement, Leslie Cromwell, PHI, 2015 2. Handbook of Biomedical instrumentation by R.S. Khandpur and Raghbir Khandpur, TMH, Second edition,1987 3. Biomedical instrumentation and measurements by R. Ananda Natarajan, PHI India, Second edition,1995 4. Medical Electronics, M.J.Kumar Doss, Prathibha Publishers, 1987 5. Electronic Instruments and Instrumentation Technology, M.M.Anand, PHI, 2015
Web Resources	1. https://bioeng.berkeley.edu/research/bioinstrumentation 2. https://www.slideshare.net/slideshow/bio-potential- and-bio- electrodes/73240647 3. https://kahedu.edu.in/naac/C-3/Additional%20documents/E- content/2651.pdf

Course outcomes: CO	On completion of this course, the students will able to:
CO1	Explain the principles of bio-potentials, ion transport, and electrode mechanisms in biomedical instrumentation.
CO2	Understand the principles of electrocardiography (ECG) and EEG, including the origin of cardiac action potentials and lead configurations.
CO3	Understand the principles of nuclear imaging and CT scan technology, including image construction techniques.
CO4	Explain the principles of ultrasonic imaging, MRI, and the construction of transducers.
CO5	Understand laser interactions in medicine, the advantages of laser surgery, and the operation of different types of endoscopes.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	2	3
CO2	2	3	2	3	3
CO3	2	3	2	3	3
CO4	3	3	2	3	3
CO5	3	3	2	3	3

Mathematical Physics & Numerical Methods

Title of the Course		Mathematical Physics & Numerical Methods					
Course Type		Elective - VI					
Year	III	Semester	VI	Credits	3	Course Code	25UEPH62
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		4	1		-	5	

Learning Objectives	
LO1	To learn matrix types, properties, eigenvalues, eigenvectors, and use Cayley-Hamilton theorem.
LO2	To learn vector differentiation, integration, and apply Gauss, Stokes, Green theorems physically.
LO3	To solve second-order differential equations, Legendre polynomials, using series, generating, recurrence methods
LO4	To learn numerical techniques for solving algebraic and transcendental equations using Bisection and Newton Raphson method.
LO5	To solve numerical integration and differential equation solving methods

UNIT	CONTENTS
I	**MATRICES:** Types of matrices – symmetric, Hermitian, unitary and orthogonal matrices– characteristic equation of a matrix – Eigen values and Eigen vectors of a matrix – Cayley-Hamilton theorem– inverse of matrix by Cayley-Hamilton Theorem.
II	**VECTOR ANALYSIS:** Introduction **-** linear vector space – Gradient of a scalar field – Divergence and curl of a vector function – Statement and Proof (only): Gauss Divergence theorem – Stoke's theorem - Green's Theorem.
III	**SPECIAL FUNCTION:** Second order linear differential equation – Legendre's differential equation and solution–Generating function - Rodrigue's formula – Recurrence relations for $P_n(x)$

IV	**NUMERICAL METHODS I:** Roots of linear and nonlinear algebraic and transcendental equations: Bisection and Newton-Raphson methods – Linear Algebraic Equations: Gauss elimination method – Gauss Jordan method - Inverse of a matrix by Gauss Jordan elimination method.
V	**NUMERICAL METHODS II:** Numerical Integration: Trapezoidal rule – Simpson's 1/3 and 3/8 rule – Solving Differential Equation: Euler method – modified Euler method – Runge-kutta (4^{th} order) method.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.

Recommended Texts	1. Mathematical Physics, Satya Prakash (Sultan Chand) 2. Numerical methods, Singaravelu, Meenakshi Publication, 4^{th} Edn. 1999.
Reference books	1. Mathematical Physics, B.D. Gupta-Vikas Publishing House, 4th Edition (2006) 2. Mathematical Physics – P. K. Chattopadhyay, New Age International Publishers. 3. Mathematical Physics – H. K. Das, S. Chand and Co, New Delhi. 4. Numerical Analysis, B.D.Gupta, Konark Publishers, New Delhi, 2013
Web Resources	1. https://arxiv.org/pdf/1203.4558v2 2. https://www.pvamu.edu/physics/facilities/physics-resources- 2/mathematicalphysics-links/ 3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath

Course outcomes: CO	On completion of this course, the students will be able to:
CO1	Analyze matrices, compute eigenvalues and eigenvectors, apply Cayley-Hamilton theorem for inversion.
CO2	Perform vector differentiation, apply gradient, divergence, curl, identities, Gauss, Stokes, Green theorems.
CO3	Solve second order differential equation – Legender's differential equation using power series method.
CO4	Apply numerical methods to solve linear, nonlinear, and algebraic equations using Gauss techniques.
CO5	Apply numerical methods for integration, differential equations, and analyze practical scientific engineering problems.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3
CO2	3	3	3	2	2
CO3	2	2	2	2	3
CO4	2	2	2	2	3
CO5	2	3	3	3	3

Maintenance of Electronic Appliances

Title of the Course	**Maintenance of Electronic Appliances**						
Course Type	**Skill Enhancement Course - VII**						
Year	**III**	**Semester**	**VI**	**Credits**	**2**	**Course Code**	**25USPH61**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		2	**-**		**-**	**2**	

Learning Objectives:	
LO1	To learn soldering tools, techniques, defects, and work with various circuit board types.
LO2	To learn power supply components, principles, applications, and use multimeters for accurate measurements.
LO3	To learn solar power systems, components, protection, and troubleshoot faults in batteries, inverters.
LO4	To learn computer assembly, Windows installation, software setup, antivirus, formatting, and routine maintenance skills.
LO5	Learn printer, scanner, network setup, IP management, Zener power supply, transistor identification.

UNIT	**CONTENTS**
I	**SOLDERING TECHNIQUES**: Soldering tools- soldering iron-soldering station-dry solder joint, cold solder joints-Good and bad solders joints. Groove board, bread board and printed circuit board
II	**POWER SUPPLY AND MEASURING INSTRUMENTS**: Transformer Zener voltage regulators-Dual Power supply IC'S 7805, 7905-switch mode power supply (SMP'S), principle of SMP'S- block diagram of SMP'S - Practical uses of Multimeter (analog and digital) –testing and measurements of resistor, capacitor and transistor
III	**SOLAR POWER SYSTEMS AND INVERTERS**: Solar Panels - Solar Inverter – their principle & operation - Protection circuits used in inverters – Solar Battery - battery level, over load, over charging - system design - Various faults and its rectification

IV	**MAINTENANCE OF COMPUTER SYSTEMS I:** Various parts of computer - its assembling - installing windows operating systems – Installation of software and antivirus - computer hardware maintenance – System formatting and maintenance.
V	**MAINTENANCE OF COMPUTER SYSTEMS II:** Installation of printer and scanner - Basic network installation - IP address setting and its maintenance – Modem - working principle of modem. **Practical Component:** Complete any two of the three listed below: 1. Install of Origin software in laptop / desktop. 2. Construct the Zener regulated power supply. 3. Identify the given transistors(s) whether it is NPN or PNP transistor

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / CSIR-NET/IIT JAM/CUET/ GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Texts	1. Study Material prepared by the Department of Physics, Kamaraj College, Thoothukudi
Reference books	1. Solar Power Hand Book, Dr. H. Naganagouda (2014) 2. Basic Electronics, 6th edition by B Grob, McGraw Hill NY 3. Basic electronics, B. Basavaraj, H.N.Shivasankar University press 4. Principles of Electronics by V K Mehta, S Chand & Co., 5th edition, 2001.
Web Resources	1. https://jlcpcb.com/blog/pcb-soldering-basic-techniques-and-overview 2. https://www.enlitia.com/resources-blog-post/solar-inverter-failures-causes- consequences-and-impact-on-energy-output 3. https://www.hp.com/us-en/shop/tech-takes/pc-maintenance-and-repair-tips 4. https://www.keysight.com/used/tw/en/knowledge/guides/voltage-regulators 5. https://www.hp.com/us-en/shop/tech-takes/how-to-connect-printer-to-computer

Course outcomes: CO	On completion of this course, the students will be able to:
CO1	Use soldering tools, fix defects, and work with various circuit board types.
CO2	Learn power supply components, applications, and use multimeters to test electronic components accurately.
CO3	Learn solar system principles, components, and troubleshoot battery, inverter, and overload faults effectively.
CO4	Assemble hardware, install Windows, set up software, antivirus, and perform system maintenance effectively.
CO5	Install printers, scanners, networks, modems, perform software tasks, Zener power supply, and transistor identification.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	2	3	3	3	2
CO5	3	3	3	3	2

Blue Print – End Semester Examinations Semester – I to VI

Class: U.G. Time: 3 Hours Max. Marks: 75

Section A (10 x 1 = 10)

Answer all questions.
Choose the correct answer. (With four options)

	Unit I	Unit II	Unit III	Unit IV	Unit V
Question Nos.	1 & 2	3 & 4	5 & 6	7 & 8	9 & 10

Section B (5 x 5 = 25)

Answer all questions choosing either (a) or (b).
Answer should not exceed 250 words

	Unit I	Unit II	Unit III	Unit IV	Unit V
Question Nos.	11 (a) & 11 (b)	12 (a) & 12 (b)	13 (a) & 13 (b)	14 (a) & 14 (b)	15 (a) & 15 (b)

Section C (5 x 8 = 40)

Answer all questions choosing either (a) or (b).
Answer should not exceed 500 words

	Unit I	Unit II	Unit III	Unit IV	Unit V
Question Nos.	16 (a) & 16 (b)	17 (a) & 17 (b)	18 (a) & 18 (b)	19 (a) & 19 (b)	20 (a) & 20 (b)