LEARNING OUTCOMES - BASED CURRICULUM FRAMEWORK (LOCF) FOR POSTGRADUATE PROGRAMME

(with effect from 2022-23)

M.Sc. Physics

DEPARTMENT OF PHYSICS

LOYOLA COLLEGE (AUTONOMOUS)
CHENNAI 600034

PREFACE

Physics is the branch of science dealing with matter and energy to comprehend the laws of nature which attempts to explain the way nature works. At post graduate level in our college, it assimilates basics for a deeper understanding of nature and enable students to follow the latest developments not only in basic science but also in areas of advanced technology. It comprehends, theoretical as well as practical knowledge about the principles behind every physical process.

The curriculum for M.Sc. degree Physics based on the Learning Outcome based Curriculum Framework (LOCF) model encompasses of eclectic variety of topics like Classical Mechanics, Statistical Mechanics, Mathematical Physics, Quantum Mechanics, Spectroscopy, Solid state Physics, Nuclear Physics, Advanced Mathematical Methods and Electronics. It includes other interdisciplinary branches of science like Astrophysics, Geophysics, Nanoscience, Climate change, Computational Physics and Network technology. The subjects are envisioned to understand the basic principles of Physics as well as provides enhanced knowledge in applying skills practically through various electronics and computational laboratory experiments. The combined assessment methods with appropriate cognitive levels are framed according to the revised BLOOM'S taxonomy.

The Post Graduate curriculum of M.Sc. Physics motivate young minds to aspire them to take research and promote them to take reputed scientific positions as their career in esteemed organizations throughout the globe. Based on the syllabus, students are eligible to appear for Government examinations. The LOCF curriculum for M.Sc. Physics is all about understanding physical systems and developing creative ability to produce highly motivated young scientific minds. It is designed to cater to the student's needs in view of launching their career in diverse fields. As the curriculum framed is based on the syllabus of the National level entrance examinations like National Eligibility Test (NET) for Junior Research Fellow (JRF) which will support the students to complete their research with government fellowship. They can enrich their knowledge in the field of their choice by taking up Value Added courses. This program gives the provision to the students to do the project during the course of the study. Students in turn can earn academic credits for the completion of the project. The department endeavors to impart an understanding of advanced concepts of Physics and its relevance in modern technological advances by way of skills acquisition, material characterization, interpreting techniques, innovation and entrepreneurship required for building their career in the appropriate fields of interest. We sincerely acknowledge the valuable inputs of the reviewers of the syllabi **Dr. S. Pari**, Head of the Department, National College, Trichy, **Dr. Manikandan**, Associate Professor and Division head, School of advanced sciences, Vellore Institute of Technology, Chennai, **Dr. P. Praveen Kumar,** Associate Professor, Presidency College, Chennai.

We acknowledge the contributions of the following members of the Board of Studies **Dr. K. Ravichandran** (University Nominee-PG Board), **Dr. R. Jayavel**, Professor, Anna University, Chennai, **Dr. G. Vinitha** (College Nominee-Subject Expert- Outside parent institute), Associate Professor, School of advanced sciences, Vellore Institute of Technology, Chennai, **Dr. Mayur Sundararajan,** Verza drives, Coimbatore (Industry Representative), **Mr. P. Irudayaraj,** Wipro technologies (Alumni), **Daniel John Britto** (PG Student representative).

DECLARATION STATEMENT

This is to inform you that the student's web version of the LOCF model is prepared and it has been formatted according to the guidelines given by LOCF committee. The subject teachers have also given declaration, that the contents are correct to the best of their knowledge.

J P Angelena

Dr .J.P. Angelena

(LOCF Mentor)

A. Stanley Raj

Dr. A. Stanley Raj

(LOCF Mentor)

S. Jerome Das

Dr. S. Jerome Das

(Head of the Department)

Dr. S. JEROME DAS
Head Dept. of Physics
Loyola College
Chennai - 600 034

CONTENTS

VISION AND MISSION OF THE COLLEGE

VISION

- Towards holistic formation of youth, grounded in excellence, through accompaniment to serve the humanity.

MISSION

- To provide inclusive education through an integral and holistic formative pedagogy.
- To promote skills that prepares them for the future.
- To kindle in young minds the spirit of social and environmental justice with a blend of academic excellence and empathy.
- To stimulate critical and conscientious scholarship leading to meaningful and innovative human Capital.

CORE VALUES

- Cura Personalis
- Pursuit of Excellence
- Moral Rectitude
- Social Equity
- Fostering solidarity
- Global Vision
- Spiritual Quotient

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	**Professional Skill Development** To provide professional training and skill development to students in physical sciences, related disciplines and nurture them to become responsible persons in the society.
PEO 2	**Core Competency Development** To augment their core-competencies and knowledge levels in science, humanities and inter-disciplinary areas by imparting education of high standards and advanced technological tools with specialized research orientation.
PEO 3	**Innovative Curriculum of Global Relevance** To upgrade the curriculum periodically based on scientific advancements, innovations and societal relevance, so as to cater to the shifting global demands as cited by University Grants Commission, CSIR, etc.
PEO 4	**Environmental Sensitivity and Sustainability** To infuse environmental sensitivity in students through academic activities and hence equip them with technical skills and scientific knowledge required to protect and safeguard the environment for a sustainable future by respecting ecological balance of the globe.
PEO 5	**Ethical Principles and Holistic Development** To promote ethical values and special focus on the holistic development of students to become proficient, skilled, competent and socially responsible people.
PEO 6	**Accessibility and Academic Excellence** To provide an accessible learning environment of excellence and equal opportunity to students, enabling them to develop their creativity, critical thinking, leadership, employability skills and making them competent for job market.

PROGRAMME OUTCOMES (POs)

PO 1	**Disciplinary and inter-disciplinary knowledge for capacity building** Students will acquire required knowledge of the laws governing nature through classroom teaching and experimenting in the laboratories. They will develop a sense of interdisciplinary approach to identify and resolve issues through project, seminars, field work, internships and industrial visits related to their curriculum.
PO 2	**Skills for effective and efficient communication** Students will be able to improve and enhance their communication skills such as reading, writing, listening and speaking. This will help them to express their ideas clearly and effectively and subsequently empower them to become agents of social change and hence pave the way for betterment of the society at large.
PO 3	**Sense of inquiry and problem-solving skills** Students will demonstrate the core competencies of their discipline through analytical reasoning, problem solving and research related skills, cooperation, team work, scientific reasoning and thinking that would make them emerge as entrepreneurs or administrative personnel.
PO 4	**Skills to impact society** Students will develop leadership, team spirit and other psychomotor skills which will help them to identify, approach and analyze the existing societal problems with an eye to look beyond gender, age, caste, creed or nationality and work for the emancipation and empowerment of humanity.
PO 5	**Energy, Ethics and Environment** They will be able to involve themselves in framing policies of social relevance and develop scientific temper to harness energy and work on alternate resources scientifically. They will be aware of the environmental issues and imbibe the spirit of ethical values in establishing a self-sustained environment for a healthy society.

PO 6	**Self-directed and lifelong learning** Through digital literacy, students will engage in self-paced and curious learning with necessary knowledge acquisition and hence develop motivation for a sustained lifelong learning capability. Students will accumulate knowledge by continuous activity centered learning and leverage the past knowledge to solve the problems in the future.
PO 7	**National and international-priorities preferences and perspectives** Students will be able to prioritize national and global issues with an aim to build a nation and an integrated world through contributions that imbibe the spirit of multicultural competency, creative thinking, critical analysis, political awareness and the much-needed awareness on international policies.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1	Acquire scientific temper leading to critical thinking and research motivation in Physics and its allied areas.
PSO 2	Gain knowledge and the skills to measure some of the properties of solid materials and understand the underlying principles governing the dynamics of rigid bodies.
PSO 3	Appreciate the principles of optics, electricity and magnetism and their applications in daily life.
PSO 4	Design and construct electronic circuits with computer interfacing for sophisticated analysis of material behavior and properties.
PSO 5	Comprehend algebraic concepts and advanced mathematical tools involved in the interpretation of various physical properties of materials.
PSO 6	Attain the required skills to interpret the Physics behind the phenomena occurring in nature and surroundings and hence apply them to enhance our life style.
PSO 7	Develop essential logical and analytical skills to approach a problem both quantitatively and qualitatively.

Correlation Rubrics

High	Moderate	Low	No Correlation
3	2	1	0

Mapping of PEOs with Vision and Mission

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
Vision	3	3	3	3	3	3
Mission	3	3	3	3	3	3

Mapping of POs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PO1	3	3	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	3	3	3	3
PO4	3	3	3	3	3	3
PO5	3	3	3	3	2	3
PO6	3	2	3	2	3	3
PO7	3	3	3	3	3	2

Mapping of PSOs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PSO1	3	3	3	3	3	3
PSO2	3	3	3	3	3	3
PSO3	3	3	3	3	3	3
PSO4	3	3	2	3	3	3
PSO5	3	3	3	3	2	3
PSO6	3	3	3	3	3	3
PSO7	3	3	3	3	3	3

Mapping of PSOs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
PSO1	3	3	3	3	3	3	3
PSO2	3	3	3	3	3	3	3
PSO3	3	3	3	3	3	3	3
PSO4	3	2	3	3	3	3	3
PSO5	3	2	3	3	3	3	3
PSO6	3	3	3	3	3	3	3
PSO7	3	3	3	3	3	3	3

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI
DEPARTMENT OF PHYSICS (2022 - Restructured curriculum)
OVERALL COURSE STRUCTURE (M.Sc. Physics)

Sem	Subject Code	Course Title	T/L/P	Category	Hours/ Week	Credit
I	PPH1MC01	Classical Mechanics	T	MC	5	6
I	PPH1MC02	Electrodynamics	T	MC	6	6
I	PPH1MC03	Mathematical Physics	T	MC	6	6
I	PPH1MC04	Electronics I	T	MC	5	6
I	PPH1MC05	Physics Practical I	L	MC	8	4
II	PPH2MC01	Statistical Mechanics	T	MC	6	6
II	PPH2MC02	Electronics II	T	MC	6	6
II	PPH2MC03	Research Methodology	T	MC	3	2
II	PPH2MC04	Physics Practical II	L	MC	8	4
II		Based On Students' Preference Two Courses Will Be Offered	T	ME	4	2
II		MOOCS# (Outside Class Hours, Additional Credits)	T	MO	2	2
II		Life Skills#	T	LS	2	1
II	PPH2CD01	Cross Disciplinary (Between Schools, Purely Internal)	T	CD	3	1
II		Summer Internship (3 To 4 Weeks) #	-	SI	-	1
III	PPH3MC01	Quantum Mechanics I	T	MC	6	7
III	PPH3MC02	Spectroscopy	T	MC	6	7
III	PPH3MC03	Physical Practical III	L	MC	8	4
III		Based on students' preference two courses will be offered	T	ME	4	2
III	PPH3ID01	Nanoscience	T	ID	6	3
III		Soft Skills#	T	SK	2	1
III		Value Added Courses #	T	VA	2	1
		LEAP#	-	SL	2	1
IV	PPH4MC01	Quantum Mechanics II	T	MC	5	5
IV	PPH4MC02	Solid State Physics	T	MC	5	5
IV	PPH4MC03	Nuclear Physics	T	MC	5	5
IV	PPH4PJ01	Project	P	PJ	15	5
					130	99

* 120 Contact hours and 10 Outside Class   #Outside Class

Major Elective (ME)

Sem	Code	Course Title	T/L	Category	Hrs	Cr
II	PPH2ME01	Astrophysics	T	ME	4	2
II	PPH2ME02	Geophysics	T	ME	4	2
II	PPH2ME03	Physics Of Semiconductor Devices	T	ME	4	2
III	PPH3ME01	Advanced Mathematical Methods	T	ME	4	2
III	PPH3ME02	Communication Physics and Network Technology	T	ME	4	2
III	PPH3ME03	Medical Physics	T	ME	4	2

Courses offered to other Departments

Sem	Code	Course title	T/L	Category	Hrs	Cr
II	PPH2CD01	Climate Change and Energy Management	T	CD	1	3
III	PPH3VA01	MATLAB Programming	T	VA	2	1

MC – Major Core; **ME**-Major Elective; **ID**-Inter-Disciplinary; **MO**-MOOC; **LS**-Life Skills; **SK-** Soft Skills;

CD-Cross Disciplinary; **VA-** Value Added; **SI**-Summer Internship;

SL-Service Learning; **PJ**-Project

M.Sc. PHYSICS Restructured CBCS curriculum with effective from June, 2022

PART	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MC	CLASSICAL MECHANICS (5H/6C)	STATISTICAL MECHANICS(6H/6C)	QUANTUM MECHANICS I (6H/7C)	QUANTUM MECHANICS II (5H/5C)
	ELECTRODYNAMICS(6H/6C)	ELECTRONICS II (6H/6C)	SPECTROSCOPY (6H/7C)	SOLID STATE PHYSICS (5H/5C)
	MATHEMATICAL PHYSICS I(6H/6C)	RESEARCH METHODOLOGY(3H/2C)	PHYSICS PRACTICAL III (8H/4C)	NUCLEAR PHYSICS(5H/5C)
	ELECTRONICS I(5H/6C)	PHYSICS PRACTICAL II (8H/4C)		
	PHYSICS PRACTICAL I (8H/4C)			
ME		ASTROPHYSICS (4H/2C)	ADVANCED MATHEMATICAL METHODS(4H/2C)	
		GEOPHYSICS (4H/2C)	COMMUNICATION PHYSICS AND NETWORK TECHNOLOGY(4H/2C)	

		PHYSICS OF SEMICONDUCTOR DEVICES (4H/2C)	MEDICAL PHYSICS(4H/2C)	
ID			NANOSCIENCE(6H/3C)	
MOOC'S		(2H/2C) (Outside class hours, additional credits)		
LS		2H(1C) (Outside class hours)		
SK			2H(1C) (Outside class hours)	
CD		CLIMATE CHANGE AND ENERGY MANAGEMENT (3H/1C) (Between schools, purely internal)		
VA			2H(1C) (Outside class hours)	
SI		3 to 4 weeks (1C) (Outside class hours)		
SL			LEAP (2H/1C) (Outside class hours)	
PJ				(15H/5C)
Hr/C	30H (28 C)	30H (23 C+2 C)	30 H (26C)	30 H (20C)

MC – Major Core; **ME**-Major Elective; **ID**-Inter-Disciplinary; **MO**-MOOC; **LS**-Life Skills; **SK**- Soft Skills; **CD**-Cross Disciplinary;

VA- Value Added; **SI**-Summer Internship; **SL**-Service Learning; **PJ** - Project

COURSE DESCRIPTORS

Course Code	PPH1MC01
Course Title	Classical Mechanics
Credits	06
Hours/Week	05
Category	Major core (MC) – Theory
Semester	I
Regulation	2022

Course Overview

1. This course deals with Lagrangian formulation for a system of particles and its applications to simple systems
2. It extensively discusses the rigid body dynamics and physical quantities in non-inertial frames
3. The modules of this course also describe the conservation theorems and cyclic coordinates obtained from Lagrangian and Hamiltonian Formulations
4. This course also includes the Eigen value equation for various oscillatory systems and discuss the normal modes, normal coordinates
5. It also includes the natural extension of Hamilton to Hamilton Jacobi formulation, Poisson brackets and canonical transformations

Course Objectives

1. To introduce generalized coordinates and constraints with examples.
2. To discuss mathematical formulation of rigid body dynamics
3. To point out the relation between various conservation theorems and their associated symmetry properties.
4. To demonstrate the use of Lagrange and Hamiltonian formulation through some applications
5. To enable the students, apply the laws of classical mechanics to various physical systems

Prerequisites	Basic knowledge on mechanics and calculus

UNIT	CONTENT	HOURS/ WEEK	COs	COGNITIVE LEVEL
I	**LAGRANGIAN FORMULATON** Mechanics of a system of particles - Constraints - D'Alembert's principle - Lagrange equations - velocity dependent potentials - applications - Variational principle - Hamilton's principle - non-holonomic systems - Conservation theorems and symmetry properties. Two body central force problem - equations of motion - first integrals - classification of orbits - conditions for closed orbits - Kepler's problem – Laplace Runge Lenz vector - scattering in a central force field - Lab frame - center of mass frame transformation.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**RIGID BODY DYNAMICS** Kinematics - degrees of freedom - Euler angles - Euler's theorem on the motion of a rigid body - Rotations - finite and infinitesimal. Angular momentum and kinetic energy - Inertia tensor - Principal axes - Euler's equations – Torque free motion of a rigid body - Symmetric top - Precession and nutation - applications – Motion in rotational frames – centrifugal and Coriolis forces	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**SMALL OSCILLATIONS** The eigenvalue equation - the principal axis transformation - free vibrations - normal coordinates – Normal modes- linear triatomic molecule – double pendulum – triple pendulum – triple parallel pendulum	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

IV	**HAMILTONIAN FORMULATION** Legendre transformation and Hamiltonian equations - Cyclic coordinates and conservation theorems - Hamiltonian equations from Variational principle: Application to various physical systems - Canonical transformations - Poisson brackets - equations of motion - conservation theorems in Poisson bracket formulation	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**HAMILTON – JACOBI FORMULATION** Hamilton-Jacobi theory - Hamilton - Jacobi equation - Hamilton's principal function - free particle in Cartesian coordinates - central force in spherical polar coordinates - application to harmonic oscillator problem – Action- angle variables - simple harmonic oscillator- Kepler's problem.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Goldstein, H., Poole, C., & Safko, J. (2011). *Classical mechanics* (3rd ed.). Pearson.
2. Calkin, M. G. (1996). *Lagrangian and Hamiltonian mechanics*. World Scientific.
3. Upadyaya, J. C. (2019). *Classical mechanics* (3rd ed.). Himalaya Publishing House.
4. Rana, N. C., & Joag, P. S. (2017). *Classical mechanics*. McGraw-Hill Education.

Suggested Readings

1. Panat, P. V. (2005). *Classical mechanics* (5th ed.). Alpha Science International.
2. Srinivasa Rao, K. N. (2003). *Classical mechanics* (2nd ed.). Universities Press.
3. Thornton, S. T., & Marion, J. B. (2014). *Classical dynamics of particles and systems* (5th ed.). Cengage.
4. Taylor, J. R. (2005). *Classical mechanics*. University Science Books.
5. Greiner, W. (2007). *Classical mechanics: Point particles and relativity*. Springer.
6. Morin, D. (2008). *Introduction to Classical mechanics: Problems and solutions*. Cambridge University Press.
7. Wells, D. A. (2005). *Lagrangian dynamics* (4th ed.). McGraw Hill Education.
8. Lim, S. C., Lai, C. H., & Kwek, L. C. (2020). *Problems and solutions on Mechanics* (2nd ed.). World Scientific.
9. Gregory, R. D. (2008). *Classical mechanics* (8th ed.). Cambridge University Press.

Web Resources

1. https://youtube.com/playlist?list=PL5E4E56893588CBA8.
2. https://www.youtube.com/watch?v=pyX8kQ-JzHI
3. https://bsc.hcverma.in/course/cm1

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and recall laws of mechanics of single particle	**K1, K2**
CO 2	Ability to construct the Lagrangian and Hamiltonian of various holonomic and non-holonomic systems.	**K3**
CO 3	Calculate normal modes and normal co-ordinates of small oscillation	**K4**
CO 4	Analyze rigid body dynamics using Euler's equation.	**K5**
CO 5	Solve Harmonic oscillator, Kepler Problem using Hamilton's -Jacobi theory	**K6**

COURSE DESCRIPTOR

<table>
<tr><td>Course Code</td><td>PPH1MC02</td></tr>
<tr><td>Course Title</td><td>Electrodynamics</td></tr>
<tr><td>Credits</td><td>06</td></tr>
<tr><td>Hours/Week</td><td>06</td></tr>
<tr><td>Category</td><td>Major Core (MC) – Theory</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td>Regulation</td><td>2022</td></tr>
<tr><td colspan="2">Course Overview
1. This course aims to bridge the gap between the fundamental principles taught in electromagnetism and its practical application to specific fields such as materials, physics, and chemistry related to energy storage and harvesting.
2. It aims to provide students with an introduction to the principles and behaviors of dynamical electric and magnetic systems, and a theoretical foundation in classical field theory.
3. Students will examine the electrodynamics starting from the nature of electrical force up to the level of in-depth solutions of Maxwell equations.
4. It aims to study the dynamics of magnetized fluids and will explore the basic equations of MHD, the different types of waves and instabilities.
5. To study the transformation of fields between inertial frames</td></tr>
<tr><td colspan="2">Course Objectives
1. To discuss the relation between Electrostatic field and Electrostatic Potential.
2. To make use of Ampere's law to calculate the magnetic fields.
3. To use Maxwell equations in analyzing the electromagnetic field due to time varying charge and current distribution.
4. To analyze charged particle dynamics and radiation from localized time varying electromagnetic sources.
5. To generalize the concepts of guided structures like transmission line, means of transporting energy or information, commonly used in power distribution and communication.
6. To explain Special Relativity, with reference to electrodynamics.</td></tr>
<tr><td>Prerequisites</td><td>Basic knowledge on Physics and Vector algebra</td></tr>
</table>

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**ELECTRIC AND MAGNETIC POTENTIAL** Gauss's law and its applications, Electric potential, Divergence and curl of E - Electric scalar potential - Poisson's and Laplace's equations, boundary value problems - uniqueness theorems - potential of a localized charge distribution - electric potential – energy of a point charge distribution - energy of a continuous charge distribution - multi pole expansion: approximate potentials at large distances - monopole and dipole terms - electric dipole moment - electric field of a dipole. Divergence and curl of B - Energy in the magnetic fields due to current carrying elements - Magnetic vector potential - magnetic potential at any point due to current carrying elements - multipole expansion of the vector potential - magnetic dipole moment - magnetic field of a dipole.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**ELECTRODYNAMICS** Biot-Savart law, Ampere's theorem, Maxwell's equation in free space and in matter, displacement current, boundary conditions, Gauge transformations - Coulomb and Lorentz gauge - momentum - Polarisation - monochromatic plane waves - energy and momentum in electromagnetic waves. Poynting's theorem - Propagation in linear media - reflection and transmission at (i) normal incidence (ii) oblique incidence - laws of geometrical optics - Fresnel's equation - Brewster's angle - boundary conditions - absorption and dispersion in	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	conductors - skin depth - reflection at a conducting surface - dispersion and anomalous dispersion - Cauchy's formula			
III	**ELECTROMAGNETIC RADIATION** Retarded scalar and vector potentials - Lienard - Wiechert potentials for a moving point charge - electric and magnetic fields of a moving point charge, velocity and acceleration fields. Electric dipole radiation - magnetic dipole radiation - radiation from an arbitrary source - power radiated by a point charge - Larmor formula - Lienard's generalization of the Larmor formula - radiation reaction - Abraham Lorentz formula. Dynamics of charged particles in static and uniform electromagnetic fields.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**GUIDED WAVES AND MAGNETO HYDRODYNAMICS (MHD)** Essential conditions for guided waves - TEM waves in coaxial cables -TE waves - rectangular waveguide - electric and magnetic fields on the surface and inside rectangular waveguide - TE and TM waves in rectangular waveguide - cut - off frequency and wavelength - cylindrical waveguides-energy flow and attenuation in waveguides-cavity resonators-phase and group velocity MHD - Dispersion relations in plasma -Definitions - magneto hydrodynamic equations - magnetic diffusion - viscosity and pressure.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**RELATIVISTIC ELECTRODYNAMICS** Four vectors - tensor algebra, Lorentz transformation - invariance of Maxwell's equations under Lorentz transformation - transformation of electromagnetic field intensities - electromagnetic field tensor -	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	electromagnetic field invariants - covariant form of Maxwell's equations - electromagnetic energy - free space and linear isotropic media; boundary conditions on the fields at interfaces- momentum tensor, conservation laws of electrodynamics.			

Text Books

1. Griffiths, D. J. (2017). *Introduction to Electrodynamics* (4th ed.). Cambridge University Press.
2. Jackson, J. D. (2007). *Classical Electrodynamics* (3rd ed.). Wiley.
3. Gupta, S. L., Kumar, V., & Singh, S. P. (2017). *Electrodynamics*. Pragati.

Suggested Readings

1. Singh, R. N. (1991). *Electromagnetic waves and fields* (5th ed.). McGraw Hill Education.
2. Capri, A. Z., & Panat, P. V. (2002). *Introduction to Electrodynamics* (3rd ed.). Alpha Science.
3. Sarwate, V. V. (2018). *Electromagnetic fields and waves* (2nd ed.). New Age International Publishers.

Web Resources

1. https://web.njit.edu/~vitaly/621/notes621_old.pdf
2. https://nptel.ac.in/
3. https://himafi.fmipa.unej.ac.id/wp-content/uploads/sites/16/2018/09/Introduction-to-Electrodinamic.pdf
4. https://ocw.mit.edu/courses/physics/8-07-electromagnetism-ii-fall-2012/lecture-notes/
5. https://www.freebookcentre.net/physics-books-download/Lecture-Notes-on-Electrodynamics.html
6. https://www.worldcat.org/title/introduction-to-electrodynamics/oclc/1004614008

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Relate potentials with fields, fields with respect to their sources and the dynamical relation between electric magnetic fields momentum and energy during EM transmission.	**K1, K2**
CO 2	Solve Maxwell’s equations for different types of sources and media.	**K3**
CO 3	Explain the concept of four vectors, tensor analysis and their use in expressing the EM field tensors.	**K4**
CO 4	Analyze charged particle dynamics and radiation from localized time varying electromagnetic sources.	**K5**
CO 5	Design and construct wave guides of specific dimensions for their use in project/research work.	**K6**

COURSE DESCRIPTOR

Course Code	PPH1MC03
Course Title	Mathematical Physics
Credits	6
Hours/Week	6
Category	MC
Semester	I
Regulation	2022

Course Overview

1. This course introduces the various aspects of complex analysis and uses of residue theorem in real variable integrals
2. This course aims to introduce basic structure of linear vector space and various abstract operations.
3. This will enable them to bring out important special functions necessary for quantum mechanics and electrodynamics.
4. Will be introduced to the techniques of Fourier transform and its applications to various physical problems and basics of Laplace transform
5. This course will also discuss the various rules of probability, distribution functions that are relevant to statistical and quantum mechanics.

Course Objectives

1. To calculate the real variable integrals using residue theorem.
2. To familiarize and use the Linear vector space concepts to quantum mechanics and other relevant branches of physics.
3. To study exclusively the solution method for various special functions.
4. To apply Fourier transform techniques to various physical systems.
5. To apply the rules of probability and also use the distribution functions in the relevant physical process

Prerequisites	Basic knowledge of real variable calculus, differential equations

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**COMPLEX ANALYSIS** Analytic function - Cauchy - Riemann equations - Laplace equation and harmonic function-Line integral in complex plane - Cauchy's theorem - multiply connected regions-Cauchy integral formula - Derivatives of analytic function - Taylor and Laurent series - Singularities - Residue theorem - Evaluation of real integrals, Application: Potential theory - (1) Electrostatic fields and complex potentials - Parallel plates, coaxial cylinders and an annular region (2) Heat problems - Parallel plates and coaxial cylinders	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**LINEAR VECTOR SPACE** Basic concepts – examples of vector spaces – scalar product: orthogonality – Schmidt orthogonalization procedure – linear operators – Dual space: ket and bra notation –basis– orthogonal basis – change of basis – Isomorphism of vector spaces – projection operator –Eigen values and eigen functions – Direct sum and invariant subspaces – orthogonal transformations and rotation.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**SPECIAL FUNCTIONS** Gamma and Beta functions - Series solution with simple examples - Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre polynomials - Generating function - Rodrigue formula – Orthogonality properties - Associated Legendre function - Recurrence relations - spherical harmonics - Graphs of Legendre functions.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

IV	**FOURIER TRANSFORM AND LAPLACE TRANSFORM** Fourier transform and its inverse – Fourier transform of elementary functions - Transform of Gaussian function and Dirac delta function -Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium - Wave equation: Vibration of an infinite string and of a semi - infinite string - Laplace equation: Potential problem in a semi - infinite strip Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Transforms of Heavy side and Dirac delta functions.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**PROBABILITY THEORY** Definitions - Laws of probability - Mean, variance - Standard deviation –Binomial distribution - Normal distribution -Poisson distribution – Moments of distribution – Recurrence relations – Sampling of variables - Variance - The t - distribution - The Chi - Square distribution.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Kreyszig, E. (2015). *Advanced Engineering Mathematics* (10th ed.). Wiley.
2. Dass, H. K., & Verma, R. (2022). *Mathematical Physics* (8th ed.). S. Chand.
3. Dass, T., & Sharma, S. K. (1998). *Mathematical methods in Classical and Quantum Physics*. University Press.
4. Bell, W. W. (2004). *Special functions for Scientists and Engineers*. Dover.

Suggested Readings

1. Arfken, G. B., Weber, H., & Harris, F. E. (2013). *Mathematical methods for Physicists: A comprehensive guide* (7th ed.). Academic Press.
2. Balakrishnan, V. (2020). *Mathematical Physics: Applications and Problems*. Springer.
3. Boas, M. L. (2006). *Mathematical methods in the Physical Sciences* (3rd ed.). Wiley.
4. Riley, K. F., Hobson, M. P., & Bence, S. J. (2018). *Mathematical methods for Physics and Engineering* (3rd ed.). Cambridge University Press.

Web Resources

1. https://www.youtube.com/watch?v=b5VUnapu-qs&list=PLbMVogVj5nJRhl_6TUGChpnt2Lg0AZvZu
2. https://www.youtube.com/watch?v=9MTqD7yxHWg&list=PLq-Gm0yRYwThklRVGuMC01Gl7m1YSv_qn
3. https://www.youtube.com/watch?v=9MTqD7yxHWg&list=PLq-Gm0yRYwThklRVGuMC01Gl7m1YSv_qn

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Acquire the skill to evaluate various real variable integrals using residue theorem	**K1, K2**
CO 2	Ability to distinguish between the real variable analysis and complex analysis	**K3**
CO 3	Appreciate the use of Linear vector space into quantum mechanics and other relevant areas of physics	**K4**
CO 4	Apply the probability rules to various statistical process and determine the relevant distribution function for a given statistical process.	**K5**
CO 5	Solve problems using Fourier transform techniques which appears in to various branches of science	**K6**

COURSE DESCRIPTOR

Course Code	PPH1MC04
Course Title	Electronics I
Credits	6
Hours/Week	5
Category	MC
Semester	I
Regulation	2022

Course Overview

1. This course deals with the types of network theorems used in circuit analysis. Students will learn to obtain the equivalent circuit using Thevenin's theorem and Norton's theorem and apply in electrical circuit analysis.
2. Students will gain knowledge on semiconductor devices like JFET, MOSFET, UJT, SCR and their applications.
3. Students will be introduced to the various applications of logic gates.
4. An introduction to operational amplifiers and the applications of OPAMPs for analog computation, filters and waveform generators will be given.
5. Importance of D/A and A/D conversions using OPAMPs will be discussed.

Course Objectives

1. To become familiar with the network theorems employed in circuit analysis.
2. To understand and appreciate the operation and applications of semiconductor devices.
3. To learn the basic techniques of building digital circuits and the basic concepts used in the construction of digital systems.
4. To develop skills to understand and construct circuits using operational amplifiers.
5. Comprehend D/A and A/D converters and their applications.

Prerequisites	Fundamental knowledge in Basic Electronics

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**NETWORK THEOREMS** Ohm's law – Series circuit – Parallel circuits – Series-Parallel circuits – Star-Delta conversion – Nodal analysis – Mesh Analysis – Kirchhoff's current law – Kirchhoff's voltage law – Superposition Theorem – Thevenin's Theorem – Norton's Theorem – Maximum Power Transfer theorem.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**SEMICONDUCTOR DEVICES** Junction Field Effect Transistor – Construction and Characteristics – JFET as an amplifier – JFET biasing – JFET applications – MOSFET - depletion and enhancement modes - MOSFETS as switches and resistors – Unijunction Transistor - UJT Saw tooth wave Generator – SCR – constructions and characteristics – SCR applications – Triac – Diac - Applications of Triac and Diac.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**LOGIC CIRCUITS AND MEMORIES** Encoders and Decoders – Four bit binary decoder - BCD to 7 segment decoder – Multiplexers – Demultiplexers – Applications of multiplexers and Demultiplexers - Flip-flops: RS, D- type, JK and Master - Slave Flip-flop – Registers - Shift right, shift left registers - Counters - Asynchronous - Synchronous - Modulus counters – BCD Counter - ring counter – Johnson's ring Counter. Semiconductor memories–ROM, EPROM, EEPROM – RAM – Static and Dynamic RAM.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

IV	**OPERATIONAL AMPLIFIER AND APPLICATIONS** Operational Amplifiers - Ideal Op-Amp – CMRR - comparator – inverting, non-inverting, summing and difference, logarithmic, antilogarithmic amplifiers - integrator and differentiator - Solving simultaneous and differential equations - high, low and band pass filters – instrumentation amplifier – Phase shift oscillator – Wein Bridge oscillator – Wave generators	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**D/A AND A/D CONVERTERS** Introduction – Binary weighted D/A converter – R/2R Ladder D/A converter – D/A accuracy and resolution – DAC 808 - A/D converter – simultaneous conversion - counter method - continuous method – Successive approximation - dual slope A/D converters – A/D accuracy and resolution – ADC0804.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Boylestad, R. L., & Nashelsky, L. (2021). *Electronic devices and circuit theory* (11th ed.). Pearson.
2. Grob, B., & Schultz, M. R. (2003). *Basic Electronics* (9th ed.). McGraw Hill Education.
3. Chattopadhyay, D., & Rakshit, P. C. (2020). *Electronics: Fundamentals and applications* (16th ed.). New Age International.
4. Dube, D. C. (2012). *Electronics: Circuits and analysis* (2nd ed.). Narosa.
5. Taub, H., & Schilling, D. (2008). *Digital Integrated Electronics*. McGraw Hill Education.
6. Millman, J., Halkias, C. C., & Parikh, C. D. (2017). *Integrated Electronics: Analog and digital circuits and systems* (2nd ed.). McGraw Hill Education.
7. Gayakwad, R. A. (2015). *Op-amps and linear integrated circuits* (4th ed.). Pearson.

Suggested Readings
1. Mithal, G. K., & Mithal, R. (1991). *Basic electronic devices and circuits* (14th ed.). McGraw Hill Education. 2. Leach, D. P., Malvino, A. P., & Saha, G. (2014). *Digital principles and applications* (8th ed.). McGraw Hill Education. 3. Choudhury, D. R., & Jain, S. B. (2018). *Linear integrated circuits* (5th ed.). New Age International Publishers. 4. Coughlin, R. F., & Driscoll, F. F. (2001). *Operational amplifiers and linear integrated circuits* (6th ed.). Prentice Hall of India.
Web Resources 1. https://nptel.ac.in/courses/108/105/108105159/ 2. https://nptel.ac.in/courses/108/108/108108122/ 3. https://nptel.ac.in/courses/108/105/108105132/ 4. https://nptel.ac.in/courses/108/108/108108114/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify the use of a few semiconductor devices, logic circuits and operational amplifiers.	**K1, K2**
CO 2	Construct logic circuits and illustrate the usage of combinational circuits.	**K3**
CO 3	Compare the working of encoders and decoders, multiplexers and demultiplexers, A/D and D/A converters.	**K4**
CO 4	Develop circuits to solve equations using operational amplifiers and design multiplexers, demultiplexers, counters and memory registers using logic circuits.	**K5**
CO 5	Design and construct electrical/electronic circuits for various applications.	**K6**

COURSE DESCRIPTOR

<table>
<tr><td>Course Code</td><td>PPH1MC05</td></tr>
<tr><td>Course Title</td><td>Physics Practical – I</td></tr>
<tr><td>Credits</td><td>4</td></tr>
<tr><td>Hours/Week</td><td>8</td></tr>
<tr><td>Category</td><td>Major Core (MC) – Practical</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td>Regulation</td><td>2022</td></tr>
<tr><td colspan="2">Course Overview
1. This course highlights the importance of having hands-on experience to measure physical quantities and use practical methods to understand theoretical concepts.
2. It helps students to acquire experimental abilities, which are essential for physics course.
3. Students will be able to use various components and equipment.
4. Students will also be able to work efficiently and safely in a laboratory, both individually and in groups.</td></tr>
<tr><td colspan="2">Course Objectives
1. Determine elastic constants, spectroscopic constants and Stefan’s constant using appropriate experimental setup.
2. Verify the inverse square law and compute the absorption coefficient using GM counter.
3. Implement the usage of transistors, diodes and logic gates.
4. Understand the application of combinational logic design in registers and counters.
5. Explore the basic functionality and applications of operational amplifiers and 555 timer.</td></tr>
<tr><td>Prerequisites</td><td>Basic Knowledge on Usage of Scientific Apparatus</td></tr>
</table>

No	List of experiments	Hours Per week Per student Per Expt.	Cos	Cognitive levels
1.	Cornu's method – Young's modulus and Poisson's ratio – Elliptic Fringes	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
2.	Iodine absorption spectrum-Spectroscopic constants			
3.	Susceptibility - Quincke's method			
4.	Black body radiation - Stefan's constant			
5.	GM counter – Inverse square law and absorption coefficient			
6.	Ultrasonic Interferometer			
7.	Thermistor – Band gap energy			
8.	Transistor Amplifier-RC coupled			
9.	Power Amplifier –IC			
10.	Design of Gates-transistor (NOT, AND, OR, NAND)			
11.	A/D converter –Parallel conversion using LM339			
12.	Combinational logic circuit design			
13.	7 segment display-2 digit optically controlled counter			
14.	Shift register, Ring counter and Johnson twisted ring counter			
15.	IC regulated power supply			
16.	FET characteristics			

17.	555 Timer -Astable Multivibrator			
18.	Op -Amp 741 -Introduction (basic functionality)			
19.	Op -Amp 741 -Solving Simultaneous Equations			
20.	PLL -remote control applications			
21.	UJT characteristics and relaxation oscillator			
22.	SCR Characteristics and angle of conduction			
23.	Encoders and Decoders			
24.	Multiplexer and Demultiplexer			
25.	Arithmetic/Logic unit – IC74181			

The staff in - charge shall select any 14 from this list. The remaining 2 experiments can be chosen from this list or can be new experiments included by the staff in - charge with prior approval of the department.

Suggested Readings

1. Singh, S. P. (1999). *Advanced Practical Physics* (23rd ed.). Pragati Prakashan.
2. Nelkon, M., & Ogborn, J. M. (1978). *Advanced level Practical Physics* (4th ed.). Pearson Education.
3. Chattopadhyay, D., & Rakshit, P. C. (2017). *An Advanced course in Practical Physics* (10th ed.). New Central Book Agency.
4. Squires, G. L. (2001). *Practical Physics* (4th ed.). Cambridge University Press.

Web Resources

1. https://vlab.amrita.edu/?sub=1&brch=282&sim=1005&cnt=1
2. https://vlab.amrita.edu/?sub=1&brch=192&sim=854&cnt=1
3. http://vlabs.iitkgp.ac.in/dec/exp1/index.html
4. https://de-iitr.vlabs.ac.in/exp/4bit-sipo-shift-register/theory.html
5. http://vlabs.iitkgp.ac.in/tcad/fet/index.html
6. http://vlabs.iitb.ac.in/bootcamp/labs/ic/exp9/exp/theory.php
7. https://vlab.amrita.edu/?sub=3&brch=60&sim=1120&cnt=2171
8. http://he-coep.vlabs.ac.in/Experiment5/Theory.html
9. https://de-iitr.vlabs.ac.in/exp/multiplexer-demultiplexer/theory.html

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Define the objective of the experiment and explain the various parameters in the formula for determining a material's physical property.	**K1, K2**
CO 2	Construct the experimental setup and carry out the experiment	**K3**
CO 3	Make a list of the observations and repeat the experiment to compute the physical quantity using the appropriate formula.	**K4**
CO 4	Interpret and analyze the obtained result and sketch the variations wherever required.	**K5**
CO 5	Design and develop electronic/electrical circuits for use in project work or in device construction.	**K6**

COURSE DESCRIPTOR

Course Code	PPH2MC01
Course Title	Statistical Mechanics
Credits	6
Hours/Week	6
Category	MC
Semester	II
Regulation	2022

Course Overview

1. This course intends to relate thermodynamics with statistical mechanics.
2. This course aims to introduce different ensemble concept and obtain solutions to simple systems.
3. This will enable them to appreciate the principles and applications of quantum statistics.
4. Will be introduced to the role and estimation of fluctuation in statistical mechanics.
5. This course will also provide basic rules for classification of phase transitions and a preliminary attempt to understand non-equilibrium phenomena.

Course Objectives

1. To estimate and use the statistical concept of entropy and relate its partial derivative with thermo dynamical parameters.
2. To understand the concept of ensemble, ensemble averages and partition function and apply them to classical ideal gas and system of harmonic oscillators.
3. To study exclusively when and how to use Bose-Einstein (BE) and Fermi-Dirac (FD) statistics.
4. To distinguish between classical and quantum statistics and the need to use them for explaining some exotic phenomena in both BE and FD statistics.
5. To appreciate and use the concept of fluctuation in statistics. Identify those parameters that are used to classify phase transitions.

Prerequisites	Basic ideas on the laws of thermodynamics and relations between thermodynamic variables.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**RELATION BETWEEN STATISTICAL MECHANICS AND THERMODYNAMICS** Macro and microstates- connection between thermodynamics and statistical mechanics- phase space and trajectories –quantization of phase space - ensemble and ensemble averages- equations of motion and Liouville's theorem- microcanonical ensemble (MCE) – ideal gas in MCE – Gibb's paradox – Sackur-Tetrode equation- Entropy and probability- classical limit- symmetry of wave function (distinguishable and indistinguishable particles) – effect of symmetry on counting - distribution function for Maxwell-Boltzmann(MB), Bose-Einstein(BE) and Fermi –Dirac (FD) statistics .	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**CANONICAL AND GRAND CANONICAL ENSEMBLES** System in contact with a heat reservoir- –Most probable distribution in CE- canonical partition function and Helmholtz free energy- relation to thermodynamic variables – classical ideal gas and harmonic oscillator in CE - calculation of statistical quantities – equi-partition theorem – two level system – concept of negative temperature – system with internal degrees of freedom – translational, rotational and vibrational partition function System in contact with a particle-energy reservoir - Most probable distribution in GCE grand canonical partition function	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	and Gibb's free energy- relation to thermodynamic variables – classical ideal gas and harmonic oscillator in GCE - calculation of statistical quantities - quantum mechanical ensemble theory.			
III	**BOSE – EINSTEIN STATISTICS:** Bose-Einstein Distribution law – black body radiation spectra – photon gas- Planck's distribution law, Rayleigh-Jean's law, Wein's displacement law, Stefan's law- phonons- Einstein's and Debye's theory of specific heat- Degeneracy and Bose-Einstein condensation- Thermodynamic properties of an ideal Bose-Einstein gas- Liquid helium – super fluidity- fountain effect - mechano-caloric effect.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**FERMI-DIRAC STATISTICS:** Ideal Fermi gas – Fermi Dirac distribution-law- thermodynamic properties of Fermi gas: completely degenerate, degenerate and slightly degenerate – electronic heat capacity –electrons in metals — Thermionic emission – Pauli paramagnetic susceptibility - White dwarf: non-relativistic and relativistic limits – Chandrasekhar limit – nuclear matter.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**FLUCTUATIONS AND PHASE TRANSITIONS:** Mean squared deviation- energy fluctuation in canonical ensemble – number fluctuation in grand canonical ensemble- Random walk and Brownian motion- First and second order Phase transition- Ising model: one dimensional Ising model- - Landau theory of phase transitions - introduction to non - equilibrium processes - diffusion equation.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Agarwal, B. K., & Eisner, M. (2011). *Statistical mechanics* (8th ed.). New Age International.
2. Pathria, R. K., & Beale, P. (2021). *Statistical mechanics* (4th ed.). Elsevier.
3. Greiner, W., Neise, L., & Stöcker, H. (1995). *Thermodynamics and statistical mechanics* (4th ed.). Springer.
4. Huang, K. (2009). *Introduction to Statistical Physics* (2nd ed.). CRC Press.

Suggested Readings

1. Reif, F. (2010). *Fundamentals of statistical and thermal physics* (4th ed.). Waveland Press.
2. Landau, L. D., & Lifshitz, E. (1980). *Statistical physics* (3rd ed.). Elsevier.
3. Hill, T. L. (1987). *Statistical mechanics: Principles and selected applications* (4th ed.). Dover.
4. Chandler, D. (1987). *Introduction to modern statistical mechanics* (6th ed.). Oxford University Press.

Web Resources

1. https://www.youtube.com/watch?v=-0S0ScEOH5w
2. https://www.youtube.com/watch?v=XIXQ38JnF0k
3. https://www.youtube.com/watch?v=SjTfNFso4mE
4. https://www.youtube.com/watch?v=CefOcjpUP-A
5. https://hepweb.ucsd.edu/ph110b/110b_notes/node93.html
6. https://slideplayer.com/slide/14328790/
7. https://www.slideserve.com/tyne/black-body-radiation
8. http://web.mit.edu/8.333/www/lectures/superfluidity/SuperfluidiHe.html
9. https://web.pa.msu.edu/courses/2019spring/PHY451/Experiments/superfluidity.html
10. https://www.studocu.com/en/document/old-dominion-university/elements-of-astrophysics/lecture-notes/white-dwarfs-lecture-notes/1161750/view
11. https://uwaterloo.ca/chem13-news-magazine/december-2015-january-2016/feature/negative-temperature

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Acquire the skill to evaluate various statistical parameters in different ensembles.	**K1, K2**
CO 2	Ability to distinguish between statistics of distinguishable and indistinguishable particles and use it on such systems where there is no explanation available in classical theories.	**K3**
CO 3	Appreciate the use of statistical tools in establishing thermodynamic laws of simple thermo dynamical systems.	**K4**
CO 4	Apply the statistical tool of averages and fluctuations for a better understanding of condensed matter.	**K5**
CO 5	Solve problems using statistical mechanics and identify their success and limitations.	**K6**

COURSE DESCRIPTOR

Course Code	PPH2MC02
Course Title	Electronics II
Credits	6
Hours/Week	6
Category	MC
Semester	II
Regulation	2022

Course Overview

1. This course deals with the architecture of microprocessor 8086, the different addressing modes and assembly language programming.
2. Implementation of procedures, macros and interrupts in microprocessor 8086 will be dealt in detail.
3. I/O operation and interfacing I/O devices to microprocessor 8086 will be covered.
4. The architecture, addressing modes, timer and counter programming of microcontroller 8051 will be discussed.
5. Introduction to Python, data types, variables, simple functions, math, and flow control will be covered in this course.

Course Objectives

1. To understand the architecture and instruction set of microprocessor 8086 and microcontroller 8051.
2. To write assembly language programs using the instruction set for microprocessor 8086 and microcontroller 8051.
3. To explain the interfacing between the peripherals and microprocessor 8086 & microcontroller 8051.
4. To develop skills to perform timer/counter programming using microcontroller 8051 and appreciate embedded system concepts.
5. Learn the data types, simple functions, math and flow control in Python and gain competence in writi and executing programs in Python.

Prerequisites	Basic knowledge in Physics and Electronics

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**INTEL 8086** Architecture, Instruction set and Introduction to Macro Assembler (ASM86) CPU architecture - addressing modes - instruction formats - instruction set - execution timing – Assembler directives – assembler operators - assembly process - translation of assembler instructions - simple programs.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**MODULAR PROGRAMMING AND MULTIPROGRAMMING** Linking and relocation - access to external identifiers – procedures - interrupts and their routines - macros - process management and IRMX86 - semaphore operations - common procedure sharing.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**I/O CONSIDERATION, INTERRUPTS AND SYSTEM BUS STRUCTURE** Programmed I/O - Interrupt I/O - block transfer and DMA - basic 8086 bus configuration - minimum and maximum modes - system bus timings - interrupt priority management - single and multiple 8259. Applications: Assembly language programs involving arithmetic and logical operations - use of subroutines - manipulating arrays - solving equations - keys and LEDs interface –delays - interfacing D/A and D/A converters - generation of waveforms - simulation of counter and successive approximation A/D converters.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

IV	**8051 ARCHITECTURE AND PROGRAMMING** Architecture – memory organization – addressing modes – instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication - Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions. Applications: Timer Counter Programming – Serial Communication Programming – Interrupt Programming	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**PYTHON PROGRAMMING** Introduction to Python programming – Python interpreter and interactive mode programming – values and types – data types – variables – statements in python – operators – precedence of operators – conditional statement – iteration – loop control statements - python functions – types of functions – list and tuples – Basic programs – Application of Python into physics problems.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Hall, D. V. (2017). *Microprocessors and interfacing: Programming and hardware* (2nd ed.). McGraw-Hill Education.
2. Kamthane, A. N., & Kamthane, A. A. (2017). *Programming and problem solving with Python*(2nd ed.). McGraw Hill Education.
3. Liu, Y. C., & Gibson, G. A. (2006). *Microcomputer systems: The 8086/8088 family : Architecture, programming, and design* (2nd ed.). Prentice Hall.
4. Mazidi, M. A., Mazidi, J. S., & McKinley, R. D. (2011). *The 8051 Microcontroller and embedded systems: Using assembly and C* (2nd ed.). Pearson Education.
5. Predko, M. (1999). *Programming and customizing the 8051 Microcontroller* (3rd ed.). McGraw Hill Education.
6. Thareja, R. (2019). *Python programming: Using problem solving approach*. Oxford University Press.
7. Vijayendran, V. (2009). *Fundamentals of microprocessor 8086* (3rd ed.). Viswanathan Printers.

Suggested Readings
1. Brey, B. B. (2008). *The intel microprocessors: Architecture, programming and interfacing* (8th ed.). Pearson. 2. Uffenbeck, J. (1987). *The 8086/8088 Microprocessors: Design, programming and interfacing*. Pearson. 3. Triebel, W. A., & Singh, A. (2003). *The 8088/8086 Microprocessors: Programming, interfacing, software, hardware and applications* (4th ed.). Pearson. 4. Kamal, R. (2011). *Microcontrollers: Architecture, programming, interfacing and system design*(2nd ed.). Pearson. 5. Mandal, S. K. (2011). *Microprocessors and Microcontrollers: Architecture, programming and interfacing using 8085, 8086 and 8051* (6th ed.). McGraw Hill Education. 6. Thareja, R. (2019). *Python programming: Using problem solving approach*. Oxford University Press.
Web Resources 1. https:nptel.ac.in/courses/108/103/108103157/ 2. https://nptel.ac.in/courses/108/105/108105102/ 3. https:nptel.ac.in/courses/106/106/106106212/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Explain the architecture and addressing modes of microprocessor 8086 and microcontroller 8051.	**K1, K2**
CO 2	Apply knowledge and demonstrate programming using the various modes of addressing in microprocessor 8086 and microcontroller 8051.	**K3**
CO 3	Select the appropriate arithmetic and logical instructions for assembly language programming using microprocessor 8086 and microcontroller 8051.	**K4**
CO 4	Design and interface external devices to microprocessor 8086 & microcontroller 8051 and implement the appropriate programming.	**K5**
CO 5	Develop programs in Python using arithmetic & logical operators and solve problems in numerical methods.	**K6**

COURSE DESCRIPTOR

Course Code	PPH2MC03
Course Title	Research Methodology
Credits	2
Hours/Week	3
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Overview

1. The aim of this course is to develop students' knowledge and understanding of the role and conduct of quantitative and qualitative research methods.
2. The course objective is to learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions.
3. Students will be exposed to the concepts of the major components of a research framework, namely problem definition, research design, data collection, ethical research concerns, report writing and submission.
4. The course equips students with the skills to review and conduct methodologically sound research as a part of their professional work that will enhance the writing of a research article.
5. The course introduces the ethical principles, challenges and the elements of quantitative analysis such as numerical methods or any mixed method approaches.

Course Objectives

1. To identify and discuss the role and importance of the method of research.
2. To apply the experimental techniques to analyze the research problems.
3. To discuss the concepts and procedures of sampling, data collection, analysis and reporting.
4. To develop the ability to apply theoretical concepts while working on a research project.
5. To develop advanced critical thinking skills to write research papers.
6. To understand the Research ethics for good scientific writing.

Prerequisites	Basic knowledge on Physics and Research

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**METHODS OF RESEARCH:** Objectives and motivation in research – types of research – research and scientific method – research problem – selecting the problem – techniques involved in defining the problem – research design – literature survey – data collection – the use of computers in research – access using internet web tools – e-mails – e-journals – uses of research engines – impact and usefulness of the research problem.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS:** Data interpretation and analysis; Precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and nonlinear curve fitting, chi-square test; Transducers (temperature, pressure/vacuum, magnetic field, vibration, optical, and particle detectors), measurement and control.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**NUMERICAL METHODS:** Solution of Nonlinear equations: Newton - Raphson method – Regula Falsi method Solutions of system of linear equations: Gauss elimination method with and without pivoting - Gauss - Siedel iterative method Solution of ordinary differential equations: Euler method - Euler modified method – Runge - Kutta method (2nd order)	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

IV	**SCIENTIFIC WRITING:** Introduction to Scientific Writing - structuring your article - characteristics of effective titles – key words and abstract – introduction – methods – results and discussion – conclusion – references – good citation behavior – time line of research.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**RESEARCH ETHICS:** Introduction to Research Ethics and Academic Honesty - Academic Integrity: Research Misconduct / Fabrication / Unethical Practices - Literature Review and Proper Use of E-Resources - Writing Quality Academic Publications: Challenges to avoid plagiarism - Plagiarism Policies, Penalties and Consequences.	7	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Anderson, V., Durston, B. H., & Poole, M. (1994). *Thesis and assignment writing*. Wiley.
2. Rajammal, & Devadas, P. (1982). *Handbook of methodology of research*. Sri Ramakrishna mission vidyalaya press.
3. Kothari, C. R. (2019). *Research methodology: Methods and techniques* (4th ed.). New Age International Publishers.
4. Kumar, R. (2018). *Research methodology: A step by step guide for beginners* (5th ed.). Sage Publications.
5. Willard, H. H., Merrit, L. L., Dean, J. A., & Settle, F. A. (2001). *Instrumental methods of analysis*(7th ed.). Wadsworth Publishing.

Suggested Readings

1. Nakra, B. C., & Chaudhry, K. K. (2016). *Instrumentation measurement and analysis* (3rd ed.). McGraw Hill Education.
2. Bhattacharya, S. K., & Chatterjee, S. (2017). *Industrial electronics and control*. McGraw Hill Education.
3. Rao, S. B., & Shantha, C. K. (2004). *Numerical methods* (5th ed.). Universities Press.
4. Sastry, S. S. (2012). *Introductory methods of numerical analysis* (5th ed.). PHI Learning.
5. Venkataraman, M. K. (1999). *Numerical methods in science and engineering* (5th ed.). National publishing company.
6. Iyengar S.R.K. *Lecture Series on Numerical methods and computation* [NPTEL series]. Department of Physics, IITD.

Web Resources

1. Research Methodology for Beginners || Research Methodology Lecture - YouTube
2. Doctoral Seminar in Research Methods I | Sloan School of Management | MIT OpenCourseWare
3. Introduction to Research Methodology - YouTube
4. Using MITx to Teach Qualitative Research Methodology | Open Learning
5. Research Methodology - Course (nptel.ac.in)

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify and discuss the role and importance of the method of research.	**K1, K2**
CO 2	Plan and prepare research problems following ethical guidelines.	**K3**
CO 3	Select the appropriate experimental techniques to analyze the research problems. Develop the ability to apply the methods while working on a research project.	**K4**
CO 4	Summarize the results of the experiment to disseminate the knowledge acquired.	**K5**
CO 5	Write a research article by systematic review of literature.	**K6**

COURSE DESCRIPTOR

Course Code	PPH2ME01
Course Title	Astrophysics
Credits	02
Hours/Week	04
Category	Major Elective (ME) – Theory
Semester	II
Regulation	2022

Course Overview

1. This course gives detailed discussion on various astronomical coordinate systems.
2. In this course, the magnitude systems, different techniques on stellar distance measurements are discussed.
3. It provides the underlying physical principles on Star formation and life cycle.
4. This course discusses the interesting features of sun, sunspots and solar cycle and Helioseismology.
5. In this course, the various types of galaxies, significance of Hubble's law and its consequences are brought.

Course Objectives

1. To develop the necessary mathematical tools to understand the motion of stars and planets.
2. To calculate stellar distances using parallax techniques and determine the temperature of star from their emission spectra.
3. To explain the physical principles behind the stellar formation and its life cycle based on modern physics.
4. To distinguish the properties of the sun, planets and other stars.
5. To appreciate and comprehend the modern view of galaxies, Hubble's law and Dark matter.

Prerequisites	Basic knowledge on Physics and Astrophysics

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**BASICS OF ASTRONOMY** System of Coordinates - Altazimuth, Equatorial (local and Universal), Ecliptic and Galactic systems. Earth-moon system-Tidal forces Precession of earth's axis Interiors Atmospheres- Planets Terrestrial planets - Jovian planets	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**PHOTOMETRIC CONCEPTS** Magnitude scale and magnitude systems, correction for observed magnitudes. The proper motion - stellar parallax Trigonometric, cluster and secular parallaxes. Method of Luminosity distance. Measurement of stellar radii - Relation of luminosity with mass, radii and surface temperature.	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**STARS AND ITS CLASSIFICATIONS** Life – Cycle of the stars – The black body model of a star – Spectral classification of stars – Stellar colours – Colour index – Hertzsprung – Russell diagram – Visual binaries – Astrometric binary stars – Spectroscopic binaries – Photometric binary stars	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**SOLAR PHYSICS** Interior -Atmosphere -Solaractivity - Helioseismology - White dwarfs-Chandrasekhar limit-Neutron stars- Pulsars	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**GALAXIES AND DARK MATTER** Observable universe – Classification of galaxies based on Hubble sequence – Properties of each galaxies – Our milky way galaxy – Star formation in galaxies – Explanations of spiral structure – Dark matter	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	in galaxies – Red – shifts and Blue – Shifts – Hubble's law in relation to the expanding universe.			

Text Books

1. Carroll, B. W., & Ostlie, D. A. (2006). *An introduction to modern Astrophysics* (2nd ed.). Cambridge University Press.
2. Karttunen, H., Kröger, P., Oja, H., Poutanen, M., & Donner, K. J. (2016). *Fundamental Astronomy*(6th ed.). Springer.
3. Kutner, M. L. (2007). *Astronomy: A physical perspective* (2nd ed.). Cambridge University Press.

Suggested Readings

1. LeBlanc, F. (2011). *An introduction to stellar Astrophysics*. Wiley.
2. Choudhuri, A. R. (2012). *Astrophysics for Physicists*. Cambridge University Press.
3. Mihalas, D., & Binney, J. (1981). *Galactic Astronomy: Structure and kinematics* (2nd ed.). W H Freeman.

Web Resources

1. https://www.youtube.com/watch?v=s4ZttiU2iL8&list=PL0yNjaybQwdudycotA6z0DFK5DZaXWE1J
2. https://www.youtube.com/watch?v=NZR6aLACvVs&list=PL2yn_e5rlIW0bsNIOc3dEadJ6YwTOoj-Z&index=12
3. https://www.youtube.com/watch?v=D5GDztHsL3U&list=PLMahwAGxKuWldeQ_qaIj8c0i7qbfyfLj4
4. https://www.youtube.com/watch?v=vKAd2ICBk2c
5. https://www.youtube.com/watch?v=vDv3iSMdYyc&list=PLbMVogVj5nJROKq6v6sZq74sjty86dAQ2

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Classify the different coordinate systems and galaxies.	**K1, K2**
CO 2	Use various methodologies to find the Radii, Luminosity and Life of stars. Interpret dark matter from physics principles.	**K3**
CO 3	Distinguish between different galaxies and examine the interior of the sun and its activities.	**K4**
CO 4	Formulate the classification of various stars using HR diagram concepts.	**K5**
CO 5	Investigate the formation of stars and galaxies by applying the principles of modern physics.	**K6**

COURSE DESCRIPTOR

Course Code	PPH2ME02
Course Title	Geophysics
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	II
Regulation	2022

Course Overview

1. Geophysics is an interdisciplinary subject applied in a wide range of industries, including oil, gas, petroleum and mineral exploration, groundwater, contaminants and salinity evaluation, government geological surveys, defense science and academic research.
2. The aim of this course is to provide the background knowledge of solid-earth, exploration and environmental geophysics. It is split into five sections: (i) Physics of Earth (ii) Geophysical and Geochemical analysis (iii) Seismology (iv) Geomagnetism and gravity (v) Geochronology and Petrophysics.
3. Each section, starts with the underlying mathematical basis and examine the applications at global, exploration, environmental scales and survey methods.
4. The course also involves methods of geophysical data analysis, modelling, visualization and interpretation through IPI2WIN and ArcGIS software.
5. Students will be introduced to career options through industry visits at Indian Meteorological Department (IMD), Chennai. The course is aimed at students from a range of numerate scientific backgrounds to choose their career and higher studies in Geophysics.

Course Objectives

1. To understand the structures and purposes of interior and exterior of the Earth.
2. To understand the formation of Earth through geophysical methods and studies on Geochemistry of groundwater.
3. To understand the geomagnetic behavior and the phenomenon of gravity of the Earth.
4. To apply the knowledge of Physics to evaluate the geophysical structures of Earth using various physic and chemical properties of rocks.

Prerequisites	Basic knowledge on Physics and Geophysics

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**PHYSICS OFTHE EARTH** Introduction to Geophysics- Earth as a member of the solar system-Atmosphere-Ionosphere- Asthenosphere-Lithosphere-Hydrosphere and Biosphere-Meteorology-Hydrological Properties of Water Bearing Materials: Porosity, void radio, permeability, transmissivity, storability, specific yield, specific retention, diffusivity, laboratory methods of determination of permeability.	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**GEOPHYSICAL AND GEOCHEMICALMETHODS** **Geophysical methods**: Geo referencing-Geographic Information system (GIS) - Electrical methods- Quantitative interpretation of Vertical Electrical Sounding curves –Subsurface and groundwater identification– 2D and 3D resistivity imaging system- Bore hole logging system- Ground Penetrating Radar and its applications - **Geochemical methods**: Introduction-Principles of ground water chemistry- Geochemical data analysis.	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**INTRODUCTION TO SEISMOLOGY** The earth's interior and crust as revealed by earthquakes- Rayleigh waves and Love waves- Elastic rebound theory- Continental drift-Earthquake magnitude and intensity-Horizontal seismograph and seismograph equation- Interior of the Earth and Earth	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	quake prediction - Concepts of Geodynamics- Numerical methods for determination of focal depth and epicentral location.			
IV	**GRAVITY AND GEOMAGNETISM** **Gravity:** Gravitational potential-Laplace's equation and Poisson's equation-Absolute and relative measurements of gravity-Worden gravimeter. **Geomagnetism:** Historical introduction – The physical origin of magnetism- Dynamo theory of earth's magnetism. Proton Precession Magnetometer-Alkali vapour Magnetometer.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**PETROPHYSICS** Fundamental concepts of petrophysics-Basic rock properties- Theory and Laboratory measurements of the physical properties of rocks - Radioactivity of the earth-Radioactive dating-Core analysis, acquisition, interpretation, and quality checks- Geopolymers.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Arthur W. Hounslow.(1995). *Water quality data -Analysis and Interpretation*(11th Edition). Lewispublishers WashingtonD.C.
2. Cook. A.H.(1973) *Physics of the Earth and Planets(* 4TH Edition). McMillan Press, London
3. John Milsom. *Field geophysics- The Geophysical field guide(6th Edition).* Wiley publications,England.
4. Krauskopf. K.B(1967). *Introduction toGeochemistry(6th Edition).* McGraw Hill.
5. Ramachandra Rao(1975). *Outline of geophysical prospecting-a manualfor Geologists(*5th Edition). University of Mysore.
6. David Keith Todd, Larry W. Mays(2005). *Groundwater Hydrology.(* 3rd edition). John Wiley And Sons Inc.,
7. R.C.Ward and M. Robinson.(2011). *Principles of Hydrology(*4thedition).Mcgraw Hill Education.

Suggested Readings
1. K. Kaul, S. Senugupta and A.K. Bhattacharya.(1990). I.K. Kaul, S. Senugupta and A.K. Bhattacharya.(1st edition). *General and Applied Geophysics (An introduction)* Association Of Exploration Geophysicists,Centre Of Exploration Geophysics Building,' Osmania University Campus, Hyderabad - 500 007, India. 2. F.D. Stacey.(1977). *Physics of the Earth(*1st edition). John Wiley and Sons, N.ew York 3. Richter, C.F.(1969). *Elementary Seismology.(* 1st edition). Eurasia Publishing house, Pvt. Ltd. New Delhi. 4. Rezhevisky and Novik.(1971). *Physical properties of Rocks(*1st edition). Mir Publications. 5. Koefeed C,(1980). *Principles of Geoelectrical Soundings(*1st edition). Elsevier.
Web Resources
1. https://sites.ualberta.ca/~vadim/Geoph325/Course325.htm 2. INTERMAGNET 3. IMD | Home 4. Signal Analysis and Imaging Group - SeismicLab - Matlab Scripts for Seismic Data Processing (ualberta.ca) 5. Geophysics | USGS.gov 6. CSIR - National Geophysical Research Institute (ngri.org.in) 7. PGDA - Home (nasa.gov)

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand physics and geology of the earth through geophysical observation and measurements.	**K1, K2**
CO 2	Outline the broad scale structure of the Earth and the physical processes governing the Earth's interior	**K3**
CO 3	Apply the geophysical methods to socially relevant problems, including natural hazards, ground water resource management and other environmental issues.	**K4**
CO 4	Ability to interpret the data obtained from the geoelectrical, geochemical, magnetic and seismic methods.	**K5**
CO 5	Design models and solve the equations with the use of both analytical and computational methods.	**K6**

COURSE DESCRIPTOR

Course Code	PPH2ME03
Course Title	Physics of Semiconductor Devices
Credits	02
Hours/Week	04
Category	Major Elective (ME)
Semester	II
Regulation	2022

Course Overview

1. Physics of Semiconductor devices emphasize the working principles of Diodes, BJT, FET and Avalanche diodes.
2. The Equivalent circuit of a p-n diode will be analyzed in this course.
3. This course will provide an industry ready expertise for semiconductor device manufacturing industries.
4. The theory of transistors and their fabrication will be elaborated.
5. It includes the physics behind Photonic devices and their characteristics are explained.

Course Objectives

1. To understand the working principles and manufacturing details of Diodes.
2. To learn the dynamic of charge carriers in a Bipolar Junction Transistor.
3. To explore the various structural fabrication techniques of FET.
4. To understand the Electroluminescence theories of Photonic devices.
5. To learn the theories of Transferred-Electron Devices and Avalanche Diodes and their applications.

Prerequisites	Under graduation in Physics

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**P-N JUNCTIONS** p-n Junction under Zero bias Conditions- The Diode Equation- Generation and Recombination Currents- Depletion Capacitance- Diffusion Capacitance and Equivalent circuit of a p-n diode- Tunneling and Tunnel Diodes- Junction Breakdown	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**BIPOLAR JUNCTION TRANSISTORS** Principle of Operation- Minority Carrier Profiles in a Bipolar Junction Transistor- Current Components and Current Gain- Base Spreading Resistance and Emitter Current Crowding Base Contacts- Effects of Nonuniform Doping in the Base Region- Output Characteristics and Early Effect- Breakdown - Bipolar Junction Transistors in Integrated Circuits.	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**FIELD-EFFECT TRANSISTORS** Introduction- Surface Charge in Metal Oxide Semiconductor Capacitor- Capacitance–Voltage Characteristics Of MIS Structure- Metal Oxide Semiconductor Field–Effect Transistors (MOSFET)- Velocity Saturation Effects in MOSFET- Subthreshold Current in MOSFETS- MOSFET Capacitances and Equivalent Circuit	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**PHOTONIC DEVICES** Introduction- Photodetectors - Light Emission in Semiconductors: Electroluminescence and Light–Emitting Diodes - Semiconductor Lasers -Crystalline Solar Cells- Integrated Optoelectronics	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

V	**TRANSFERRED-ELECTRON DEVICES AND AVALANCHE DIODES** Introduction- Ridley-Watkins-Hilsum-Gunn Effect- Transferred-Electron Devices-Impatt, Trapatt, and Baritt Diodes.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Shur, M. (2019). *Physics of semiconductor devices*. Pearson.
2. Sze, S., & Lee, M. K. (2015). *Semiconductor devices: Physics and Technology* (8th ed.). Wiley.
3. Colinge, J. P., & Colinge, C. A. (2005). *Physics of semiconductor devices* (2nd ed.). Springer.

Suggested Readings

1. Grasser, T. (2020). *Noise in nanoscale semiconductor devices*. Springer.
2. Sze, S. M., Li, Y., & Ng, K. K. (2021). *Physics of semiconductor devices* (4th ed.). Wiley.
3. Achuthan, M. K., & Bhat, K. N. (2006). *Fundamentals of semiconductor devices*. McGraw Hill Education.

Web Resources

1. Semiconductor Device Physics (Lecture 1: Semiconductor Fundamentals) - YouTube
2. Introduction to Semiconductor Physics and Devices - YouTube
3. (201) Semiconductors - Physics inside Transistors and Diodes - YouTube
4. EE130 Lecture Notes (berkeley.edu)
5. semiconductors lecture notes (1)_0.pdf (iare.ac.in)

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Explain the fundamental principles and applications of semiconductor devices	**K1, K2**
CO 2	Apply the laws to draw the equivalent circuits of semiconductor diodes and transistors	**K3**
CO 3	Explain and differentiate between the working and device fabrication of various electronic devices.	**K4**
CO 4	Summarize the different methods and principles involved in device fabrication, device characteristics and some applications.	**K5**
CO 5	Apply theoretical concepts and basic formulas to design new semiconductor devices	**K6**

COURSE DESCRIPTOR

Course Code	PPH2CD01
Course Title	Climate Change and Energy Management
Credits	1
Hours/Week	3
Category	Cross-Disciplinary (CD)
Semester	II
Regulation	2022

Course Overview

1. The thematic areas related to climate change and clean energy management.
2. The adverse effects of Greenhouse emission and its contribution to global warming.
3. The expected consequences of climate change and the role of adaptation.
4. The significant role of renewable energy resources in energy management.
5. The importance of addressing climate change issues, for conservation and sustainability.

Course Objectives

1. To provide students with the basic knowledge of climate science and the importance of energy.
2. To help students understand the key concepts of climate science and climate change.
3. To introduce them to energy conservation, its impact on society, various energy sources, energy conversion processes and energy management.
4. To analyze the causes of climate change and identify how human activities affect the climate.
5. To probe the principal challenges and opportunities for climate change action.

Prerequisites	Basic knowledge of science and environment.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**CLIMATE SCIENCE** Introduction – Climate and Weather – Earth's Climate System – Natural Greenhouse Effect – The Radiation Balance – Greenhouse Gases - Past Climate – Industrial Revolution –Human emissions of CO_2.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**IMPACTS OF CLIMATE CHANGE** Keeling curve – Global Temperature Increase –Heat Waves, Forest Fire, Sea Level Rise, Ocean Acidification – Effects on Food security and production – Human health and livelihood – Adaptation and Mitigation Strategies.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**ENERGY SCENARIO** World's Energy Scenario – Global Energy Consumption – Energy Demand – Energy and Climate Change – Global Threat.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**ALTERNATE AND SUSTAINABLE ENERGY** Classification of Energy Resources – Non-Renewable Energy Sources: Oil, Coal and Natural Gas – Renewable Energy Sources: Solar, Wind, Hydro, Ocean and Geothermal Energy – Energy Conversion, Storage and Utilization.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**ENERGY MANAGEMENT: POLICIES AND TECHNOLOGIES** Energy Management: Definition and Significance – Global and National Perspectives – Alternate Energy Policies – International Agreements: The United Nations Framework Convention on Climate	7	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	Change, Kyoto Protocol, Paris Agreement – Future Technologies – Biofuels, Hydrogen, Geoengineering.			

Text Books

1. Dessler, A. E. (2021). *Introduction to modern climate change* (3rd ed.). Cambridge University Press.
2. Earle, S. (2021). *A brief history of the earth's climate: Everyone's guide to the science of climate change*. New Society Publishers.
3. Maslin, M. (2021). *Climate: A very short introduction* (4th ed.). Oxford University Press.
4. Parry, M., Rosenzweig, C., & Mel, M. D. (2021). *Our warming planet: Climate change impacts and adaptation*. World Scientific.

Suggested Readings

1. Lieberman, B., & Gordon, E. (2022). *Climate change in human history: Prehistory to the present*(2nd ed.). Bloomsbury Academic.
2. Moran, A. (2015). *Climate change: The facts*. Stockade books.

Web Resources

1. https://en.wikipedia.org/wiki/Climate_Change:_Global_Risks,_Challenges_and_Decisions
2. https://en.wikipedia.org/wiki/Effects_of_climate_change
3. www.ipcc.ch
4. www.aip.org/history/climate/
5. https://en.wikipedia.org/wiki/National_Action_Plan_for_Climate_Change
6. http://nca2014.globalchange.gov/
7. https://www.globalcitizen.org/en/content/nobel-prize-in-physics-2021-climate-scientists

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Acquire a broad knowledge of the issues related to climate change.	**K1, K2**
CO 2	Understand the key concepts of climate science and its significance in conserving Nature.	**K3**
CO 3	Acquainted with climate change adaptation and mitigation strategies.	**K4**
CO 4	Apply the knowledge of alternate energy sources to propose clean energy solutions.	**K5**
CO 5	Analyze the key aspects of energy management and suggest feasible solutions for a sustainable future.	**K6**

COURSE DESCRIPTOR

Course Code	PPH2MC04
Course Title	Physics Practical – II
Credits	4
Hours/Week	8
Category	Major Core (MC) – Practical
Semester	II
Regulation	2022

Course Overview

1. This course highlights the importance of having hands-on experience to measure physical quantities and use practical methods to understand theoretical concepts.
2. It helps students to acquire experimental abilities, which are essential for physicists.
3. Students will be able to use various components and equipments.
4. Students will also be able to work efficiently and safely in a laboratory, both individually and in groups.

Course Objectives

1. To determine elastic constants and hardness parameters of materials using appropriate experimental setup.
2. To calculate the resistivity and dielectric parameters of crystals using apparatus.
3. To understand the application of operational amplifiers as filters and D/A converters.
4. To develop simple assembly language programs using microprocessor 8086.
5. To explore the usage of Python language to execute simple programs involving arithmetic and logic instructions.

Prerequisites	Basic knowledge of the usage of scientific apparatus

S. No	List of experiments	Hours Per week Per student Per Expt.	Cos	Cognitive levels
1.	Cornu's method – Young's modulus and Poisson's ratio – Hyperbolic Fringes	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
2.	Dielectric studies			
3.	Hardness studies			
4.	Electrical conductivity studies- Four Probe Method			
5.	GM counter–Feather Analysis.			
6.	F.P. etalon – Spectrometer – Thickness of air film			
7.	B-H loop by CRO			
8.	Hall Effect			
9.	Magnetic susceptibility – Guoy's method			
10.	Constant deviation spectrograph – Copper arc spectra			
11.	Inverter-Low D.C. to High A.C. converter			
12.	A/D -Binary counter -IC 7493			
13.	555 Timer –Temperature control (thermistor)			
14.	OP-AMP Waveform generators			
15.	Op -Amp 741 –Second order filters – Single pole and double pole			
16.	Op -Amp 741 -D/A converter (R-2R &Weighted)			

17.	Microprocessor 8086-Introduction I (arithmetic and logical- all modes)			
18.	Microprocessor 8086-Introduction II (code conversions and arrays)			
19.	Microprocessor 8086 –Interface I (LEDs)			
20.	Microprocessor 8086 –Interface II(LEDs & switches)			
21.	Microprocessor 8086 –Interface III – water level controller			
22.	Turbo Debugger –Introduction I(simple programs– Trace mode)			
23.	Python – Introduction I			
24.	Python – Introduction II			

The staff in - charge shall select any 14 from this list. The remaining 2 experiments can be chosen from this list or can be new experiments included by the staff in - charge with prior approval of the department.

Suggested Readings

1. Singh, S. P. (1999). *Advanced Practical Physics* (23rd ed.). Pragati Prakashan.
2. Nelkon, M., & Ogborn, J. M. (1978). *Advanced level Practical Physics* (4th ed.). Pearson Education.
3. Chattopadhyay, D., & Rakshit, P. C. (2017). *An Advanced course in Practical Physics* (10th ed.). New Central Book Agency.
4. Squires, G. L. (2001). *Practical Physics* (4th ed.). Cambridge University Press.

Web Resources

1. https://vlab.amrita.edu/?sub=1&brch=282&sim=1005&cnt=1
2. https://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=1
3. https://vlab.amrita.edu/?sub=3&brch=45&sim=539&cnt=900
4. https://vlab.amrita.edu/?sub=1&brch=282&sim=1507&cnt=1
5. https://vlab.amrita.edu/?sub=1&brch=282&sim=879&cnt=1
6. http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAE/exp2/index.html
7. https://he-coep.vlabs.ac.in/Experiment6/index1.html
8. https://python-iitk.vlabs.ac.in/exp/arithmetic-operations/simulation.html

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Define the objective of the experiment and explain the various parameters in the formula for determining a material's physical property.	**K1, K2**
CO 2	Construct the experimental setup and carry out the experiment	**K3**
CO 3	Make a list of the observations and repeat the experiment to compute the physical quantity using the appropriate formula.	**K4**
CO 4	Interpret the obtained result and sketch the variations wherever required.	**K5**
CO 5	Analyze the result of the experiment to build or create a piece of equipment or a device for use in project/research activity.	**K6**

COURSE DESCRIPTOR

Course Code	PPH3MC01
Course Title	Quantum Mechanics -I
Credits	7
Hours/Week	6
Category	Major Core (MC)
Semester	III
Regulation	2022

Course Overview

1. An introduction to linear vector space and the associated algebra
2. Use Schroedinger formalism to solve 1 and 3D problems to understand the concepts exclusive to quantum mechanics.
3. Extensive use of abstract operator algebra to learn about angular momentum and its importance.
4. Use of different approximation methods to perturbed systems.
5. Quantum mechanical description of scattering and their applications.

Course Objectives

1. To learn quantum mechanics from the abstract concept of linear vector space, linear operators, and their algebra, unitary transformation and its consequence.
2. Make extensive use of Schroedinger representation to learn about the newer concepts of quantization of energy, and angular momentum and tunneling across barrier.
3. To understand and appreciate the commutative and non-commutative algebra in the special context of angular momentum in general.
4. To solve time independent perturbed systems using various methods and give an account of splitting of atomic spectral lines an estimate of ground state energy of simple systems.
5. To provide a formulation for scattering phenomena and correlate it with experimental results.

Prerequisites	1. A thorough understanding of mechanics. 2. Knowledge of partial differential equation and variable separable method. 3. Commendable knowledge of integral and differential calculus.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**GENERAL FORMALISM** Linear vector space – ket and bra notations – inner product – norm of a vector – linear independence – dimension and basis of a vector space–Hilbert space. Linear Operators – Hemitian adjoint – Eigenvalues and eigenfunctions– representation theory : matrix representation of basis, bra and ket vectors, inner and outer product – change of basis – unitary operators – matrix elements – unitary transformation – diagonalisation – coordinate and momentum representation.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**EXACTLY SOLVABLE PROBLEMS** Time dependent Schrodinger wave equation – the three pictures in quantum mechanics – Particle in a box – Step potential – delta potential – potential barrier –barrier penetration – simple harmonic oscillator – operator method – number states – coherent states – orbital angular momentum – eigenvalue problem (analytical method)– Hydrogen atom.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**ANGULAR MOMENTUM (**Bra-ket notation**)** General angular momentum operators – ladder operators - commutation relations – eigenkets – matrix representation of operators – spin angular momentum – properties of spin operators - spin half systems – eigenkets – Pauli matrices – magnetic moment of an electron- addition of angular momentum – recursion relation connecting Clebsch-Gordan coefficients.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

IV	**APPROXIMATION METHODS** Time independent perturbation theory – non degenerate energy levels – first order and second order correction to energy and wave function – anharmonic oscillator, ground state of Helium atom – degenerate energy levels – Stark effect – spin-orbit interaction – Zeeman effect- WKB approximation (qualitative) – variational method – upper bound on ground state energy, Hydrogen molecule.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**SCATTERING THEORY AND APPLICATIONS** Scattering cross section – scattering amplitude – partial waves– scattering by a central potential - partial wave analysis – scattering by a square potential well – Breit-Wigner formula – scattering length – phase shift – Born approximation – scattering by a screened Coulomb potential – validity of Born approximation- scattering cross section relation between Lab and centre of mass of coordinate system	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Shankar, R. (2011). *Principles of Quantum mechanics* (2nd ed.). Springer.
2. Bransden, B. H., & Joachain, C. J. (2012). *Quantum mechanics* (2nd ed.). Pearson.
3. Zettili, N. (2009). *Quantum mechanics: Concepts and Applications* (2nd ed.). Wiley.
4. Arul Dhas, G. (2008). *Quantum mechanics* (2nd ed.). PHI.
5. Agarwal, B. K., & Prakash, H. (2005). *Quantam mechanics* (5th ed.). PHI.
6. Kakani, S. L., & Chandalia, H. M. (2004). *Quantum mechanics: Theory and Problems* (3rd ed.). Sultan Chand and Sons.
7. Thankappan, V. K. (1993). *Quantum mechanics* (2nd ed.). New Age International.

Suggested Readings
1. Mathews, P. M., & Venkatesan, K. (2017). *A Textbook of Quantum mechanics* (2nd ed.). Tata McGraw-Hill Education. 2. Griffiths, D. J., & Schroeter, D. F. (2019). *Introduction to Quantum mechanics* (3rd ed.). Cambridge University Press. 3. Tannoudji, C. C., Diu, B., & Laloe, F. (1977). *Quantum mechanics (Vol.1)* (2nd ed.). Wiley-VCH. 4. Carlson, T. (2013). *Photoelectron and auger Spectroscopy*. Springer. 5. Chatwal, G. R., & Anand, S. K. (2010). *Spectroscopy: Atomic and molecular* (5th ed.). Himalaya Publishing House. 6. Hollas, J. M. (2004). *Modern spectroscopy* (4th ed.). Wiley.
Web Resources
1. https://www.youtube.com/watch?v=TcmGYe39XG0&list=PL0F530F3BAF8C6FCC&index=1 2. https://archive.nptel.ac.in/courses/115/101/115101107/ 3. https://www.youtube.com/watch?v=zdouC7ZNTJ0 4. https://www.digimat.in/nptel/courses/video/115102023/L01.html 5. https://www.digimat.in/nptel/courses/video/115106066/L39.html 6. https://www.youtube.com/watch?v=l5ddR3JzM5Y

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify and summarize all the new algebra.Apply the new algebra to systems and interpret the results that are exclusive to quantum world.	**K1, K2**
CO 2	Employ the concept of commutative and non-commutative algebra in explaining orbital and spin angular momentum.	**K3**
CO 3	Devise theoretical methods to explain scattering phenomena and compare with experimental results.	**K4**
CO 4	Choose appropriate approximation methods to evaluate the energy corrections in perturbed systems.	**K5**
CO 5	Integrate all the concepts to facilitate problem solving with an aim to appreciate the new concepts.	**K6**

COURSE DESCRIPTOR

Course Code	PPH3MC02
Course Title	Spectroscopy
Credits	7
Hours/Week	6
Category	Major Core (MC)
Semester	III
Regulation	2022

Course Overview

1. This course focuses on the fundamentals of rotational, infrared, Raman, electronic and NMR spectroscopic analysis.
2. This course helps the students to understand the working principles of spectroscopic instruments like FTIR, NMR, Mossbauer and other spectrometers.
3. In this course students learn to analyze the spectroscopic fingerprints and interpret them for chemical analysis.
4. Resonance spectroscopic techniques (ESR and NMR) will be discussed in detail.
5. This course demonstrates applications like atomic, nuclear and molecular structural analysis of various materials.

Course Objectives

1. To understand the vibrational and rotational spectroscopic principles.
2. To know the fundamentals of FTIR, NMR techniques.
3. To use spectroscopic instruments like FTIR for analyzing the samples.
4. To understand the theory of electronic spectroscopy and ESR instrumentation.
5. To explain the theory of Mossbauer spectroscopy, instrumentation and interpretation.

Prerequisites	Basic knowledge in Physics and electromagnetic radiations

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**MICROWAVE SPECTROSCOPY** Rotation of molecules-Rotational spectra - Rigid and non-rigid diatomic rotator- Intensities of spectral lines- Effect of Isotopic substitution-Polyatomic molecules (Linear, symmetric top and asymmetric top)-Chemical analysis by microwave spectroscopy- Techniques and instrumentation- microwave oven.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**INFRARED SPECTROSCOPY** Vibration of Diatomic molecules-Simple Harmonic Oscillator-Anharmonic oscillator-Diatomic vibrating rotator- The vibration-rotation spectrum-Interactions of rotations and vibrations-The vibrations of polyatomic molecules-Influence of rotation on the Vibrational spectra of linear and symmetric top molecules-Analysis by infrared techniques-Instrumentation-FTIR spectroscopy.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**RAMAN SPECTROSCOPY** Classical and quantum mechanical picture of Raman effect-Polarizability-Pure rotational Raman spectra- Vibrational Raman Spectra-Raman activity of vibrations of CO_2 and H_2O-Rule of mutual exclusion-Overtone and combination vibrations- Rotational fine structure -Vibrations of spherical top molecule-structure determination from Raman and IR spectroscopy-techniques and instrumentation-FT Raman spectroscopy-Surfaces for SERS study-SERS microbes-Surface selection rules	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

IV	**ELECTRONIC SPECTROSCOPY** Electronic spectra of diatomic molecule-Frank-Condon principle-Dissociation energy and dissociation products-Rotational fine structure-Fortrat diagram-predissociation-Shapes of some molecular orbits-Chemical analysis by electronic spectroscopy-Techniques and instrumentation-ESR spectroscopy-Introduction- Techniques and instrumentation.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**NUCLEAR SPECTROSCOPY** Nuclear magnetic resonance spectroscopy-Introduction-Interaction of spin and magnetic field- population of energy levels-Larmor precession-Relaxation times-Double resonance- Chemical shift and its measurement- Coupling constant-Coupling between several nuclei- Quadrupole effects-C13 NMR spectroscopy- Interpretation of simple spectrum - Mossbauer spectroscopy: Principle-instrumentation-Applications of Mossbauer spectroscopy: Chemical shift-Effect of electric and magnetic fields.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Aruldhas, G. (2007). *Molecular Structure and Spectroscopy* (2nd ed.). PHI.
2. Banwell, C. N., & McCash, E. M. (2004). *Fundamentals of Molecular Spectroscopy* (5th ed.). Tata McGraw-Hill Education.

Suggested Readings

1. Chaudhuri, R. K., Mekkaden, M., Raveendran, A. V., & Narayanan, A. S. (2010). *Recent advances in Spectroscopy: Theoretical, Astrophysical and Experimental perspectives*. Springer.
2. Tuniz, C., Kutschera, W., Fink, D., Herzog, G. F., & Bird, J. R. (2011). *Accelerator mass Spectrometry: Ultrasensitive analysis for global science*. CRC Press.
3. Engel, T. (2015). *Quantum Chemistry and Spectroscopy* (3rd ed.). Pearson.
4. Watts, J. F., & Wolstenholme, J. (2019). *An Introduction to surface analysis by XPS and AES*(2nd ed.). Wiley.
5. Carlson, T. (2013). *Photoelectron and auger Spectroscopy*. Springer.

6. Chatwal, G. R., & Anand, S. K. (2010). *Spectroscopy: Atomic and molecular* (5th ed.). Himalaya Publishing House.
7. Hollas, J. M. (2004). *Modern spectroscopy* (4th ed.). Wiley.

Web Resources

1. JLExp13.pdf (mit.edu)
2. https://nptel.ac.in/courses/115101003
3. Infrared spectroscopy - Wikipedia
4. B-2 Mossbauer Spectroscopy - Physics 191r (harvard.edu)
5. Surface-enhanced Raman spectroscopy - Wikipedia

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and explain the fundamental concepts and applications of microwave, IR, Raman and other spectroscopic methods.	**K1, K2**
CO 2	Make use of electronic spectroscopy for chemical analysis.	**K3**
CO 3	Analyze the NMR and FTIR spectra of various samples and identify their chemical structure.	**K4**
CO 4	Choose suitable spectroscopic technique and examine the chemical composition of a material.	**K5**
CO 5	Apply the knowledge acquired and use spectroscopic instruments to examine and develop new materials.	**K6**

COURSE DESCRIPTOR

Course Code	PPH3ME01
Course Title	Advanced Mathematical Methods
Credits	2
Hours/Week	4
Category	Major Elective (ME)
Semester	III
Regulation	2022

Course Overview

1. This course introduces the various advanced special functions which are relevant to physical sciences
2. This course aims to applications of Laplace transform techniques which are relevant to physical problems.
3. This will enable them to bring out important special functions necessary for quantum mechanics and electrodynamics.
4. Will be introduced to the tensor algebra and analysis in a simple way.
5. This course will also discuss group theoretical concepts and its relevance to physical sciences.

Course Objectives

1. To determine the solutions of various advanced level special differential equations.
2. To familiarize and use the Laplace transform techniques to relevant physical problems.
3. To perform integrals based on error functions.
4. To learn the tensor analysis which are relevant to general theory of relativity.
5. To apply the various group theoretical tools in to quantum mechanics and condensed matter physics

Prerequisites	Basic knowledge of real variable calculus, differential equation

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**SPECIAL FUNCTIONS - I** Laguerre polynomials - Generating function - Orthogonality properties - Recurrence relation - Associated Laguerre polynomial	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**SPECIAL FUNCTINOS – II** Bessel function - Generating function – Hankel function – Recurrence relations - Spherical Bessel function - Graphs - Orthonormality relation. - The error function and its properties	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**APPLICATION OF LAPLACE TRANSFORM** Application: (1) Response of an RC circuit to a single square wave (2) Response of a damped vibrating system to a single square wave and to a unit impulse (3) Systems of two differential equations - two masses connected by a spring	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**TENSOR ANALYSIS** Tensors in Physics - Notation and conventions - Contra and covariant tensors of rank one and two - Transformation from Cartesian to polar coordinates - Algebra of tensors - outer and inner products - Contraction - Symmetric and anti-symmetric tensors - Quotient law - Conjugate tensors - Metric tensor - Raising and lowering of indices Cartesian tensors - Rotation and translation - Orthogonal transformations - Transformation of divergence and curl of vectors Stress, strain and Hooke's law - Piezoelectricity and dielectric susceptibility - Moment of inertia tensor	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

V	**GROUP THEORY** Groups - Symmetry transformation of a square - Conjugate element and classes – multiplication of classes - Subgroups - cyclic group - Normal subgroups and factor groups – Direct product of groups - Isomorphism and homomorphism - Permutation groups - Distinct groups -representation theory of finite groups - Molecular point groups - irreducible representation of point groups - reducible representation - Schur's lemma and the orthogonality theorem - character of the representation - the example of C4V – irreducible representation and regular representation	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Erwin Kreyzig, Advanced Engineering Mathematics, 8^{th} Edition(1991),Wiley Eastern Ltd.
2. H. K. Dass, Mathematical Physics, First edition(2010), S. Chand Publishing.
3. M.K. Venkatraman, Numerical methods in science and Engineering (Unit – 4 & 5), Fifth edition(1999), The national publishing company.

Suggested Readings

1. Comer, D. (2013). *Internet working with TCP/IP* (6th ed.). Prentice Hall of India.
2. Taub, H., & Schilling, D. L. (2017). *Principles of communication systems* (4th ed.). McGraw Hill Education.
3. Kurose, J. F., & Ross, K. W. (2013). *Computer networking: A top-down approach* (7th ed.). Pearson.
4. Lee, C. Y. (1988). *Mobile Communication Engineering* (2nd ed.). Tata McGraw Hill.

Web Resources

1. https://www.youtube.com/watch?v=9MTqD7yxHWg&list=PLq-Gm0yRYwThklRVGuMC01Gl7m1YSv_qn
2. https://www.youtube.com/watch?v=9MTqD7yxHWg&list=PLq-Gm0yRYwThklRVGuMC01Gl7m1YSv_qn
3. https://www.youtube.com/watch?v=NmYdDE7b-bc&list=PLMdnA49lASokRJHnH6Hm1A6ZzmQCS2f1D
4. https://www.youtube.com/watch?v=e0eJXttPRZI&list=PLlXfTHzgMRULkodlIEqfgTS-H1AY_bNtq
5. https://www.youtube.com/watch?v=uaQeXi4E7gA&list=PLdgVBOaXkb9D6zw47gsrtE5XqLeRPh27_

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Acquire the skill of determining the solution of advanced special differential equations	**K1, K2**
CO 2	Calculate the integrals based on error functions	**K3**
CO 3	Ability to distinguish Laplace transform and Fourier transform techniques	**K4**
CO 4	Apply the tensor analysis basics to general relativity and anisotropic materials	**K5**
CO 5	Solve problems in group theory which are relevant to quantum mechanics, condensed matter physics	**K6**

COURSE DESCRIPTOR

<table>
<tr><td>Course Code</td><td>PPH3ME02</td></tr>
<tr><td>Course Title</td><td>Communication Physics and network technology</td></tr>
<tr><td>Credits</td><td>2</td></tr>
<tr><td>Hours/Week</td><td>4</td></tr>
<tr><td>Category</td><td>Major Elective (ME)</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td>Regulation</td><td>2022</td></tr>
<tr><td colspan="2">Course Overview
1. The Course provides the students with basic information of communication physics and fundamental knowledge of the concepts of network technology.</td></tr>
<tr><td colspan="2">Course Objectives
1. To expose students to the advancements in communication physics.
2. To provide insights into the basic concepts of network technology.
3. To help students understand the principle guiding cellular communication.
4. To introduce the various network models and their limitations.
5. To aid in analysing the applications of networking and attempt simple designing.</td></tr>
<tr><td>Prerequisites</td><td>Basic knowledge of electronics and physical media.</td></tr>
</table>

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**DIGITAL TRANSMISSION AND MODULATION TECHNIQUES** Basic concepts of Communication - Analog and Digital transmission - Synchronous / Asynchronous Transmission - Line configurations - Interfacing. Digital data Digital signals - Variations of NRZ and bi - phase - Digital data Analog signals - ASK, FSK, PSK, QPSK - Analog data digital signals - PCM, DM.	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**OPTIC FIBRE COMMUNICATION** Fibre Optic Communication Systems – Step – Graded index fibres – Wave propagation – Fibre modes – Single and multimode fibres –Numerical aperture – Dispersion – Fibre bandwidth – Fibre losses - Scattering, absorption, bending, leaky mode and mode coupling losses – Attenuation coefficient -- Material absorption.	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**CELLULAR COMMUNICATION** Evolution of Mobile communication - Spread spectrum & hopping - fading and Doppler spread - Cellular systems - Medium access control - Principles of SDMA, FDMA, TDMA & CDMA and their comparison - GSM - Radio interface - Localization and calling - Handover - Security & Authentication - Mobile IP - IP packet delivery.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**BASICS OF NETWORK TECHNOLOGY** Introduction: Uses of computer networks - Network hardware – LAN, MAN, WAN - Network software – OSI AND TCP/IP Reference models.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	The Physical Layer: The theoretical basis for data communication - Guided Transmission media - Transmission impairments. The Data Link Layer: Data link layer design issues - Error detection and correction – Parity Check and Cyclic Redundancy Check - Elementary data link protocols.			
V	**NETWORK DESIGN AND ISSUES** The network layer: Network layer design issues - Routing algorithms - Congestion control algorithms. The transport layer: Transport layer design issues – Simple Transport protocols - Internet transport protocols UDP, TCP. The application layer: Domain Name System - Electronic mail – World Wide Web.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. William Stallings. (2014). *Data and Computer Communications* (10th ed.). Pearson.
2. Tanenbaum, A. S., & Wetherall, D. J. (2013). *Computer Networks* (5th ed.). Prentice Hall of India.
3. Forouzan, B. A. (2013). *Data Communications and Networking* (5th ed.). McGraw-Hill.
4. Schiller, J. H. (2008). *Mobile Communications* (2nd ed.). Pearson Education.

Suggested Readings

1. Comer, D. (2013). *Internet working with TCP/IP* (6th ed.). Prentice Hall of India.
2. Taub, H., & Schilling, D. L. (2017). *Principles of communication systems* (4th ed.). McGraw Hill Education.
3. Kurose, J. F., & Ross, K. W. (2013). *Computer networking: A top-down approach* (7th ed.). Pearson.
4. Lee, C. Y. (1988). *Mobile Communication Engineering* (2nd ed.). Tata McGraw Hill.

Web Resources

1. Data Communications and Networks (ITS323, Lecture 2, 2014) - YouTube
2. Introduction to Networking | Network Fundamentals Part 1 - YouTube
3. 01 Introduction DATA COMMUNICATIONS AND NETWORKING PART 1 - YouTube
4. (201) 01 Introduction DATA COMMUNICATIONS AND NETWORKING PART 1 - YouTube
5. Computer Communication Networks Lecture Notes (kent.edu)

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Comprehend the basics of communication and modulation techniques	**K1, K2**
CO 2	Acquainted with optical fibre communication principles and applications	**K3**
CO 3	Attain knowledge about the fundamentals of cellular communication	**K4**
CO 4	Gain insights into the basic concepts of computer technology and apply them to algorithms	**K5**
CO 5	Acquire skills for Network Design and analyse issues related to layers	**K6**

COURSE DESCRIPTOR

Course Code	PPH3ME03
Course Title	Medical Physics
Credits	2
Hours/Week	4
Category	Major Elective (ME)
Semester	III
Regulation	2022

Course Overview

1. This course will provide a comprehensive survey of modern nuclear medical imaging as well as a look into the emerging field of molecular imaging.
2. The basic principles of radiotherapy treatment modalities, radiation detection, dose calibration methods, and image-based treatment planning will be reviewed.
3. Basic understanding of Nanomedicine and Applications
4. The course provides the necessary physics background that underpins day-to-day use of ultrasound in medicine.

Course Objectives

1. To familiarize students with basic principles of radiation physics and also X-ray Generators, Particle Accelerators used in radiotherapy.
2. To understand the basic physics of the electromagnetic and particulate forms of ionizing & non ionizing radiation.
3. To demonstrate in-depth knowledge of topics in medical physics, including imaging and therapy
4. To appreciate the use and developments of Nanomedicines.

Prerequisites	Basic knowledge on Physics and Medical Physics

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**BASIC INTRODUCTION TO MEDICAL PHYSICS** Physics discoveries - Tools for physics applied to medicine - Medical imaging - PET and PET/CT - Conventional radiation therapy - Principles of Radiation detection and measurements – Radiation dosimeters and Radiation monitors.	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**RADIATION EVALUATION AND CONTROL** Basic concepts of Radiation protection standards –External radiation protection – Radiation dose limits –Equivalent dose, effective dose, committed dose – radiation exposures – Evaluation of external and internal radiation hazards and control- radioactive waste disposal – Radiation emergencies	11	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**LASERS IN MEDICINE** Superiority of Laser, Laser tissue interaction, physical effects on human skin of laser beam reflection, absorption, scattering), different interaction mechanism (photodynamic therapy), Lasers in Surgery: different surgical treatments.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**PHYSICS OF ULTRASOUND & IMAGING** Production & properties of ultrasound – propagation of ultrasound through body tissue – Acoustic impedance and acoustical characteristics in human body –ultrasound scanning modes – Ultrasound cardiography (UCG) – Doppler effect – Double doppler shift – doppler systems – ultrasonic tomography – applications of ultrasound in medicine.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

V	**NANOMEDICINE** Concept of nanomedicines, Rationale for designing of nanomedicines, Materials for preparation of nanomedicines, Different structures of nanomedicines. Applications of nanomedicines for Antibacterial Treatments- Drug Delivery - Diabetes.	10	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Cerrito, L. (2017). *Radiation and Detectors: Introduction to the Physics of Radiation and Detection devices*. Springer.
2. Bhargava, S. K., & Bhargava, S. (2018). *Textbook of Radiology for Residents & Technicians* (5th ed.). Bhargava.
3. Thayalan, K. (2014). *The Physics of Radiology and Imaging*. Jaypee Medical Publishers.
4. Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., & Boone, J. M. (2020). *The Essential Physics of Medical Imaging* (4th ed.). Wolters Kluwer.
5. Thayalan, K. (2017). *Basic Radiological Physics* (2nd ed.). Jaypee Brothers Medical Publishers.
6. Gilani, S. A., & Abbasi, T. A. (2012). *Lecture notes on Ultrasound Physics and Instrumentation: Ultrasound* (2nd ed.). Javed Medical Book Shop.
7. Fish, P. (1990). *Physics and Instrumentation of Diagnostic Medical Ultrasound*. Wiley.
8. Dendy, P. P., & Heaton, B. (2011). *Physics for Diagnostic Radiology* (3rd ed.). CRC Press.
9. Podgorsak, E. B. (2016). *Radiation Physics for Medical Physicists* (3rd ed.). Springer.
10. Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., & Boone, J. M. (2020). *The Essential Physics of Medical Imaging* (4th ed.). Wolters Kluwer.
11. Martin, A., Harbison, S., Beach, K., & Cole, P. (2018). *An Introduction to Radiation Protection* (7th ed.). CRC Press.
12. Gibbons, J. P. (2019). *Khan's: The Physics of Radiation Therapy* (6th ed.). Wolters Kluwer.

Suggested Readings

1. Thayalan, K. (2014). *The Physics of Radiology and Imaging*. Jaypee Medical Publishers.
2. Jelinkova, H. (2013). *Lasers for Medical Applications: Diagnostics, Therapy and Surgery*. Elsevier.
3. Waynant, R. W. (2001). *Lasers in Medicine*. CRC Press.
4. Gibbs, V., Cole, D., & Sassano, A. (2011). *Ultrasound Physics and Technology:How, why and when*. Elsevier.
5. Miele, F. J. (2013). *Ultrasound Physics and Instrumentation* (5th ed.). Miele Enterprises.
6. Jain, K. K. (2017). *The Handbook of Nanomedicine* (3rd ed.). Humana Press.
7. Webster, T. J. (2012). *Nanomedicine: Technologies and Applications*. Woodhead.

Web Resources
1. https://www.youtube.com/watch?v=TcmGYe39XG0&list=PL0F530F3BAF8C6FCC&index=1 2. https://archive.nptel.ac.in/courses/115/101/115101107/ 3. https://www.youtube.com/watch?v=zdouC7ZNTJ0 4. https://www.digimat.in/nptel/courses/video/115102023/L01.html 5. https://www.digimat.in/nptel/courses/video/115106066/L39.html 6. https://www.youtube.com/watch?v=l5ddR3JzM5Y

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Explain the various physics principles involved in therapy, Medical imaging and Medicines.	**K1, K2**
CO 2	Interpret diagnostic ultrasound images based on understanding of the interaction between ultrasound and tissue.	**K3**
CO 3	Critically analyze the role of lasers in medicine, their applications in diagnostic and therapeutic processes.	**K4**
CO 4	Construct electronic circuits based on the various principles involved in developing a medical gadget.	**K5**
CO 5	Formulate methodologies that combine Nanotechnology to device Drug Delivery systems.	**K6**

COURSE DESCRIPTOR

Course Code	PPH3ID01
Course Title	Nanoscience
Credits	03
Hours/Week	06
Category	Inter Disciplinary (ID)
Semester	III
Regulation	2022

Course Overview

1. Introduction to the underlying principles and applications of the emerging field of Nanoscience and Nanotechnology.
2. Intended for a multidisciplinary audience.
3. Introduces tools and principles relevant at the nanoscale dimension.
4. Discusses current and future nanotechnology applications in physics, chemistry, biology and engineering.
5. Identify societal and technology issues that may impede the adoption of nanotechnology.

Course Objectives

1. To learn definitions of nanoscience and nanotechnology as research and technology development fields.
2. To understand the historical perspective on major findings that resulted in the establishment of nanotechnology as a research field; understand the motivation behind the research.
3. To explore the new physics/chemistry in the nano dimension and discuss advantages over the traditional disciplines.
4. To familiarize with selected topics in nanoscience, including experimental techniques, material synthesis, basic principles, and nanoscale material properties.

Prerequisites	Basic knowledge on Physics and Nanoscience

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**FUNDAMENTALS OF NANOSCALE SCIENCE** 1.1. Introduction - nano and nature - background to nanotechnology - scientific revolutions opportunities at the nanoscale - time and length scale in structures - influence of nano over micro/macro, size effects and crystals, One dimensional, Two dimensional and Three dimensional nanostructured materials, mechanical-physical-chemical properties. 1.2. Energy landscapes basic intermolecular forces - interdynamic aspects of intermolecular forces.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**CLASSIFICATION OF NANOPARTICLES AND THEIR PROPERTIES** 2.1. Metal Nanoparticles: Definition of a nano system - classification of nanocrystals; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – top down and bottom up approach- Magnetic nanomaterials: Fundamentals of magnetic materials, Dia, Para, Ferro, Ferric, and Superpara magnetic materials, Nanostructured Magnetism. 2.2. Semiconductor Nanocomposites: Types of Nanocomposites (Metal oxides, ceramic and Glass), Core - Shell nanoparticles - Types of systems - properties of nanocomposites. Carbon Nanostructures: Introduction, Fullerenes, C60, CNT, mechanical, optical and properties.	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**SYNTHESIS OF NANOMATERIALS** 3.1. Physical methods: Thermal evaporation, Spray pyrolysis, Molecular beam epitaxy (MBE), Physical vapour deposition (PVD), Microwave heating, 3.2. Chemical methods: Chemical and co -	16	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	precipitation, Sol fundamentals - sol - gel synthesis of metal oxides, Micro emulsions or reverse micelles, Solvothermal, Sonochemical synthesis, Electrochemical synthesis, Photochemical synthesis, Langmuir - Blodgett (LB) technique, Chemical vapour deposition (CVD)			
IV	**CHARACTERIZATION TECHNIQUES** 4.1. Powder X - Ray Diffraction, Scanning electron microscope (SEM), Transmission electron microscope (TEM), Scanning tunnelling microscope (STM), Atomic force microscope (AFM), Scanning probe microscopy (SPM), UV - Visible absorption, Impedance measurement 4.2. Brunauer - Emmett - Teller (BET) Surface Area Analysis, Energy dispersive X - ray (EDX), X - ray photoelectron spectroscopy (XPS) and Photoluminescence.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**APPLICATIONS OF NANOMATERIALS AND NANOCOMPOSITES** 5.1. Nanophotonics and Devices: Imaging of cancer cells, Biological tags and Targeted nano drug delivery system. Issues and Challenges of functional Nanostructured Materials for electrochemical Energy Storage Systems - 5.2. Nanosensors: Sensors based on physical properties - Electrochemical sensors, Sensors for aerospace, defence and Biosensors. Energy: Solar cells, LEDs and Photovoltaic device applications. Photocatalytic applications: Environmental Applications: Air purification, Water purifications and Volatile organic pollution degradation. Carbon nanotubes: Field emission, Fuel cells and Display devices.	15	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Viswanathan, B. (2006). *Structure and Properties of Solid state materials* (2nd ed.). Alpha Science International.
2. Pradeep, T. (2017). *Nano:The Essentials: Understanding Nanoscience and Nanotechnology*. McGraw Hill Education.
3. David.B. Williams and C. Barry Carter (2016) *Transmission Electron microscopy : A Textbook for Materials Science,* Springer International Publishing Switzerland
4. Hellborg, D. Brunt, R. Hellborg H. J. Whitlow O. Hunderi (1992) *SEM Surface characterization A users source book*.
5. David Brandon & Wayne D. Kaplan (2003) Microstructural characterization of materials, John Wiley & sons, 2nd edition.

Suggested Readings

1. Ajayan, P. M., Schadler, L. S., & Braun, P. V. (2006). *Nanocomposite Science and Technology*. Wiley-VCH.
2. Schmid, G. (2011). *Nanoparticles: From theory to application* (2nd ed.). Wiley.
3. Kulkarni, S. K. (2014). *Nanotechnology: Principles and practices* (3rd ed.). Springer.
4. Viswanathan, B. (2009). *Nano materials*. Narosa.
5. Bandyopadhyay, A. K. (2009). *Nano materials* (2nd ed.). New Age International.
6. Brundle, C. R., Evans, C. A., & Wilson, S. (1992). *Encyclopedia of materials characterization: Surfaces, interfaces, thin films*. Butterworth Heinemann.
7. Charles P. Poole, J., & Owens, F. J. (2007). *Introduction to Nanotechnology*. Wiley.
8. Schubert, U. S., & Husing, N. (2019). *Synthesis of inorganic materials* (4th ed.). Wiley.
9. Milani, P., & Iannotta, S. (2012). *Cluster beam synthesis of Nanostructured materials*. Springer

Web Resources

1. https://en.wikipedia.org/wiki/Nanotechnology
2. https://ec.europa.eu/jrc/en/research-topic/nanotechnology
3. http://www.hse.gov.uk/nanotechnology/
4. https://www.nano.gov/nanotech-101/
5. http://www.crnano.org/whatis.htm
6. http://www.nnci.net
7. https://ec.europa.eu/programmes/horizon2020/en/h2020-section/nanotechnologies
8. http://www.research.ibm.com/pics/nanotech/defined.shtml
9. https://www.nsf.gov/crssprgm/nano/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Classify nanoparticles based on various factors.	**K1, K2**
CO 2	Use the different methodologies for synthesis and characterization of nanomaterials.	**K3**
CO 3	Differentiate between pure and composite nanoparticles and their uses.	**K4**
CO 4	Select a particular methodology and material for synthesis, characterization and analysis.	**K5**
CO 5	Design or develop sensors for different applications. Catering to the needs of the recent developments.	**K6**

COURSE DESCRIPTOR

Course Code	PPH3MC03
Course Title	PHYSICS PRACTICAL– III
Credits	4
Hours/Week	8
Category	Major Core (MC) – Practical
Semester	III
Regulation	2022

Course Overview

1. This course highlights the importance of having hands-on experience to measure physical quantities and use practical methods to understand theoretical concepts.
2. It helps students to acquire experimental abilities, which are essential for physicists.
3. Students will be able to use various components and equipment.
4. Students will also be able to work efficiently and safely in a laboratory, both individually and in groups

Course Objectives

1. Determine wavelength of monochromatic source and laser parameters using appropriate apparatus.
2. Establish 'e' and 'e/m' values using corresponding experimental setup.
3. Construct simple interfacing devices to microprocessor 8086 and execute assembly language programs.
4. Understand the usage of microcontroller 8051, its programming and applications.
5. Develop programs to solve numerical method problems using Python programming language.

Prerequisites	Basic knowledge on usage of scientific apparatus.

S. No	List of experiments	Hours Per week Per student Per Expt.	Cos	Cognitive levels
1	Michelson Interferometer – Wavelength of monochromatic source.	8	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
2	Milikan oil drop method – electronic charge ‘e’			
3	Hydrogen spectra – Rydberg’s constant			
4	Laser Beam parameters			
5	Viscosity of a liquid - Meyer’s disc			
6	Constant deviation spectrograph – Iron arc spectra			
7	e/m Magnetron method			
8	Inverter - Low D.C. to High A.C. converter			
9	A/D - Binary counter - IC 7493			
10	555 Timer - Temperature control (thermistor)			
11	OP-AMP Waveform generators			
12	Turbo Debugger - Arrays manipulations			
13	Microprocessor 8086 - Interface (A/D - Counter)			
14	Microprocessor 8086 - Interface (Stepper motor control)			
15	Microprocessor 8086 - Interface (7 segment display multiplexing)			
16	Microprocessor 8086 - Interface (7x5 LED dot matrix display)			
17	Micro controller 8051 - Introduction I			
18	Micro controller 8051 - Introduction II			
19	Microcontroller 8051 – Interface – Home Appliance			

20	Microcontroller 8051 – Interface – LEDs and switches			
21	Microcontroller 8051 – Interface – seconds counter			
22	Python – Arrays			
23	Python – Matrices			
24	Python – Numerical methods I and II			
25	Python – Advanced applications – bot automation- Statistical methods			

The staff in-charge shall select any 14 from this list. The remaining 2 experiments can be chosen from this list or can be new experiments included by the staff in-charge with prior approval of the department.

Suggested Readings

1. Singh, S. P. (1999). *Advanced Practical Physics* (23rd ed.). Pragati Prakashan.
2. Nelkon, M., & Ogborn, J. M. (1978). *Advanced level Practical Physics* (4th ed.). Pearson Education.
3. Chattopadhyay, D., & Rakshit, P. C. (2017). *An Advanced course in Practical Physics* (10th ed.). New Central Book Agency.
4. Squires, G. L. (2001). *Practical Physics* (4th ed.). Cambridge University Press.

Web Resources

1. https://vlab.amrita.edu/?sub=1&brch=189&sim=1106&cnt=1
2. https://vlab.amrita.edu/?sub=1&brch=189&sim=342&cnt=1
3. https://vlab.amrita.edu/?sub=1&brch=195&sim=359&cnt=1
4. https://vlab.amrita.edu/?sub=1&brch=195&sim=357&cnt=1
5. https://ae-iitr.vlabs.ac.in/exp/function-generator/pretest.html
6. http://vlabs.iitb.ac.in/vlabs-dev/labs/8051-Microcontroller-Lab/labs/exp1/index.php
7. http://vlabs.iitb.ac.in/vlabs-dev/labs/python-basics/index.html
8. http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/exp3/introduction.php

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Define the objective of the experiment and explain the various parameters in the formula for determining a material's physical property.	**K1, K2**
CO 2	Construct the experimental setup and carry out the experiment	**K3**
CO 3	Make a list of the observations and repeat the experiment to compute the physical quantity using the appropriate formula.	**K4**
CO 4	Interpret the obtained result and sketch the variations wherever required.	**K5**
CO 5	Analyze the result of the experiment to build or create a piece of equipment or a device for use in project/research activity.	**K6**

COURSE DESCRIPTOR

Course Code	PPH4MC01
Course Title	Quantum Mechanics -II
Credits	5
Hours/Week	5
Category	Major Core (MC)
Semester	IV
Regulation	2022

Course Overview

1. This course intends to give an outline of the study of perturbed system from microscopic point of view.
2. Aims at providing the underlying principles of behaviour of systems at relativistic speeds.
3. An introduction to the conservation laws and their associated symmetries.
4. An extension of quantum mechanics to a system of particles and theories of approximation methods to many body problems.
5. An introduction to the basics of field quantisation and Feynmann diagrams.

Course Objectives

1. To calculate the transition probabilities and set selection rules for spectral transition for different types of time dependent perturbation.
2. To construct and solve Dirac equation for a free particle and particle in a central potential.
3. To construct the wave function for a collection of identical particles. Also appreciate the conservation laws associated with different symmetries.
4. To introduce approximation methods for solving many body problem.
5. To learn the concept of second quantization for different fields. Also learn to draw Feynman diagrams for various scattering phenomena.

Prerequisites	1. A thorough understanding of mechanics. 2. Knowledge of partial differential equation and variable separable method 3. Commendable knowledge of integral and differential calculus.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**TIME DEPENDENT PERTURBATION THEORY** General theory of time-dependent perturbation - first order perturbation – constant perturbation – harmonic perturbation – absorption and emission of radiation: Hamiltonian of a charged particle in electromagnetic field – electric dipole approximation – transition probability – Einstein coefficients- spontaneous and stimulated emission- selection rules- Rayleigh scattering	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**RELATIVISTIC QUANTUM MECHANICS** K – G equation – interpretation – particles in a Coulomb field – Dirac's equation for a free particle – Dirac's matrices – covariant form of Dirac's equation – negative energy states – probability density – plane wave solution – spin of Dirac's particle – magnetic moment of electron – spin-orbit interaction – radial equation for electron in a central potential -Dirac equation and solution for a mass-less particle – Hydrogen atom – Lamb shift	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**IDENTICAL PARTICLES, SYMMETRIES AND CONSERVATION LAWS** Identical particles in quantum mechanics – exchange degeneracy – permutation operators – two - particle system – symmetric and anti-symmetric kets – system with arbitrary number of particles – parity - Symmetry transformations – conservation laws and degeneracy – discrete symmetries – parity or space inversion – parity conservation - time reversal.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**MANY ELECTRON SYSTEM AND APPROXIMATION METHODS** Central field approximation- Thomas-Fermi model of the atom- - molecular orbital method (MO)- MO treatment of hydrogen molecule ion and hydrogen	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	molecule- valence bond treatment of hydrogen molecule- Linear combination of atomic orbitals (LCAO) methods- Hartree - equation- Hartree-Fock equation- Born-Oppenheimer approximation-exchange correlation effects in many electron system- density functional theory.			
V	**ELEMENTS OF FIELD QUANTIZATION** Introduction – quantization of free electromagnetic field – creation and annihilation operators – Lagrangian field – non-relativistic fields – relativistic fields – Klein - Gorden field – Dirac's field – electromagnetic field – interacting fields – Feynmann diagrams – electron- photon interaction scattering: Coulomb scattering – Moller scattering – Bhabha scattering – Bremstrauhlung and pair production.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Shankar, R. (2011). *Principles of Quantum mechanics* (2nd ed.). Springer.
2. Bransden, B. H., & Joachain, C. J. (2012). *Quantum mechanics* (2nd ed.). Pearson.
3. Zettili, N. (2009). *Quantum mechanics: Concepts and Applications* (2nd ed.). Wiley.
4. Arul Dhas, G. (2008). *Quantum mechanics* (2nd ed.). PHI.
5. Agarwal, B. K., & Prakash, H. (2005). *Quantam mechanics* (5th ed.). PHI.
6. Kakani, S. L., & Chandalia, H. M. (2004). *Quantum mechanics: Theory and Problems* (3rd ed.). Sultan Chand and Sons.
7. Thankappan, V. K. (1993). *Quantum mechanics* (2nd ed.). New Age International.

Suggested Readings

1. Mathews, P. M., & Venkatesan, K. (2017). *A Textbook of Quantum mechanics* (2nd ed.). Tata McGraw-Hill Education.
2. Griffiths, D. J., & Schroeter, D. F. (2019). *Introduction to Quantum mechanics* (3rd ed.). Cambridge University Press.
3. Tannoudji, C. C., Diu, B., & Laloe, F. (1977). *Quantum mechanics (Vol.1)* (2nd ed.). Wiley-VCH.
4. Carlson, T. (2013). *Photoelectron and auger Spectroscopy*. Springer.
5. Chatwal, G. R., & Anand, S. K. (2010). *Spectroscopy: Atomic and molecular* (5th ed.). Himalaya Publishing House.
6. Hollas, J. M. (2004). *Modern spectroscopy* (4th ed.). Wiley.

Web Resources

1. https://www.youtube.com/watch?v=oyKBgby6RGE
2. https://bit.ly/38Qq9Ps
3. https://www.digimat.in/nptel/courses/video/115106065/L25.html
4. https://www.digimat.in/nptel/courses/video/115108074/L01.html
5. https://www.digimat.in/nptel/courses/video/104101124/L01.html
6. https://www.youtube.com/watch?v=Gj7RWTLgb2o

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify and summarize all the rules of the new algebra. Apply the new algebra to interpret the experimental results.	**K1, K2**
CO 2	Construction of Dirac's equation, its solution and interpretation of the results.	**K3**
CO 3	Classify and correlate the different symmetries associated with conservation laws, the fields and their quanta.	**K4**
CO 4	Choose appropriate approximation methods to evaluate the total energy or electronic structure of many body problems.	**K5**
CO 5	Integrate all the concepts to facilitate problem solving with an aim to appreciate the new concepts.	**K6**

COURSE DESCRIPTOR

Course Code	PPH4MC02
Course Title	Solid State Physics
Credits	05
Hours/Week	05
Category	Major Core (MC) - Theory
Semester	IV
Regulation	2022

Course Overview

1. An introduction to the various symmetries in 3 dimension crystalline materials, their classification and experimental method of determining crystal structure will be given.
2. The theoretical models involving lattice contribution to the study of elastic and thermal properties of the materials will be dealt.
3. The dynamics of the collective electrons behavior in explaining the transport and dielectric phenomena will be discussed in detail.
4. A detailed discussion will be on the theoretical principles behind the origin of magnetism and classification and properties of magnetic materials.
5. The microscopic physics behind the novel phenomena of superconductivity and associated properties, and an insight into the high temperature superconductivity will be discussed.

Course Objectives

1. To understand the various crystal structures, the microscopic theory behind the diffraction technique.
2. To distinguish materials as metals, semiconductor and insulator using band structure and study their transport phenomena.
3. To provide theoretical and experimental means of determining the Fermi surface an exclusive property of conductors.
4. To study the theories of different types of magnetism and dielectrics
5. To learn the theories supporting superconducting phenomenon and its applications.

Prerequisites	Basic knowledge in Physics

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**CRYSTAL STRUCTURE AND LATTICE DYNAMICS** Lattice - translation symmetry –Mathematical interpretation of symmetry operations- 3D crystal systems - Bravais lattices - Reciprocal lattice - Miller indices; X Ray Diffraction - Bragg's law (Vector form) - atomic scattering factor - structure factor - extinction rules for BCC, FCC, ZnS and diamond structure. Lattice vibrations for a linear mono atomic lattice - linear diatomic lattice – acoustical and optical modes - extinctions and optical branch in ionic crystals - quantisation of lattice vibrations - inelastic scattering of phonons.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**THEORY OF METALS AND SEMICONDUCTOR** Brillouin zones - electrons in periodic potential - Bloch's theorem – Kronig - Penney model - nearly free electron model - effective mass - zone schemes - band model of metal-Monovalent metals- optical properties of monovalent metals, semiconductor and insulator. Intrinsic semiconductor - carrier concentration - impurity semiconductors (n and p type) - carrier concentration - Junction properties- Metal-Metal junction, Metal-Semiconductor junction, Semiconductor-Semiconductor junction.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**TRANSPORT PHENOMENA AND DIELECTRIC PROPERTIES** Thermal conductivity of lattice - of free electrons - Fermi surface - effect of electric field on Fermi surface - effect of magnetic field on Fermi surface - Quantization of Electron Orbits: Experimental Study of Fermi Surfaces-	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	Hall effect. dipole moment - atomic polarizability - Classius - Mossotti equation - theory of electronic polarisation - frequency dependent polarizability - ferro electricity.			
IV	**MAGNETISM** Larmor diamagnetism - Langevin's theory of para magnetism - molecular field theory of ferromagnetism -domain theory of hysteresis - anti-ferromagnetism– and Ferrimagnetism. Magnetostriction effect, Nano magnetic materials, Thermal stability, Effect of size on fine particles– Weiss molecular field interaction theory. Giant Magneto Resistance effect, TMR Effect, Spin polarized tunneling, Magnetoresistive Random Access Memory (M-RAM)	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**CRYSTAL STRUCTURE AND LATTICE DYNAMICS** Lattice - translation symmetry –Mathematical interpretation of symmetry operations- 3D crystal systems - Bravais lattices - Reciprocal lattice - Miller indices; X Ray Diffraction - Bragg's law (Vector form) - atomic scattering factor - structure factor - extinction rules for BCC, FCC, ZnS and diamond structure. Lattice vibrations for a linear mono atomic lattice - linear diatomic lattice – acoustical and optical modes - extinctions and optical branch in ionic crystals - quantisation of lattice vibrations - inelastic scattering of phonons.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. R.K. Puri and V.K. Babber.(2005). *Solid State Physics (*3rd Edition). S. Chand and company Ltd.
2. John Sydney Blakemore.(2005). *Solid State Physics.* Cambridge University press.
3. Dr. Ajay Kumar Saxena.(2005). *Solid State Physics.* MacMillan India Ltd.

Suggested Readings
1. Mircea S. Rogalski, Stuart B. Palmer..(2000). *Solid State Physics.* Gordan& Breach 2. Mohammad Abdul Wahab (2018). *Solid State Physics: Structure and properties of materials.* (3rd edition). Narosa Publishing House Pvt. Ltd. 3. Charles Kittel.(2015). *Introduction to Solid State Physics(8th Edition).* John Wiley & sons. 4. Neil. W. Ashcroft, N. David Mermin.(2010) Solid state Physics. Harcourt Asia PTE Ltd.
Web Resources
1. https://www.electrical4u.com/thermal-conductivity-of-metals/ 2. https://insightsimaging.springeropen.com/articles/10.1186/s13244-021-01125-z 3. http://hyperphysics.phy-astr.gsu.edu/hbase/Solids/scond.html 4. https://bit.ly/38Qq9Ps

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Classify nanoparticles based on various factors.	**K1, K2**
CO 2	Use the different methodologies for synthesis and characterization of nanomaterials.	**K3**
CO 3	Differentiate between pure and composite nanoparticles and their uses.	**K4**
CO 4	Select a particular methodology and material for synthesis, characterization and analysis.	**K5**
CO 5	Design or develop sensors for different applications. Catering to the needs of the recent developments.	**K6**

COURSE DESCRIPTOR

<table>
<tr><td>Course Code</td><td>PPH4MC03</td></tr>
<tr><td>Course Title</td><td>Nuclear Physics</td></tr>
<tr><td>Credits</td><td>05</td></tr>
<tr><td>Hours/Week</td><td>05</td></tr>
<tr><td>Category</td><td>Major Core (MC) – Theory</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td>Regulation</td><td>2022</td></tr>
<tr><td colspan="2">Course Overview
1. The discipline of physics that educates about atomic nuclei and their constituents and interactions along with the familiarization of other forms of nuclear matter.</td></tr>
<tr><td colspan="2">Course Objectives
1. To acquire knowledge on nuclear size, shape and forces like physical properties.
2. To understand nuclear model and reactors
3. To study nuclear reactions and background concepts
4. To understand radioactive concepts and theories
5. To Explore and study elementary particles and their models</td></tr>
<tr><td>Prerequisites</td><td>Fundamental knowledge in Nuclear Physics</td></tr>
</table>

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**NUCLEAR SIZE, SHAPE AND FORCES** Introduction to nuclear properties – nuclear size determination - Electron scattering method – Electric Quadrupole moment. Properties of Nuclear forces: Energy levels of light nuclei and the hypothesis of the charge independence of nuclear forces - Two - nucleon potentials - - Ground state of the deuteron - ISO - spin formalism - Meson theory of nuclear forces - Exchange forces - Nucleon-nucleon scattering singlet and triplet parameters.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**NUCLEAR MODELS** Liquid drop model - Semi - empirical mass formulas and nuclear fission - Binding energy - Weizsacker mass formula - Levy's formula - Atomic masses and its significance - Shell model - Magic numbers - Optical model - Unified model - Barrier penetration - The collective nuclear model.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**NUCLEAR REACTIONS** Resonance Scattering and Nuclear reaction cross-section - Breit-Wigner dispersion formula - The compound nucleus - Continuum theory - Absorption cross -section at high energies. - Stability of heavy nuclei – Bohr - Wheeler theory of fission- Activation energy for fission - Controlled chain reaction – Basic ideas of Nuclear Reactors.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**RADIOACTIVITY FUNDAMENTALS** Gamow theory of alpha decay – Types of Beta decay - Energy spectrum - Fermi theory - Fermi and Gamow - Teller selection rules - Fermi-Curie plot - Non - conservation of parity – Pion condensation - - Nuclear isomerism.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

V	**ELEMENTARY PARTICLES** Classification – types of interaction hadrons and leptons – symmetries and conservation laws – CP invariance – Time Reversal - CPT theorem – classification of hadrons - Quark model – Gellman Okubo mass formula for octets and decuplet hadrons – charm, bottom, top quarks - Elementary concepts of weak interactions.	13	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Nuclear Physics, D. C. Tayal, Himalaya Publishing House, Mumbai Edition:, 2011.
2. Nuclear physics: Theory and Experiment, Radha Raman Roy, B.P. Nigam New Age International, Chennai (1st Ed.) 2008.
3. Introduction to Elementary Particles, David Jeffery Griffiths, Wiley VCH (2nd Ed.) 2008.
4. Nuclear and Particle Physics: An Introduction, B R Martin, John Wiley & Sons (2nd Ed.) 2011.
5. Elementary Particle Physics in a Nutshell, Christopher G Tully, Princeton University Press 2011.
6. Concepts of Nuclear Physics, B. B. Cohen, TMGH, Bombay, 1971.

Suggested Readings

1. Principles of Nuclear Reactor Engineering, Samuel Glasstone, Van Nostrand ACS Publications 1956.
2. Atomic Nucleus, R. D. Evans, Mcgraw-Hill NY. 1955.
3. Theoretical Nuclear Physics, J. M. Blatt and V. F. Weisskopf, Berlin 1979.
4. Introduction to Nuclear Physics, H. Enge, Addision-Wesley Reading MA. 1975.
5. Nuclear Structure, A. Bohr and B. R. Mottelson, Benjamin Reading, Vol. I (1969) and Vol.II (1975).

Web Resources

1. main.pdf (soton.ac.uk)
2. Nuclear Shell Model of an Atom - Theory, Explanation, Difference Between Shell Structure of Nuclei and Shell Structure of Atom (byjus.com)
3. Microsoft Word - Ch03-Radioactivity.docx (lbl.gov)
4. Elementary particles in nuclear physics (uwo.ca)

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Identify and summarize all the rules of the new algebra. Apply the new algebra to interpret the experimental results.	**K1, K2**
CO 2	Construction of Dirac's equation, its solution and interpretation of the results.	**K3**
CO 3	Classify and correlate the different symmetries associated with conservation laws, the fields and their quanta.	**K4**
CO 4	Choose appropriate approximation methods to evaluate the total energy or electronic structure of many body problems.	**K5**
CO 5	Integrate all the concepts to facilitate problem solving with an aim to appreciate the new concepts.	**K6**

COURSE DESCRIPTOR

Course Code	PPH3VA01
Course Title	MATLAB Programming
Credits	2
Hours/Week	2
Category	Value Added course
Semester	III
Regulation	2022

Course Overview

1. The course utilizes the MATLAB environment to provide students with a working knowledge of computer-based problem-solving methods.
2. It focusses mainly on problem solving skills using computational tools relevant to science and engineering, including programming and numerical analysis techniques.
3. It envisages the students to outline, write, test, and debug computer programs to solve problems and display results, with emphasis on proper documentation of computer code and reports.
4. Common examples and applications of physics and engineering are used throughout the course
5. This course offers heterogeneous environment to the students namely electrical, biomedical, mechanical and undeclared engineering students.

Course Objectives

1. To provide students an understanding of the expectations of industry through programming knowledge.
2. To improve employability skills of science and engineering students.
3. To bridge the skill gaps and make students industry ready for competing with software skills.
4. To provide an opportunity to students to develop inter-disciplinary skills using computational techniques.
5. To nurture students to gain valuable experience with an effective industry standard tool that is useful throughout the course.

Prerequisites	Fundamental knowledge in computer operations

UNIT	CONTENT	HOURS/ WEEK	COs	COGNITIVE LEVEL
I	**INTRODUCTION TO PROGRAMMING IN MATLAB** Variables- Scripts- and Operations-Basic scalar operations- Built in functions-Element wise functions-vector operations-Vector functions-Matrices -Indexing- Plotting	2	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
II	**VISUALIZATION AND PROGRAMMING** User defined functions- Relational operators-Conditional operators-Types of plotting- Cartesian plot- 3d line plot- sub plots – Multiple plots – Visualizing matrices – Color maps – Surface Plots -Surf – contour	2	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**SOLVING EQUATIONS AND CURVE FITTING** Systems of Linear Equations- Matrix Decompositions-Polynomial – Polynomial operations – Polynomial fitting – Non-linear root finding – Minimizing a function – Numerical Differentiation-Numerical integration- ODE Solvers- Higher order equations	2	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
IV	**ADVANCED METHODS** Probability and statistics – random numbers -advanced data structures – Cells and structures – Arrays – reading and writing images – animation-videos -debugging-performance measures	2	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**SYMBOLICS, SIMULINK®, FILE I/O, BUILDING GUIS** Symbolic math toolbox-symbolic variables-symbolic expressions-Simulink library browser-connections- Block specifications-toolboxes-reading and writing I/O files- Building GUIs-Developing and publishing software.	2	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

Text Books 1. Krister Ahlersten, 2012, An Introduction to Matlab – Ist edition 2. Subhas Chakravarty , 2012, Technology and Engineering Applications of Simulink, - InTech, I Edition. 3. Stephen J. Chapman , 2015, MATLAB Programming for Engineers, Cengage Learning, 5th Edition. 4. Stormy Attaway, 2013, Matlab: A Practical Introduction to Programming and Problem Solving,Butterworth-Heinemann; 3rd edition. 5. Jim Sizemore , John Paul Mueller, 2014, MATLAB For Dummies, John Wiley & Sons, 1st Edition. 6. Misza Kalechman, Practical MATLAB Basics for Engineers (Practical Matlab for Engineers),CRC Press; 1st edition.
Suggested Readings 1. Serhat Beyenir, 2012, A Brief Introduction to Engineering Computation with MATLAB, Rice University, I Edition. 2. Todd Young, Martin J. Mohlenkamp, 2017, Introduction to Numerical Methods and Matlab Programming for Engineers, - Ohio University, I edition 3. Jan Valdman, 2016, Applications from Engineering with MATLAB Concepts, InTech , I edition. 4. Kelly Bennett, 2014, MATLAB Applications for the Practical Engineer, InTech , I edition. 5. Daniel T. Valentine, Brian Hahn, Essential MATLAB for Engineers and Scientists, Academic Press; 6th edition. 6. L. F. Shampine, I. Gladwell, S. Thompson, 2003, Solving ODEs with MATLAB,Cambridge University Press; 1st edition
Web Resources 1. Getting Started with MATLAB - Video - MATLAB (mathworks.com) 2. Introduction to MATLAB - Video - MATLAB (mathworks.com) 3. Analyzing and Visualizing Data with MATLAB - Video - MATLAB (mathworks.com) 4. Beyond Excel: Enhancing Your Data Analysis with MATLAB Video - MATLAB (mathworks.com) 5. Data Science with MATLAB Video - MATLAB (mathworks.com) 6. Preprocessing Your Data in MATLAB Video - MATLAB & Simulink (mathworks.com) 7. How to Import Data from Files Programmatically - Video - MATLAB (mathworks.com) 8. Using Basic Plotting Functions - Video - MATLAB (mathworks.com) 9. How to Create a MATLAB Function - Video - MATLAB (mathworks.com) 10. Functions with Multiple Inputs and Outputs - Video - MATLAB (mathworks.com) 11. Managing Code in MATLAB: Functions of Variable Numbers of Inputs and Outputs - Video - MATLAB (mathworks.com) 12. The Complete MATLAB Course: Beginner to Advanced! - YouTube 13. MATLAB Complete Course || Learn MATLAB || Learn MATLAB in 6 Hours - YouTube

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	Understand and apply the variables and built in functions used in MATLAB	K1, K2
CO 2	Identify and visualize the plotting methods using surf, contour and 3d line plotting.	K3
CO 3	Applying MATLAB functions to solve differential equations and create new customized functions for solving equations	K4
CO 4	Analyze the problems and solve problems using SIMULINK	K5
CO 5	Design Graphical User Interface for user friendly environment to interface coding and logics to publish it as a software tool for potential users.	K6

COURSE DESCRIPTOR

Course Code	PPH4PJ01
Course Title	PROJECT
Credits	15
Hours/Week	5
Category	Project
Semester	IV
Regulation	2022

CL AND CO BASED CIA QUESTION PAPER FORMAT

SECTION	MARKS	Q. NO	K1	K2	K3	K4	K5	K6
A	Answer ALL (6 x 2= 12)	1	+					
		2	+					
		3	+					
		4		+				
		5		+				
		6		+				
B	Answer 1 out of 2 (1 x 7 = 7)	7			+			
		8			+			
C	Answer 1 out of 2 (1 x 7 = 7)	9				+		
		10				+		
D	Answer 1 out of 2 (1 x 12 = 12)	11					+	
		12					+	
E	Answer 1 out of 2 (1 x 12 = 12)	13						+
		14						+
No. of CL based Questions with Max. marks			3 (2)	3 (2)	1 (7)	1 (7)	1 (12)	1 (12)
No. of CO based Questions with Max. marks			CO 1		CO 2	CO 3	CO 4	CO 5
			6 (12)		1 (7)	1 (7)	1 (12)	1 (12)

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Physics

FIRST CONTINUOUS ASSESSMENT EXAMINATION, JUNE, 2022

PPH4 MCO1 QUANTUM MECHANICS II

Date: 15-06-2022 TIME: 10.00 am TO 11.30 am

II M.Sc (Physics) Max: 50 marks

SECTION A

Answer **ALL** questions: 6 x 2 = 12 marks

1 State the principle of **LASER** (K1)

2 Distinguish between stimulated and spontaneous emission.(K2)

3 Find the velocity of an elementary particle whose mass is 10 times its rest mass?(K1)

4 Explain the adiabatic theorem (K2)

5 What is dipole approximation?(K1)

6 Explain Bremsstrahlung and pair production (K2)

SECTION - B

Answer any **ONE** questions 1x7 = 7marks

7 Solve the Dirac equation for a free particle and obtain its energy spectrum. (K3)

8 A pion at rest decays into a muon and a neutrino. Find the energy of the outgoing muon in terms of the two masses, $m\pi$ and $m\mu$ (assume $m\nu=0$). the velocity of the outgoing muon (K3)

SECTION – C

Answer any **ONE** questions 1x7 = 7marks

9 A system in an unperturbed state n is suddenly subjected to a constant perturbation $H'(r)$ which exists during time 0 to t. Examine the probability for transition from state n to state k and show it varies simple harmonically.(K4)

10 List and explain the configuration space rules for Feynman graphs.(K4)

SECTION D

Answer any **ONE** question: 1 x 12 = 12 marks

11 Evaluate the time dependent perturbation theory with reference to sinusoidal perturbation and obtain an expression for transition probability.(K5)

12 Determine the time dependent perturbation theory with reference to harmonic perturbation and obtain an expression for transition probability (K5)

SECTION E

Answer any **ONE** question: 1 x 12 = 12 marks

13 Elaborate in detail the structure of space time. (K6)

14 Formulate the procedure for quantization of complex scalar field. From the discussion explain the annihilation, creation and particle number operators (K6)

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COGNITIVE LEVEL (CL) AND COURSE OUTCOME (CO) BASED END SEMESTER EXAMINATION QUESTION PAPER FORMAT (PG)

SECTION		Q. NO	K1	K2	K3	K4	K5	K6
A	(4 x 5 =20)	1	+	+				
	Answer ALL	2	+	+				
		3	+	+				
		4	+	+				
B	(2 x 10 = 20)	5			+			
	Answer 2 out of 4	6			+			
		7			+			
		8			+			
C	(2 x 10 = 20)	9				+		
	Answer 2 out of 4	10				+		
		11				+		
		12				+		
D	(1 x 20 = 20)	13					+	
	Answer 1 out of 2	14					+	
E	(1 x 20 = 20)	15						+
	Answer 1 out of 2	16						+
No. of CL based Questions with Max. marks			5 (10)	5 (10)	2 (20)	2 (20)	1 (20)	1 (20)
No. of CO based Questions with Max. marks			CO 1		CO 2	CO 3	CO 4	CO 5
			10(20)		2 (20)	2 (20)	1 (20)	1 (20)

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Physics

SEMESTER EXAMINATION, JUNE, 2022
PPH1 MCO1 CLASSICAL MECHANICS

I M.Sc 15.06.2022

Duration : 3 hrs Max. Marks : 100

SECTION A			
Answer ALL the Questions			
1.	**Answer the following (5 x 1 = 5)**		
a)	Define Hamilton's function.	K1	CO1
b)	Write down the expression for Coriolis force.	K1	CO1
c)	What are Inertial and non-inertial frames?	K1	CO1
d)	Define Poisson bracket of functions A and B with respect to (q,p).	K1	CO1
e)	Define Inertia tensor.	K1	CO1
2.	**Fill in the blanks (5 x 1 = 5)**		
a)	In general, the rigid body has_____________ degrees of freedom.	K1	CO1
b)	In absence of a given component of applied force, the corresponding component of linear momentum of the object is ____________________.	K1	CO1
c)	The number of independent coordinates required to describe a system is called ______.	K1	CO1
d)	The work-energy theorem states that the work done is equal to the change in _____.	K1	CO1
e)	For canonical transformation, the value of Poisson bracket {Q,P} is ___________.	K1	CO1
3.	**Match the following, in the following cases (5 x 1 = 5)**		
	System - **degrees of freedom**		
a)	Oxygen molecule - One	K2	CO1
b)	4 particles moving freely in space - Five	K2	CO1
c)	A particle is constrained to move along the inner surface of a fixed hemispherical bowl - Twelve	K2	CO1
d)	Three particles connected by three rigid massless rods - Two	K2	CO1
e)	A rigid body having two points fixed - Six	K2	CO1
4.	**Write TRUE or FALSE (5 x 1 = 5)**		
a)	Constraint in a Rigid body is Rheonomic.	K2	CO1
b)	Generalized co-ordinates are independent of each other.	K2	CO1
c)	Earth is always an inertial reference frame.	K2	CO1

d)	The phase space has only momentum coordinates.	K2	CO1
e)	The Laplace-Runge-Lenz vector of a planet is always conserved	K2	CO1
SECTION B			
Answer any TWO of the following in 100 words (2 x 10 = 20)			
5.	Derive the Euler – Lagrange's equation from DeAlembert's Principle.	K3	CO2
6.	Using Poisson brackets relation, prove that $[J_x, J_y]=J_z$	K3	CO2
7.	Show that the K.E. of a rotating rigid body in a co-ordinate system of principal axes is given by $T=1/2(I_1 \omega_1^2 + I_2 \omega_2^2 + I_3 \omega_3^2)$	K3	CO2
8.	Write a note on "Infinitesimal canonical Transformations".	K3	CO2
SECTION C			
Answer any TWO of the following in 100 words (2 x 10 = 20)			
9.	Analyze the superiority of Lagrangian approach over Newtonian approach.	K4	CO3
10.	Obtain the Lagrange's equation for a simple pendulum. Deduce the formula for its time period.	K4	CO3
11.	Calculate the inertia tensor for the system of four point masses 1 gm,2 gm,4 gm and 5 gm located at the points (1 0 0), (1 1 0), (1 2 1), (2 1 -1) c.m.	K4	CO3
12.	Outline the problem of scattering of charged particles by a coulomb field and obtain Rutherford's formula for the differential cross section	K4	CO3
SECTION D			
Answer any ONE of the following in 250 words (1 x 20 = 20)			
13.	Set up the equation motion for symmetric top and discuss its results.	K5	CO4
14.	Formulate Lagrange's equations to find the equation of motion of a compound pendulum in a vertical plane about a fixed horizontal axis. Hence find the period of small amplitude oscillations of the compound pendulum.	K5	CO4
SECTION E			
Answer any ONE of the following in 250 words (1 x 20 = 20)			
15.	Solve the Euler – Lagrangian equation for two body problem under central force, bring out various conserved quantities and classify the various types of orbit.	K6	CO5

16.	Construct two coupled pendulums, and determine a.T and V matrices. (4 marks) b.The normal frequencies. (4 marks) c.The normal coordinates. (4 marks) d.The equation of motion. (4 marks) e.The eigen vectors with general solution. (4 marks)	K6	CO5

COGNITIVE LEVEL (CL) AND COURSE OUTCOME (CO) BASED ASSESSMENT METHOD FOR LAB CIA EXAMINATION (PG)

Assessment	Criteria	Marks (50)	COGNITIVE LEVEL (CL)				
			K1, K2	K3	K4	K5	K6
CIA Practical Test for 50 marks	Aim, Apparatus and Formula, Formula expansion with units and tabular column	10	+				
	Preliminary adjustments, initial set up, observing the reading	20		+			
	Calculation, Verification	15				+	
	Result						+
	Record Note book	5			+		
No. of CL based Questions with Max. marks			1 (10)	1 (20)	1 (5)	1 (10)	1(5)
No. of CO based Questions with Max. marks			CO 1	CO 2	CO3	CO 4	CO 5
			5 (50)				

COGNITIVE LEVEL (CL) AND COURSE OUTCOME (CO) BASED ASSESSMENT METHOD FOR PG LAB SEMESTER EXAMINATION

Assessment	Criteria	Marks (100)	COGNITIVE LEVEL (CL)				
			K1, K2	K3	K4	K5	K6
Semester Practical Examination for 50 marks	Aim, Apparatus, Formula, Formula expansion with units and tabular column	20	+				
	Preliminary adjustments, initial set up, observing the reading	40		+			
	Calculation, Verification	30				+	
	Result						+
	Viva-voce	10			+		
No. of CL based Questions with Max. marks			1 (20)	1 (40)	1 (10)	1 (20)	1 (10)
No. of CO based Questions with Max. marks			CO 1	CO 2	CO 3	CO 4	CO 5
			5 (100)				

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 600 034

Department of PHYSICS

PRACTICAL CIA EXAMINATION, JULY, 2021

PHYSICS PRACTICAL I (PG)

I M.Sc. Physics Practical 16.06.2022

Time: 9.00 am to 1.00 pm Max. Marks: 50

1	Aim, Apparatus and Formula	K1	CO1	5 Marks
2	Formula expansion with units and tabular column	K2	CO1	5 Marks
3	Preliminary adjustments, initial set up, observing the reading	K3	CO2	20 Marks
4	Record Note book	K4	CO3	5 Marks
5	Calculation, Verification and Result	K5, K6	CO4, CO5	15 Marks

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 600 034
Department of PHYSICS
SEMESTER EXAMINATION, JUNE, 2022
PHYSICS PRACTICAL I (MC)

I M.Sc. Physics Practical 16.06.2022

Time: 9.00 am to 1.00 pm Max. Marks: 100

1	Aim, Apparatus and Formula	K1	CO1	10 Marks
2	Formula expansion with units and tabular column	K2	CO1	10 Marks
3	Preliminary adjustments, initial set up, observing the reading	K3	CO2	40 Marks
4	Viva-Voce	K4	CO3	10 Marks
5	Calculation, Verification and Result	K5, K6	CO4, CO5	30 Marks

LOCF BASED DIRECT ASSESSMENTS

COGNITIVE LEVEL (CL) AND COURSE OUTCOME (CO) BASED CIA QUESTION PAPER FORMAT (PG)

SECTION		Q. NO	COGNITIVE LEVEL (CL)					
			K1	K2	K3	K4	K5	K6
A	(5 x 1 = 5) Answer ALL	1(a)	+					
		(b)	+					
		(c)	+					
		(d)	+					
		(e)	+					
	(5 x 1 = 5) Answer ALL	2(a)		+				
		(b)		+				
		(c)		+				
		(d)		+				
		(e)		+				
B	(1 x 8 = 8) Answer 1 out of 2	3			+			
		4			+			
C	(1 x 8 = 8) Answer 1 out of 2	5				+		
		6				+		
D	(1 x 12 = 12) Answer 1 out of 2	7					+	
		8					+	
E	(1 x 12 = 12) Answer 1 out of 2	9						+
		10						+
No. of CL based Questions with Max. marks			5 (5)	5 (5)	1 (8)	1 (8)	1 (12)	1 (12)
No. of CO based Questions with Max. marks			CO1		CO2	CO3	CO4	CO5
			10 (10)		1 (8)	1 (8)	1 (12)	1 (12)

Forms of questions of **Section A** shall be MCQ, Fill in the blanks, True or False, Match the following, Definition, Missing letters. Questions of **Sections B, C, D and E** could be Open Choice/ built in choice/with sub sections. Component III shall be exclusively for cognitive levels K5 and K5 with 20 marks each. CIA shall be conducted for 50 marks with 90 min duration.

COGNITIVE LEVEL (CL) AND COURSE OUTCOME (CO) BASED END SEMESTER EXAMINATION QUESTION PAPER FORMAT (PG)

SECTION		Q. NO	COGNITIVE LEVEL (CL)					
			K1	K2	K3	K4	K5	K6
A	(5 x 1 = 5) Answer ALL	1(a)	+					
		(b)	+					
		(c)	+					
		(d)	+					
		(e)	+					
	(5 x 1 = 5) Answer ALL	2(a)		+				
		(b)		+				
		(c)		+				
		(d)		+				
		(e)		+				
B	(3 x 10 = 30) Answer 3 out of 5	3			+			
		4			+			
		5			+			
		6			+			
		7			+			
C	(2 x 12.5 = 25) Answer 2 out of 4	8				+		
		9				+		
		10				+		
		11				+		
D	(1 x 15 = 15) Answer 1 out of 2	12					+	
		13					+	
E	(1 x 20 = 20) Answer 1 out of 2	14						+
		15						+
No. of CL based Questions with Max. marks			5 (5)	5 (5)	3 (30)	2 (25)	1 (15)	1 (20)
No. of CO based Questions with Max. marks			CO1		CO2	CO3	CO4	CO5
			10 (10)		3 (30)	2 (25)	1 (15)	1 (20)

IMPORTANT

- Forms of questions of **Section A** shall be MCQ, Fill in the blanks, True or False, Match the following, Definition, Missing letters.
- Questions of **Sections B, C, D and E** could be Open Choice/ built in choice/questions with sub divisions.
- Maximum sub divisions in questions of Sections B, C shall be 2 and 4 in Sections D, E).

TOTAL MARKS DISTRIBUTION OF DIRECT ASSESSMENTS BASED ON CL AND CO (PG)

Course Outcome	**CO1**		**CO2**	**CO3**	**CO4**	**CO5**	**TOTAL**
Cognitive Levels	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	
CIA 1	5	5	8	8	12	12	50
CIA 2	5	5	8	8	12	12	50
Comp III	-	-	-	-	20	20	40
Semester	5	5	30	25	15	20	100
Total Marks (CL)	**15 (6%)**	**15 (6%)**	**46 (19%)**	**41 (17%)**	**59 (25%)**	**64 (27%)**	**240**
Total Marks (CO)	**30 (12%)**		**46 (19%)**	**41 (17%)**	**59 (25%)**	**64 (27%)**	**240**