CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA - KERALA

DEPARTMENT OF PHYSICS

(SELF FINANCING)

BACHELOR OF PHYSICS

COURSE PLAN

2020-2021

EVEN SEMESTER

HOD : Prof. V P Anto

SEMESTER -6

PH6 B10: THERMAL AND STATISTICAL PHYSICS

Lecture Hours 72 hrs, Credits: 4

Internal: 20, External: 80, Examination 3 Hours

Objectives

Understand the theoretical basis of thermodynamics and statistical physics

Unit- I

Module I

Thermodynamic system- Thermal equilibrium-zeroth law-concept of heat and temperature-thermodynamic equilibrium- quasistatic process -extensive and intensive variables- thermodynamic process (cyclic and non cyclic)-indicator diagram- work done in isothermal, adiabatic, isobaric and isochoric –cyclic processes- concept of path and point functions-internal energy- first law of thermodynamics-relation between P,T,V ,in adiabatic process-slope of adiabatic and isothermal process -application of first law to heat capacities-(relation between Cp and Cv) and latent heat– adiabatic and isothermal elasticity of a gas) (18 hours , 32 marks)

Module II

Reversible and irreversible processes , Conditions for reversibility-second law of thermodynamics-heat engine, Carnot engine, derivation for expression for efficiency, efficiency, Carnot's refrigerator-thermodynamical scale of temperature- Carnot's theorem and its proof.- application of second law(Clausius-Clapyron equation)- internal combustion engine-otto engine ,diesel engine -its efficiencies (11 Hours, 20 Marks)

Module III

Entropy and adiabatics- definition of entropy-Change of entropy in a Carnot cycle-Change of entropy in an reversible cycle (Claussius theorem) -Change of entropy in an irreversible cycle (Claussius inequality)- Change in entropy of a perfect gas during a process-Change in entropy in a irreversible process-change in entropy due to free expansion-Change in entropy due to spontaneous cooling by conduction, radiation….etc, - Principle of increase of entropy-Entropy and available energy-Entropy and disorder-Nernst heat theorem ,entropy temperature diagrams.

(14 Hours, 22 Marks)

Module IV

Thermodynamic functions-Enthalpy, Helmhlotz function, Gibbs function-Maxwell's thermodynamic relations-TdS relations-application of Maxwell's thermodynamical relations-1.variation of intrinsic energy with volume-2.Joule-Kelvin coefficient3.Claussius-Clapeyron equation from Maxwell's thermodynamic relations- changes of phase. properties – Standard normal curve.

(10 Hours, 15 Marks)

Unit II

Module V

Statistical distributions-Maxwell-Boltzmann statistics (no derivation)-Distribution of molecular energies in an ideal gas-Average molecular energy- Equi partition theorem, Maxwell-Boltzmann speed distribution law-Expressions for rms speed, most probable speed and mean speed

(8 Hours, 15 Marks)

Module VI

Bose Einstein and Fermi Dirac distribution laws (no derivations)- Application of BE distribution law to black body radiation-Planck's radiation law-Stefan's law-Wien's displacement law-Fermi energy-Expression for Fermi energy of electron system-electron energy distribution- average electron energy at absolute zero-Degeneracy pressure and its astrophysical significance.

(11 Hours, 22 Marks)

Reference Books:

1. Heat and Thermodynamics-DS Mathur (V Edn.)
2. Statistical Mechanics – An Elementary Outline – Avijit Lahiri – Universities Press
3. Physics- Resnick and Halliday
4. Heat and Thermodynamics-Zemansky
5. Thermodynamics – Y V C Rao – Universities Press
6. Advanced Physics Second Edition – Keith Gibbs – Cambridge University Press
7. Thermodynamics and statistical mechanics-Brijlal Subramanium
8. Heat and Thermodynamics- A Manna

OBJECTIVES

- ***Understand the zero and first laws of thermodynamics***
- ***Understand the thermodynamics description of the ideal gas***
- ***Understand the second law of thermodynamics and its applications***
- ***Understand the basic ideas of entropy***
- ***Understand the concepts of thermodynamic potentials and phase transitions***
- ***Understand the basic principles of statistical physics and its applications***

LESSON PLAN

Unit/ session/ hours (Time Required)	**Topics for student preparation (input)**	**Procedure (process) Student centric Method of teaching**	**Activity**	**Learning outcome (output)**	**Assessment**
Module 1 Introduction to Thermodynamics 18 hours	Definitions-Scope-Law of thermodynamics-Applications	• Discussion • Participative learning • Problem solving	• Peer Group Discussion on Thermodynamic system and laws of thermodynamics	• To understand the laws of thermodynamics	Evaluation Through MCQ
Module-2 Reversible and	Reversible and irreversible processes	• Lecture • Discussion	• Group Discussion on	• To understand the Reversible	Quiz

irreversible processes 11 Hours	, Conditions for reversibility- -heat engine- efficiencies	• Problem solving • Demonstrations of Heat engines. •	heat engine- efficiencies	and irreversible processes	
Module-3 Entropy and its Change 14 Hours	definition of entropy- Change of entropy in different systems- Nernst heat theorem	• Lecture • Discussion • Problem solving • seminar	• Discussion and survey of entropy change in different systems	To Understand the basic ideas of entropy	Evaluation through tests
Module-3 Thermodynamic functions 10 Hours	Thermodynamic functions- application of Maxwell's thermodynamical relations- Claussius-Clapeyron equation- changes of phase	• Lecture • Problem solving • Group study	• Maxwell's thermodynamical relations Device construction	• Understand the concepts of thermodynamic potentials and phase transitions	Evaluation Through MCQ
Module 4 Statistical distributions 8 Hours	Statistical distributions-Maxwell-Boltzmann statistics- Equi partition theorem- Maxwell-Boltzmann speed distribution law	• Problem solving • Lecture • Discussion • Seminar	• Explanation of Equi partition theorem • Stellar study	• Understand the basic principles of statistical mechanics and Maxwell-Boltzmann statistics	viva
Module 5 Quantum Statistics 11 Hours	Bose Einstein and Fermi Dirac statistics- -Fermi energy- Degeneracy pressure and its astrophysical significance.	• Problem solving Lecture • Discussion	• Practical realization of Black body • Experimental verification of	• Understand the concepts of Bose Einstein and Fermi Dirac	General seminars Internal Exam

			Stefans law • Tabulation of Fermi energy of different matels	distribution laws and fermi energy	

Course outcomes

CO1	Understand the zero and first laws of thermodynamics
CO2	Understand the thermodynamics description of the ideal gas
CO3	Understand the second law of thermodynamics and its applications
CO4	Understand the basic ideas of entropy.
CO5	Understand the concepts of thermodynamic potentials and phase transitions
CO6	Understand the basic principles of statistical physics and its applications

UNIT WISE BREAK UP

LECTURE HOURS: 54

OBJECTIVE

a) Understand the theoretical basis of thermodynamic.

b) Understand the basic principles of statistical physics and its applications

Module Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Module 1 :	**Introduction to Thermodynamics**	**18**			
Unit 1.	Thermodynamic processes	10	Check the	Lecture and	To make short notes on the features, scope

Unit 2.	First law of thermodynamics	8	knowledge in Thermodynamics	Discussion	applications of Thermodynamics
Module 2	Second law of thermodynamics	**11**			
Unit 1.	Second law	5	To learn about reversible and irreversible process	Lecture and Illustrations	Applications of second law
Unit 2.	Heat Engine	6	To learn the working of engines	Illustrations and Working	Comparison of different engines
Module 3	**Entropy**	**14**			
Unit 1	Entropy And Third law of thermodynamics	2	To understand entropy change	Lecture and discussion	Set theory problems Draw T -S Diagram
Module 4	**Thermodynamic functions**	**10**			
Unit 1.	Maxwells Thermodynamic functions	5	To realize the Thermodynamic functions	Lecture , discussion and working	problems
Unit 2.	Phase change	5	To realize different Phase	Illustrations Lecture	Applications of phase change
Module 5	**Ststistical mechanics**	**8**			

Unit 1	M- B statistics	8	To read about Probability	Lecture and Problem solving	To write the applications of M- B statistics
Module 6	**Quantum Statistics**	**11**			
Unit 1	B-E statistics	6	To read about bosons	Lecture and Problem solving	To write the applications of B-E statistics
Unit 2.	F- D statistics	5	To read about Fermions	Lecture and Problem solving	To write the applications of F-D statistics

Teacher in Charge : Jose Sunny

PH6 B11 : SOLID STATE PHYSICS, SPECTROSCOPY AND LASER PHYSICS

Total Lecture Hours:72 ,Credits:4

Internal:20 ,External :80, Examination 3 hours

OBJECTIVES

To familiarize students with crystal physics, X-Ray diffraction as well as molecular spectroscopy.

UNIT –1 SOLID STATE PHYSICS

Module 1-Crystal Physics **15 hours** **Max marks 27**

Lattice Point & Space Lattice-Basis and crystal structure, unit cells and lattice Parameters, Unit cells v/s primitive cells, Crystal systems, crystal symmetry. The 23 symmetry elements in a cubical crystal, rotation axis and inversion. Symmetry elements, Bravais space lattices-metallic crystal structure , sodium chloride, diamond, zinc sulphide, hexagonal and closed packed structure, directions, planes and Miller indices.

(Section 4.1 to 4.8, 4.11 to 4.15 and 4.18 - Solid State Physics by S.O. Pillai**)**

Module 2 X-ray Diffraction **5 hours** **Max marks 10**

Bragg's law – Braggs X-ray spectrometer-Rotating Crystal method

Section 5.7 to 5.11- Solid State Physics by S.O. Pillai

Module 3 Super conductivity **8 hours** **Max marks 12**

A survey of superconductivity-Mechanism of Superconductors-Effects of Magnetic Field-Meissner Effect-isotope Effect-Energy Gap -Coherence Length- Josephson effect-BCS Theory (Qualitative idea only) -Application of Superconductivity, Type I and Type II superconductors.

(Section 8.1 to 8.5 & 8.10 of Solid State Physics - S.O. Pillai)

UNIT-2 MOLECULAR SPECTROSCOPY

Module 4 Basic Elements of Spectroscopy **5 hours** **Max marks 10**

Quantum of Energy-Regions of Spectrum-Representation of Spectrum-Basic Elements of Practical Spectroscopy-Signal to Noise Ratio-Resolving Power-Width & Intensity of Spectral Transitions (Section 1.2 to 1.8 of Fundamentals of Molecular Spectroscopy by Banwell & Elaine Mcash**)**

Module 5 Microwave Spectroscopy **8 hours** **Max marks 15**

Classification of Molecules-Interaction of Radiation with Rotating Molecules-Rotational Spectrum of Rigid Diatomic Molecule-Example of CO-Selection Rule-Intensity-Spectrum of non –rigid Rotator-Example of HF-Spectrum of symmetric Top molecule- Example of Methyl chloride-Information derived from Rotational Spectrum.

(Section 6-Rotation of Molecules, Section 6.1 to 6.6, 6.9, 6.13, 6.14 of Molecular Structure & Spectroscopy by G Aruldhas & Chapter 2 - Fundamentals of Molecular Spectroscopy by Banwell & Elaine M Mccas

Module 6. Infra Red Spectroscopy 9 hours Max marks 15

Vibrational Energy of an Anharmonic Oscillator-Diatomic Molecule (Morse Curve)-IR Spectra-Spectral Transitions & Selection Rules-Example of HCL-Vibration-Rotation Spectra of Diatomic Molecule-Born Oppenheimer Approximation-Instrmentation for Infra Red Spectroscopy

(Section 7 to 7.5, 7.15, 7.16 of Molecular Structures & Spectroscopy by G Aruldhas & Chapter 3 of Fundamentals of Molecular Spectroscopy by Banwell & Elaine M Mccash)

Module 7 Raman Spectroscopy 10 hours Max narks 15

Raman Effect, Elements of Quantum theory & Applications-Pure Rotational Raman Spectrum-Examples of Oxygen and carbon-dioxide-Rotational Raman spectrum of symmetric Top molecule-Example of chloroform. Vibrational Raman spectrum of Symmetric Top Molecule-Example of Chloroform. (Molecular Structures & Spectroscopy by G Aruldhas & Chapter 4 of Fundamentals of Molecular Spectroscopy by Banwell & Elaine M Mccash)

Module 8 Laser Physics 12 hours Max marks 22

Induced Absorption-Spontaneous Emission & Stimulated Emission-Einstein Coefficients Principle of Laser-Population inversion-Pumping-Properties of Laser-Types of Laser- Principle & working of Ruby laser, Helium Neon Laser & Semiconductor Laser- -Yag Lasers (Qualitative ideas only). Application of Lasers

(Chapter 12 Masers & Lasers, Solid State Physics by S.O. Pillai, Lasers –Theory & Applications by K Thyagarajan & Ajoy Ghatak)

References

1. Solid Sate Physics by M A Wahab
2. Introduction to Molecular Spectroscopy by G M Barrow
3. Raman Spectroscopy by Long D A
4. Modern Physics by R Murugeshan
5. Optical Communications – M Mukunda Rao – Universities Press
6. Principles of Condensed Matter Physics – P M Chaikin & T C Lubensky – Cambridge University Press

OBJECTIVES

- ***To familiarize students with basic aspects of crystal physics and X-Ray Diffraction***
- ***To enable the students to get deeper view on molecular spectroscopy and photonics.***

LESSON PLAN

Unit/ session/ hours (Time Required)	**Topics for student preparation (input)**	**Procedure (process) Student centric Method of teaching**	**Activity**	**Learning outcome (output)**	**Assessment**
Module 1 Crystal Physics 15 hours	Definitions-Types of Symmetry elements-Packing Factor-Miller Indices	• Discussion • Lecture • Participative learning • Problem solving	• Construction of various crystal structures	• To understand the basics of crystallography	Evaluation Through MCQ and Viva
Module-2 X-Ray Diffraction 5 Hours	Braggs Law and Derivation-X-Ray Photometer-Rotating Crystal method	• Lecture • Discussion • Problem solving • Seminar Presentation	• Group Discussion on different crystal methods	• To understand the basic principles of X-Ray Diffraction.	Quiz
Module-3 Superconductivity 8 Hours	Definitions-Mechanism-Properties-Meissner Effect-Isotope	• Lecture • Discussion • Problem solving	• Paper review discussions on latest	• To understand the basic elements of superconducti	Evaluation through tests

	effect-Josephson effect-BCS Theory-Applications	• seminar	innovation in the field	vity.	
Module-4 Basic elements of Spectrocopy 5 Hours	Definitions-Electromagnetic Spectrum-Grating Spectrometer-Factors to consider-Intensity of Spectral Lines	• Lecture • Problem solving • Group study	• Incorporating videos on practical spectroscopy • Representation of different spectroscopies in flowchart	• Understand the basic elements of spectroscopy	Evaluation Through MCQ
Module 5 Microwave Spectroscopy 8 Hours	Classification of molecules-Evaluation of I-Isotope Effect-Nonrigid Rotator	• Problem solving • Lecture • Participative Learning • Seminar	• Group Discussion	• To Understand the basics ideas of microwave spectroscopy	viva
Module 6 Infrared Spectroscopy 9 Hours	Definitions-Scope-Harmonic Ocillator model-Anharmonic Oscillator model-Selection Rules-Diatomic vibrating rotator	• Problem solving • Lecture • Discussion	• Practical realization of Spectroscopy • Finding out the applications of infrared spectroscopy • Analyzing recent advancements in the field	• To Understand the basics ideas of infra red spectroscopy	General seminars Internal Exam

Module 7 Raman Spectroscopy 10 Hours	Definitions-scopes-Classical and Quantum Theory-Rotational and vibrational Raman spectrum	• Problem solving • Lecture • Discussion • Participative Learning	• Finding more about Dr C V Raman • Understanding modern innovations in the field	• To Understand the basics ideas of infra red spectroscopy	• Viva
Module 8 Laser Physics 12 Hours	Definitions-types of lasers-Applications	• Experiential Learning • Lecture • Participative Learning	• Practical sessions to calculate the wavelength of Laser and its properties	• To understand various ideas of photonics	• Practical Exam

Course outcomes

CO1	Understand the basic aspects of crystallography in solid state physics
CO2	Understand the basic principles of X-Ray Diffraction.
CO3	Understand the basic elements of spectroscopy
CO4	Understand the basics ideas of microwave and infra red spectroscopy
CO5	Understand the fundamental ideas of photonics

UNIT WISE BREAK UP

LECTURE HOURS: 72

OBJECTIVE

c) Understand the theoretical basis of crystallography

d) Understand the basic principles of spectroscopy and photonics

Module Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Module 1 :	**Crystal Physics**	**5**			Construction of various crystal elements
Unit 1.	Crystals and crystal symmetry	2			

Unit 2.	Bravis space lattices, Packing Factors and Miller indices	3	Check the knowledge in crystals and co-ordinate systems	Lecture and Discussion	
Module 2	**X-Ray Diffraction**	**5**			
Unit 1.	Braggs Law	3	To check the basic knowledge on Braggs law	Lecture and Illustrations	Solving problems based on the theory
Unit 2.	Rotating Crystal Method	2	To learn the different diffraction methods	Illustrations and discussion	Comparison of different methods of X-Ray diffraction
Module 3	**Super Conductivity**	**8**			
Unit 1	Superconductivity, mechanism, Meissner Effect	4	To understand concept of superconductivity	Lecture and discussion	Determining the properties and applications of superconductors
Unit 2	Josephson Effect, BCS Theory, Types of Superconductors	4	To understand various phenomenas	Illustrations and lectures	Comparison of types of superconductors
Module 4	**Basic elements of Spectroscopy**	**5**			
Unit 1.	Representation of Spectrum, Basic elements of Practical Spectroscopy	5	To realize various spectrum representations	Lecture , discussion	Flow chart of spectral series in detail

Module 5	**Microwave Spectroscopy**	**8**			
Unit 1	Classification of molecules, Rotational spectroscopy of rigid diatomic molecule	4	To check the knowledge about different types of molecules	Lecture and Problem solving	To write the applications of microwave spectroscopy
Unit 2	Spectrum of non-rigid Rotator	4	To understand bond structure of molecules	Lecture and Problem solving	To find out different models for analysing molecular spectroscopy
Module 6	**Infra red Spectroscopy**	**9**			
Unit 1	Harmonic and Anharmonic oscillator model	5	To read about harmonic oscillators	Lecture and Problem solving	To solve the problems based on theory
Unit 2.	Rotational spectra of diatomic molecule	4	To read about diatomic molecule and rotational spectra	Lecture and Problem solving	To write the applications of Infra red spectroscopy
Module 7	**Raman Spectroscopy**	**10**			
Unit 1	Raman effect ,Rotational Raman	5	To read about C V Raman and	Lecture and Illustrations	To make a write up on the

	effect		Raman Effect		contributions pf C V Raman
Unit 2	Vibrational Raman Spectrum	5	To read about Vibration changes in molecules	Lecture and Discussions	To solve the problems based on the theory
Module 8	**Laser Physics**	**12**			
Unit 1	Principle of Laser	7	To read about laser and its properties	Lecture and Illustrations	To write on the applications of Lasers
Unit 2	Types of Laser	5	To understand different types of Lasers	Lecture and Illustrations	To make a comparative study on lasing action of different lasers

Teacher in Charge : Merin Jose V

PH6 B13(E1) Elective- Computational Physics (54 hrs. – 3 credits)

Internal: 20, External: 80, Examination 3 Hours

Objectives

Understand Python Programming and computational approach in physics

UNIT I

Introduction to Python Programming: **20 hours** **Max marks 47**

Concept of high level language, steps involved in the development of a Program – Compilers and Interpreters - Introduction to Python language, Advantages of Python in comparison with other Languages - Different methods of using python: Using python as a calculator, Writing python programs and execution - Inputs and Outputs - Variables, operators, expressions and statements -- Strings, Lists, list functions (len, append, insert, del, remove, reverse, sort, +, *, max, min, count, in, not in, sum), sets, set functions(set, add, remove, in, not in, union, intersection, symmetric difference)-Tuples and Dictionaries, Conditionals, Iteration and looping - Functions and Modules - File input and file output, Pickling.

UNIT II.

Numerical Methods in physics **22 hours** **Max marks 47**

(Programs are to be discussed in Python) General introduction to numerical methods, Comparison between analytical and numerical techniques - Curve Fitting: Principle of least squares, fitting a straight line - Interpolation: Finite difference operator, Newton's forward difference interpolation formula, Solution of algebraic equations: Newton-Raphson method - Numerical differentiation and integration: Difference table, Trapezoidal and Simpson's (1/3) method - Solution of differential equations :Runge Kutta method (Second order) -Taylor's Series : Sin(x) and Cos(x).

UNIT III.

Introduction to Computational approach in physics **12 hours** **Max marks 32**

(Programs are to be discussed in Python) One Dimensional Motion: Falling Objects: Introduction – Formulation: from Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium - Simulation of free fall and numerical integration, Two dimensional motion: Projectile motion (by Euler method)-Motion under an attractive 42 Inverse Square- law force Accuracy considerations .(elementary ideas)(Graphics not required, data may be presented in table form)

References:

(For Python any book can be used as reference. Moreover a number of open articles are available freely in internet. Python

is included in default in all GNU/Linux platforms and It is freely downloadable for Windows platform as well. However use of GNU/Linux may be encouraged).

1. www.python.org
2. Python Essential Reference, David M. Beazley, Pearson Education
3. Core Python Programming, Wesley J Chun, Pearson Education
4. Python Tutorial Release 2.6.1 by Guido van Rossum, Fred L. Drake, Jr., editor. This Tutorial can be obtained from website (http://www.altaway.com/resources/python/tutorial.pdf)
5. How to Think Like a Computer Scientist: Learning with Python, Allen Downey , Jeffrey Elkner , Chris Meyers, http://www.greenteapress.com/thinkpython/thinkpython.pdf
6. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, Newdelhi (or any other book)
7. Numerical methods for scientists and engineers, K. Sankara Rao, PHI
8. Introductory methods of numerical analysis, S.S.Shastry , (Prentice Hall of India,1983)
9.Computational Physics, V.K.Mittal, R.C.Verma & S.C.Gupta-Published by Ane Books,4821,Pawana Bhawan,first floor,24 Ansari Road,Darya Ganj,New Delhi-110 002 (For theory part and algorithms. Programs must be discussed in Python)

OBJECTIVES

- ***Understand the Basics of Python programming***
- ***Understand the applications of Python modules***
- ***Understand the basic techniques of numerical analysis***
- ***Understand and apply computational techniques to physical problems***

LESSON PLAN

Unit/ session/ hours (time Required)	**Topics for student preparation (input)**	**Procedure (process) Student centric Method of teaching**	**Activity**	**Learning outcome (output)**	**Assessment**
Unit 1 Introduction to Python Programming (20 Hours)	Concept of high-level language and Python Basics	-Discussion -Participative learning -Explain Python Language using software	• Peer Group Discussion on High-Level Language	• To understand basics of programming	Evaluation Through MCQ & simple programs
Unit 2 Numerical Methods in physics (20 Hours)	Numerical methods Euler method, RK method, least square fitting, Simpson's and Trapezoidal rule, Interpolation &Newton Raphson method	• Lecture • Discussion • Problem solving numerically • Solving problems by programs	• Group Discussion on writing programs for each problem	• To develop problem solving skill & also programming skill	Problems & programs
Unit 3 Introduction to Computational approach in physics (12 Hours)	Problems in Physics and its solution, Corresponding programs	• Lecture • Discussion • Problem solving • Writing programs	• Writing programs with different conditions	To Understand the program developing for solving a problem	Evaluation through tests– writing and checking outputs of the programs

Course Outcomes

CO1	Understand the Basics of Python Programming
CO2	Understand the applications of Python Modules
CO3	Understand the basic techniques of numerical analysis
CO4	Understand and apply computational techniques to physical problems

UNIT WISE BREAK UP

LECTURE HOURS: 54

OBJECTIVE

e) Understand the basis of Programming language

f) Developing program writing skills

Module Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Unit 1 :	Introduction to Python Programming:	**5**	Check the knowledge in programming language	Lecture and Discussion	To make short notes on the topics &writing simple programs
Section 1	Data Types &Variables	5			
Section 2	Iterating Loops &conditionals	10			
Unit 2	Numerical Methods	**10**			
Section 1	Programming	10	To learn about numerical methods and programming	Lecture and Illustrations of programs	Developing programs
Unit 3	Computational approach in physics	**10**	Developing programs for problems in physics	Theory & Illustration of programs	Writing programs related to problems in physics

Teacher in Charge : Raichal P John

SEMESTER 4

PHY4B04: ELECTRODYNAMICS II ,54 hours (Credit - 3)
Internal: 15, External: 60, Examination 2hrs

Objectives

Understand the theoretical basis of thermodynamics and statistical physics

Unit- I

ELECTRODYNAMICS **15 Hrs** **2 marks**

Electromotive force – Ohm's law, electromotive force, motional emf – Electromagnetic induction -Faradays law, induced electric field, inductance, energy in magnetic fields – Maxwell's equations –Electrodynamics before Maxwell, Maxwell's modification of Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations inside matter, Boundary conditions – Continuity equation – Poynting's theorem
[Sections 7.1 to 7.3 and 8.1 of Introduction to Electrodynamics by David J Griffiths. Additional problems should be done from chapter 7 of Berkeley Physics Course: Vol.2: Electricity and Magnetism (2nd Edn.) by Edward M Purcell.]

Unit- II

ELECTROMAGNETIC WAVES **15 Hours** **22 marks**

Waves in one dimension, The wave equation, sinusoidal waves, boundary conditions :reflection and transmission, Polarization – Electromagnetic waves in vacuum , Wave equation for **E** and **B**, monochromatic plane waves in vacuum, energy and momentum of E.M. waves, Poynting vector -Electromagnetic waves in matter, Propagation through linear media, reflection and transmission at normal incidence .Potential formulation – Scalar and vector potentials, Gauge transformations, Coulomb gauge and Lorentz gauge.
[Sections 9.1 to 9.3.2 and 10.1of Introduction to Electrodynamics by David J Griffiths. Additional problems should be done from chapter 9 of Berkeley Physics Course: Vol.2: Electricity and Magnetism (2nd Edn.) by Edward M Purcell.]

Unit III

TRANSIENT CURRENTS **8 Hours** **12 marks**

Types of transients – DC transient currents in R-L circuits – Short circuit current – Time constant –DC transient currents in R-C circuits – Double energy transients – Theory of BG
[Sections 22.1, 22.2, 22.4, 22.5, 22.6, 22.8, 22.10 and 10.52 of Electrical Technology Vol. 1 by B.L. Theraja and A. K. Theraja]

Unit IV

AC CIRCUITS **8 Hour** **12 marks**

A resonant circuit – Alternating current – Alternating current networks – Admittance and impedance – Power and energy in AC circuits

[Sections 8.1 to 8.5of Berkeley Physics Course: Vol.2: Electricity and Magnetism (2nd Edn.) by Edward M Purcell.Additional problems should be done from the relevant sections from chapters and 14 of the book of Electrical Technology Vol. 1 by B. L. Theraja and A. K. Theraja]

Unit V

NETWORK THEOREMS **8 Hours** **11 marks**

Kirchhoff's laws, Voltage sign and current direction, Solution of simultaneous equations using determinants, Source conversion, Superposition theorem, Ideal equivalent circuits, Thevenin's theorem, Reciprocity theorem, Delta / Star transformation – Star / Delta transformation – Norton's theorem, Maximum power transfer theorem. [Sections 2.2 to 2.6, 2.14 to2.23, 2.25, 2.26, 2.27 and 2.30 from Electrical Technology Vol. 1 by B L. Theraja and A. K. Theraja]

Books of Study:

1. Introduction to Electrodynamics, 4thEdn. – David J Griffiths – Prentice Hall India Learning Pvt. Ltd
2. Berkeley Physics Course: Vol.2: Electricity and Magnetism, 2nd Edn. – Edward M. Purcell – McGraw-Hill
3. A Text Book of Electrical Technology Vol. 1 – B. L. Theraja, A. K. Theraja – S. Chand Publishers, 1997

Reference Books :

1. Electricity and magnetism by Arthur F Kip
2. Physics Vol. II by Resnick and Halliday
3. Electricity and Magnetism by D.N Vasudeva (12threvised edition)
4. Introductory AC Circuit theory – K Mann & G J Russell- Universities Press
5. NPTEL video lectures available online

OBJECTIVES

- Understand the basic concepts of electrodynamics
- Understand and analyze the properties of electromagnetic waves
- Understand the behavior of transient currents
- Understand the basic aspects of ac circuits
- Understand and apply electrical network theorems

LESSON PLAN

Unit/ session/ hours (time Required)	Topics for student preparation (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
Unit 1 Electrodynamics 15 hours	Ohm's law, Faraday's law, Maxwell's equations, Ampere's law, Boundary conditions	• Discussion • Participative learning • Problem solving	• Peer Group Discussion on boundary conditions	• To understand basic electrodynamics	Evaluation Through descriptive problems
Unit-2 Electromagnetic waves 15 Hours	Waves in one dimension, boundary conditions , reflections and transmission, polarization, pointing vector, electromagnetic waves in matter gauge transformations	• Lecture • Discussion • Problem solving • Seminar • Class tests	• Group Discussion on pointing vector and potential formulation	• To understand electromagnetic wave propagation in both vacuum and matter	Quiz Problems Test papers
Unit -3 Transient currents 8 Hours	Types of transients-Transient currents in R-L circuits-Double energy transients-Theory of BG	• Lecture • Discussion • Problem solving • Seminar	• Group discussion on seminars	• To learn about growth and decay of current in different circuits	Evaluation through tests
Unit-4 AC Circuits 8 Hours	A resonant circuit-Alternating current-Alternating current networks-Power and energy in AC circuits	• Lecture • Problem solving • Group study	• Peer activity learning by reviewing journals	• To understand the basic aspects of ac circuits	Evaluation Through MCQ
Unit 5 Network Theorems 8 Hours	Kirchoff's laws-Solution of equations using determinants-Thevenin theorem-Norton's theorem-Maximum power	• Lecture • Discussion • Experiential Learning • Seminar	• Practical verification of different laws in lab	• Understand and apply electrical network theorems	Experimentally verifying Thevenin theorem

	transfer theorem				

Course outcomes

CO1	Understand the basic concepts of electrodynamics
CO2	Understand and analyze the properties of electromagnetic waves
CO3	Understand the behavior of transient currents
CO4	Understand the basic aspects of ac circuits
CO5	Understand and apply electrical network theorems

UNIT WISE BREAK UP

LECTURE HOURS: 54

OBJECTIVE

g) Understand the concepts of electrodynamics and electromagnetic waves.

h) Understand the basic principles circuit theory and transient currents

Module Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
Unit 1 :	**Electrodynamics**	**15**	Check the knowledge in electrodynamics (I)	Lecture and Discussion	To make short notes on the topics and problems
Section 1.	Ohm's law, Faraday's law, Ampere's law	4			
Section 2.	Maxwell's equations & boundary conditions	8			

Section 3	Continuity equation and pointing theorem	3			
Unit 2	**Electromagnetic waves**	**15**			
Section 1.	Wave equation, boundary conditions: reflection and transmission	5	Learn about electromagnetic waves	Lecture and Illustrations	Problems
Section 2.	Electromagnetic waves in matter	10	Learn About em waves in matter	Lecture and discussion	problems
Unit 3	**Transient circuits**	**8**			
Section 1	Types of transients and BG		Learn about transient currents	Lecture and illustrations	Problem soving
Unit 4	**AC Circuits**	**8**			
Section 1.	Alternating current networks	6	Learn about AC networks	Lecture and illustrations	Solving various circuit diagrams
Section 2.	Power and energy in AC circuits	2	Learn about power and energy	Lecture and illustrations	Calculating power and energy of various circuit diagrams
Unit 5	**Network Analysis**	**8**			
Section 1	Kirchoff's Laws-Solution using determinants-superposition theorem	4	Learn about various laws in network analysis	Lecture and illustrations	Solving problems
Section 2	Thevenin theorem-Reciprocity theorem-Nortons Theorem	4	Learn about various laws in network analysis	Lecture and illustrations	Practical verification of Thevenin Theorem

Teachers in Charge : Merin Jose V & Raichal P John

SEMESTER 2

PHY2 B02: MECHANICS II
Lecture Hours 36 hrs, Credits: 2
Internal: 15, External: 60, Examination 2 Hours

OBJECTIVES

Understand the fundamentals of mechanics

UNIT I

Non inertial Systems and Fictitious Forces **8 Hours** **18 marks**

Galilean transformations – Uniformly accelerating systems – The apparent force of gravity –Pendulum in an accelerating car – The principle of equivalence – The driving force of the tides – Physics in a rotating coordinate system – Time derivatives and rotating coordinates – Acceleration relative to rotating coordinates – The apparent force in a rotating coordinate system – The Coriolis force – Deflection of a falling mass – Motion on the rotating earth – Weather systems – Foucault's pendulum

[Sections 8.1 to 8.5 of An Introduction to Mechanics (1stEdn.) by Daniel Kleppner and Robert J.Kolenkow]

UNIT II

Central Force Motion **(10 Hours; 22 marks)**

Central force motion as a one-body problem – General properties of central force motion – Motion confined to a plane – Energy and angular momentum as constants of the motion – The law of equal areas – Finding the motion in real problems – The energy equation and energy diagrams – Noninteracting particles – Planetary motion – Hyperbolic orbits – Satellite orbit – Kepler's laws –The law of periods – Properties of the ellipse
[Sections 9.1 to 9.7 of An Introduction to Mechanics (1stEdn.) by Daniel Kleppner and Robert J.Kolenkow]

UNIT III

Harmonic Oscillator **(8 Hours; 18 marks)**

Introduction and review – Standard form of the solution – Nomenclature – Initial conditions and the frictionless harmonic oscillator – Energy considerations – Time average values – Average energy – Damped harmonic oscillator – Energy and Q-factor – Q factor of two simple oscillators – Graphical analysis of a damped oscillator – Solution of the equation of motion for the damped oscillator – Forced harmonic oscillator – Undamped forced oscillator – Resonance
[Sections 10.1 to 10.3 of An Introduction to Mechanics (1stEdn.) by Daniel Kleppner and Robert J.Kolenkow]

UNIT IV

Waves

(10 Hours; 21 marks)

What is a wave? Normal modes and travelling waves- Progressive waves in one direction- Wave speeds in specific media- Superposition -Wave pulses- Motion of wave pulse of constant shape-Superposition of wave pulses-Dispersion; Phase and Group velocities-Energy in a mechanical wave -Transport of energy by a wave-Momentum flow and mechanical radiation pressure-Waves I two and three dimension
[Chapter 7 progressive waves(except the topic , The phenomenon of cut off) of vibrations and waves by A P French]

Books of Study:

1. **An introduction to Mechanic, Ist Edn. Daniel Klepper & Robert j Kolenkow McGraw Hill**
2. **Vibrations &Waves – A. P French – The MIT Introductory Physics Series CBS Publishers &Distributors**

Reference Books:

Berkeley Physics Course : Vol.1 : Mechanics, 2ndEdn. – Kittel *et al.* – McGraw-Hill

OBJECTIVE

- Understand the features of non-inertial systems and fictitious forces
- Understand and analyze the features of central forces with respect to planetary motion
- Understand the basics ideas of harmonic oscillations
- Understand and analyze the basic concepts of wave motion

LESSON PLAN

Unit/ session/ hours (time Required)	Topics for student preparation (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
Unit 1 Noninertial Systems and Fictitious Forces 8 hours	Non-inertial systems, fictitious forces, rotating coordinate systems, Coriolis forces, motion of rotating earth, Foucault's pendulum.	• Discussion • Problems	• Peer Group Discussion on coordinate system , Coriolis force, Foucault's Pendulum	• To understand basic mechanics	Evaluation Through MCQ and problems
Unit-2 Central Force Motion 10 Hours	Central force problem, Energy & angular momentum, energy diagrams, planetary motion, Kepler's laws	• Lecture • Discussion • Problem solving	• Group Discussion on finding motion in real problems	• To understand Central force &planetary motion	Quiz and problems
UNIT III Harmonic Oscillator 8 Hours	Harmonic oscillator- Standard form of solution, energy considerations, time average values, damped harmonic oscillator, graphical analysis, equation of motion for undriven damped oscillator, forced harmonic oscillator, Resonance	• Lecture • Discussion • Problem solving • Seminar • Assignment	• Resonance • Different types harmonic oscillation	To Understand the harmonic oscillation motion possessed by different systems	Evaluation through tests Descriptive problems
UNIT IV Waves 10 Hours	Waves, dispersion, Superposition, wave pulses, phase and group velocities, energy of waves, Waves in two and three dimensions	• Lecture • Problem solving • Group study	• Waves in two& three dimensions	• Understand basic concept of wave motion	Evaluation Through MCQ

Course outcomes

CO1	Understand the features of non-inertial systems and fictitious forces
CO2	Understand and analyze the features of central forces with respect to planetary forces
CO3	Understand the basic ideas of Harmonic oscillator
CO4	Understand the basic concepts of wave motion

UNIT WISE BREAK UP

LECTURE HOURS: 36

OBJECTIVE

Understand Basic mechanics

Module Number	Topic	No. of Lecture Hours	Pre- class activity	Pedagogy (in class)	Out of class assignment
UNIT 1 :	Non inertial systems and fictitious forces	**8**	Check the knowledge in Newtonian Mechanics	Lecture and Discussion	-To make short notes on the discussed topics - Extra problems as assignment
Section 1.	Rotating coordinate systems	5			
Section 2.	Coriolis force and Foucault's pendulum	3			
UNIT 2	Central Force Motion	**10**	Give problems based on this topic	Lecture and Illustration	Problems
Section 1.	Finding motion in real problems	8			
Section 2.	Kepler's laws	2	Discuss Planetary motion	Lecture and discussion	Problems

UNIT 3	**Harmonic Oscillator**	**8**	Basic ideas of oscillatory motion	Lecture and discussion	Problems
Section 1 Section 2	Energy considerations Different types of oscillatory motion	2 6	To understand Energy diagrams	Lecture and discussion	problems
UNIT 4	**Waves**	**10**			
Section 1.	Superposition, wave pulses	3	Basic ideas of waves	Lecture , discussion of problems Seminar	Problems Assignment on notes
Section 2.	Energy of mechanical wave-momentum flow, waves in 2D and 3D	5	Waves in one dimension	Illustrations Lecture	Problems

Teacher in Charge : Raichal P John