COMPUTATIONAL PHYSICS

Course Code: 22BSPH03 **L-T-P: 2:0:2**

Total Hours: 60 **Credits: 3**

Prerequisite: Fundamentals of physics and basics of programming

Course Learning Objectives (CLO)

The objective of this course is to

Introduce the fundamental concepts of physics and develop skills to simulate the Physics/Engineering problems using computer programs

Module 1 **[12 hours]**

Oscillations: Periodic motion-simple harmonic motion-characteristics of simple harmonic motion-vibration of simple spring-mass system. Resonance-definition, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor and forced oscillations, Simulations of Simple harmonic motion, Damped Oscillations, Forced Oscillations.

Module 2 **[12 hours]**

Wave Mechanics: Heisenberg's uncertainty principle and its application, Wave function, Properties of Wave Function. Interpretation of Wave Function, Time independent Schrodinger equation-Energy Eigen values, General solution of the time independent Schrodinger equation in terms of linear combinations of stationary states, Application to the spread of Gaussian wave packet for a free particle in one dimension, Wave packets, Problems, wave functions and probability densities for a particle in one dimensional box – a python approach.

Module 3 **[12 hours]**

Laser: Interaction between radiation and matter (induced absorption, spontaneous and stimulated emission). Expression for energy density at thermal equilibrium in terms of Einstein's coefficients. Characteristics of laser light, Conditions for laser action- population inversion and Meta stable state, Requisites of laser system, Construction and working of Carbon Dioxide (CO_2) laser, Nd-YAg laser, Applications of lasers - LIDAR, Numerical, Simulation of determination of wavelength of laser

Module 4 **[12 hours]**

Optical Fiber: Construction and light propagation mechanism in optical fibers, total internal reflection Acceptance angle, Numerical Aperture (NA), Expression for numerical aperture in terms of refractive indices of core and cladding, Condition for wave propagation in optical fiber, V-number

and Modes of propagation, Types of optical fibers, Attenuation; absorption, scattering and radiation loss, Point to point communication systems, Numerical, Simulation of total internal reflection.

Module 5 **[12 hours]**

Digital Electronics: Digital and Analog Signals and Systems, Binary Digits, Logic Levels, and Digital Waveforms, Logic Gates: Logical Operators, Logic Gates-Basic Gates (OR, AND, NOT), Other gates (NOR gates and NAND gates), Universal Gates and realization of other gates using universal gates, Half adder and full adder, Boolean Algebra: Rules and laws of Boolean algebra, De-Morgan's Theorems, Numerical, Simulation by verification of truth table of Logic gates.

TEXT BOOK

1. "A text book of Oscillations, Waves and Acoustics", M. Ghosh and D Bhattacharya, 5th Edition, S. Chand Publishing, 2016.
2. "Concepts of Modern Physics", Arthur Beiser, 6th Edition, McGraw-Hill, 2003.
3. "Solid State Electronics Devices", B. G. Streetman, Pearson Prentice Hall, New Jersey, 7th Edition, 2014.
4. "Computational Physics: A Practical Introduction to Computational Physics", K.N. Anagnostopoulos, The National Technical University of Athens, 2014

REFERENCE BOOK

1. "Engineering Physics", S. P. Basavaraju,.
2. "Fundamentals of Physics", Halliday and Resnick, 11th Edition, Wiley, UK, 2018
3. "Semiconductor Devices: Physics and Technology", S. M. Sze, Wiley, India, 2nd Edition, 2011
4. "Introduction to Python for Engineers and Scientists: Open-Source Solutions for Numerical Computation", Sandeep Nagar, ISBN-13 (pbk): 978-1-4842-3203-3 https://doi.org/10.1007/978-1-4842-3204-0

OUTCOMES

At the end of the course, students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Explain the concepts of damped and forced oscillation	Understanding (2)
CO2	Outline the concepts of quantum physics	Understanding (2)
CO3	Illustrate the fundamentals of photonics to Various Laser Applications	Applying (3)
CO4	Understand the role of laser properties in optical fibre communication	Understanding (2)
CO5	Interpret the concepts of digital electronics to their applications	Applying (3)
CO6	Examine the physics problems using simple computing programs and simulate the results	Analysing (4)

CO/PO: Mapping												
(3/2/1 indicates strength of correlation) 3-High, 2-Medium, 1-Low												
Course Outcome (COs)	Program Outcome (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	1										
CO3	3	2	1									
CO4	2	1										
CO5	3	2	1		1							
CO6	3	2	1	1	2							

Bloom's Taxonomy-Revised

LEVEL	DESCRIPTION	MEANING	ACTION VERBS
6	Creating	Can the student create a new product or POV?	Assemble, construct, create, change, combine, compose, design, develop, formulate, invent, modify, organize, propose, theorize, write
5	Evaluating	Can the student justify a stand or decision?	Appraise, agree, assess, argue, conclude, decide, defend, judge, prioritize, prove, rate, recommend, select, support, value
4	Analyzing	Can the student distinguish between different parts?	Contrast, compare, criticize, differentiate, discriminate, dissect, distinguish, examine, experiment, operate, question, simplify, test
3	Applying	Can the student use information in a new way?	Choose, demonstrate, dramatize, employ, illustrate, interpret, schedule, sketch, solve, use
2	Understanding	Can the student explain ideas and concepts?	Classify, describe, discuss, explain, identify, infer, locate, outline paraphrase, recognize, report, summarize, select, translate
1	Remembering	Can the student recall or remember information?	Define, duplicate, find, list, label, match, memorize, name, omit, recall, repeat, state, spell, tell