ENGINEERING PHYSICS

SH 152

Lecture : 4 **Year : I**
Tutorial : 1 **Part : II**
Practical : 2

Course Objectives:
To provide students a concept and sound knowledge of physics with the emphasis in present day applications to apply them in relevant fields. The background of physics corresponding to Proficiency Certificate Level is assumed.

1 Oscillation (6 hours)

- 1.1 Physical pendulum
  - 1.1.1 Bar pendulum
  - 1.1.2 Interchangeability of point of suspension and point of oscillation
  - 1.1.3 Minimum time period in case of physical pendulum
  - 1.1.4 Torsion pendulum
- 1.2 Damped and Forced Oscillation
  - 1.2.1 Damped harmonic oscillator
  - 1.2.2 Difference between free and damped oscillator
  - 1.2.3 Energy in damped oscillation
  - 1.2.4 Relaxation time
  - 1.2.5 Forced oscillation and resonance
  - 1.2.6 Sharpness of resonance
  - 1.2.7 Quality factor

2 Acoustics (3 hours)

- 2.1 Introduction
  - 2.1.1 Threshold of hearing and loudness
  - 2.1.2 Reverberation and reverberation time
  - 2.1.3 Absorption coefficient
  - 2.1.4 Sabine's Law
  - 2.1.5 Conditions for good acoustics
- 2.2 Ultrasound
  - 2.2.1 Production (piezoelectric) of ultrasound and its applications
  - 2.2.2 Test of structure and materials
  - 2.2.3 Medical uses

3 Heat and Thermodynamics (8 hours)

- 3.1 Quantity of Heat
  - 3.1.1 Calorific value of Foods and Fuels
  - 3.1.2 Bomb Calorimeter
  - 3.1.3 Specific heat of solid: Dulong - Petit law, Einstein's law
- 3.2 Nature of Heat
  - 3.2.1 Degree of freedom
  - 3.2.2 Maxwell's law of equipartition of energy
  - 3.2.3 atomicity of gases
  - 3.2.4 Vander-Waal's equation of real gases
  - 3.2.5 Critical constants
- 3.3 Thermodynamics
  - 3.3.1 Laws of Thermodynamics
  - 3.3.2 Clapeyron latent heat equation
  - 3.3.3 Entropy and Third law of thermodynamics
  - 3.3.4 Negative energy
  - 3.3.5 Maxwell's thermodynamic relations
  - 3.3.6 Gibb's free energy and phase transitions
- 3.4 Heat and Mass Transfer
  - 3.4.1 Fourier's law of thermal conductivity
  - 3.4.2 Use of thermal conductivity in building sciences
  - 3.4.3 Thermal resistance
  - 3.4.4 Types of convection
  - 3.4.5 Law of diffusion
  - 3.4.6 Relation between Stefan's law and Newton's law of Cooling
  - 3.4.7 Pyrheliometer and Pyrometer

4 Optics (17 hours)

- 4.1 Geometrical optics
  - 4.1.1 Lens separation
  - 4.1.2 Chromatism in lens combination
- 4.2 Interference
  - 4.2.1 Interference in thin films (reflected and transmitted light)
  - 4.2.2 fringes produced by a wedge-shaped thin film
  - 4.2.3 Newton's rings (both reflected and transmitted case)
  - 4.2.4 Determination of wavelength of light and refractive index of liquid by using Newton's rings.
- 4.3 Diffraction
  - 4.3.1 Introduction: Fresnel and Fraunhoffer's diffraction
  - 4.3.2 Fraunhoffer's diffraction at single slit
  - 4.3.3 Intensity distribution in the diffraction pattern due to a single slit
  - 4.3.4 Multiple slits, diffraction grating
  - 4.3.5 X-ray diffraction, X-rays in material testing

4.4 Polarization
- 4.4.1 Introduction: double refraction, Nichol prism (construction and uses)
- 4.4.2 Retardation plate (quarter and half wave plates), plane, elliptical and circular polarized light (theoretical and mathematical explanation)
- 4.4.3 Optical activity, specific rotation

4.5 Laser
- 4.5.1 Introduction: Laser and ordinary light, properties of laser
- 4.5.2 Induced absorption, spontaneous and Stimulated emission, active medium, population inversion, metastable state
- 4.5.3 Pumping (types: optical, electrical, chemical and heating)
- 4.5.4 He-Ne laser, semiconductor Laser
- 4.5.5 Uses of laser

4.6 Fiber Optics
- 4.6.1 Introduction: Propagation of light wave
- 4.6.2 Types of optical fiber: step index and graded index
- 4.6.3 Fiber transmission – single and multimode, self focusing, acceptance angle and numerical aperture
- 4.6.4 Applications

5 Electrostatics (8 hours)

5.1 Electric Field
- 5.1.1 Electric field due to a electric dipole (along axial line and equatorial line)
- 5.1.2 Electric dipole in an external electric field
- 5.1.3 Electric field due to linear electric quadrupole (along axial line)
- 5.1.4 Electric field: a ring of charge, circular ring and disc of charge

5.2 Electric Potential
- 5.2.1 Potential due to electric dipole
- 5.2.2 Potential due to linear quadrupole
- 5.2.3 potential due to continuous charge distribution, potential due to ring of charge and disc of charge

5.3 Capacitors
- 5.3.1 Cylindrical Capacitor
- 5.3.2 Charging and discharging of capacitor
- 5.3.3 Capacitor with dielectrics: dielectrics and Gauss law
- 5.3.4 High intensity electrostatic fields: uses and hazards (xerography, inkjet, precipitation)

6 Electromagnetism (6 hours)

- 6.1 Electromagnetic induction
  - 6.1.1 Faraday's laws
  - 6.1.2 Induction and energy transformation
  - 6.1.3 Induced electric field
  - 6.1.4 Self-induction and mutual induction
  - 6.1.5 LR circuit
  - 6.1.6 Energy stored in a magnetic field and energy density
  - 6.1.7 Induced magnetic field: modified Ampere's law and displacement current
- 6.2 Eddy Current
  - 6.2.1 Introduction
  - 6.2.2 Applications: Induction cooker, Electric Guitar, Metal Detector and Eddy Current Breaking
  - 6.2.3 Cyclotron and Synchrotron

7 Electromagnetic waves (6 hours)

- 7.1 Maxwell's Equations
  - 7.1.1 Differential and integral forms
  - 7.1.2 Conversion of Maxwell's equations from integral form to differential form and differential form to integral form
  - 7.1.3 Maxwell's equations in different media
- 7.2 Applications
  - 7.2.1 Wave equations: non conducting and conducting medium and free space
  - 7.2.2 Plane solution of wave equations, amplitude of electromagnetic waves, speed of electromagnetic waves, ratio of electric and magnetic fields
  - 7.2.3 Continuity equation
  - 7.2.4 Energy transfer and Poynting vector, Radiation pressure

8 Photon and matter waves (6 hours)

- 8.1 Quantum Physics
  - 8.1.1 Inadequacy of classical mechanics and rise of quantum mechanics, Quantization of energy
  - 8.1.2 Group velocity and phase velocity, electrons and matter waves
  - 8.1.3 de-Broglie wavelength, its applications
  - 8.1.4 Heisenberg uncertainty principle and its applications
  - 8.1.5 Wave functions and its significance

8.2 Schrodinger wave equation
- 8.2.1 Time dependent and independent equation
- 8.2.2 Probability distribution
- 8.2.3 One dimensional infinite potential well, particle in a box
- 8.2.4 Barrier tunneling (reflection and transmission coefficient)

Tutorial

There shall be related tutorials exercises in class and given as regular homework exercise. Tutorial can be as following for each specified chapters

1. Oscillation (2 hours)
   Physical pendulum related numerical, torsional pendulum: determination of moment of inertial and modulus of rigidity; minimum time period and interchangeability of point of suspension and point of oscillation in bar pendulum
   Damped harmonic motion: amplitude and energy related problems, energy loss and quality factor related problems
   Force harmonic motion: Amplitude and resonance frequency related problems
2. Acoustics (1 hour)
   Reverberation time calculation by using Sabine's relation, absorption coefficient, total absorbing power calculation, intensity level related problems
3. Heat and Thermodynamics (2 hours)
   Calculation of Calorific value, Einstein's law related problems, Maxwell's equipartition of energy related problems for mono, dia and triatomic molecule, Calculation of critical constants, phase transition related problems, Newton's law of cooling related problems, Change in entropy related problems, Fourier's law of thermal conductivity related problems
4. Optics (4 hours)
   Combination of lens related problems for calculation of equivalent focal length, principal points, position of image, achromatism related problems (for separation and joined cases)
   Interference: interference in thin films, wedge shaped and Newton's rings related problems
   Diffraction: Intensity distribution from single slit related and diffraction grating related numerical
   Polarization: Specific rotation, wave plates (quarter and half) related problems
   Optical fiber: Refractive index for core and cladding, Numerical aperature and acceptance angle calculation
5. Electrostatics (3 hours)
   Electric dipole related problems for electric field and potential, Electric dipole in an external electric field related problem, electric quadrupole related numerical, problems related to charged ring and disc for both electric field and electric potential, calculation of numerical value of

cylindrical capacitor, determination of electric field, displacement vector and polarization vector in case of dielectric in a capacitor

6. Electromagnetism (1 hour)
   Determination of self-induction of solenoid and toroid, rise and decay related problems in LR circuit, displacement current related numerical, time period and maximum energy for an charged particle in cyclotron related problems
7. Electromagnetic Waves (1 hour)
   Prove that velocity of electromagnetic wave is equal to velocity of light in free space, intensity of electromagnetic waves related problems, determination of maximum value of electric and magnetic fields due to electromagnetic wave, radiation pressure related problems
8. Photon and Matter waves (1 hour)
   De-Broglie wavelength related problems, Heisenberg's uncertainty related numerical, Energy states calculation for infinite potential well, transmission coefficient related numerical in finite potential barrier

Practical

1. To determine the acceleration due to gravity and radius of gyration of the given metal bar using bar pendulum.
2. To determine the modulus of elasticity of the given material and moment of inertia of the circular disc about the wire as an axis passing through its center and perpendicular to its plane by using torsional Pendulum
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee's method
4. To determine the mechanical equivalent of heat by given method
5. To determine the wavelength of the sodium light using Newton's rings
6. To determine the wavelength of sodium light using wedge-shaped method
7. To determine the wavelength of LASER light using diffraction grating and hence determine the particle size of lycopodium power
8. To determine the focal length of two lenses when they are separated by some finite distance
9. To determine the chromatic aberration of a convex lens between red and blue colors
10. To determine the capacitance of the given capacitor by the method of charging and discharging through resistor
11. To plot the graph between frequency and current in LCR series circuit and hence determine the quality factor of the circuit
12. To study the growth and decay of current in LR circuit then determine the self-inductance of the given inductor
13. To determine the dielectric constant of the given material

Final exam

Chapter	Hours	Marks Distribution*
1	6	6
2	3	4
3	8	7
4	17	17
5	8	9
6	6	5
7	6	6
8	6	6

References

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2. Pokharel, Bhattarai, and Paudel (2024). “Fundamentals of Engineering Physics”, Benchmark Publication.
3. Brij Lal and Subrahmanyam, (2001).‘’A text book of Optics”, S. Chand Publisher.
4. Basudeva, A.S. (2016). ‘Modern Engineering Physics”, S. Chand Publisher.
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6. Brij Lal and Subrahmanyam, (1985). ‘Waves and Oscillation”, S. Chand publisher.
7. Brij Lal and Subrahmanyam, (2001). ‘Heat and Thermodynamics”, S. Chand publisher
8. Avadhanulu, Kshirsaga and Arun Murthy, (2018). A text Book of Engineering Physics, S. Chand publisher.