Hall Ticket No | | | | | | | | | | | Question Paper Code: AHSB04

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech I Semester End Examinations(Regular) - December, 2019

Regulation: IARE – R18

WAVES AND OPTICS

Time: 3 Hours **(Common to AE | ME | ECE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Compare a particle with a wave and discuss about dual nature of radiation. **[7M]**
   (b) Describe the phenomena of photoelectric effect with experimental arrangement. **[7M]**
2. (a) Obtain the 3-dimensional, time independent Schrodinger's wave equation for an electron. **[7M]**
   (b) An electron is confined to a one dimensional potential box of length 2 A^0. Calculate the energies corresponding to the second and fourth quantum states. **[7M]**

UNIT – II

3. (a) Define a metallic solid and draw its band diagram to discuss its electronic behavior. Explain the origin of energy band formation in solids **[7M]**
   (b) Using Kronig-Penny model show that the energy spectrum of an electron contains a number of allowed energy bands separated by forbidden bands. **[7M]**
4. (a) Discuss in detail Hall effect and obtain an expression for Hall coefficient. Mention the uses of Hall effect. **[7M]**
   (b) Find the Hall voltage in a Si doped with 10^{23} phosphorous atoms per m^3. The Si sample is 100 µm thick with a current flow of 10^{-3} A for a magnetic field of 10^{-1} Wb/m^2. **[7M]**

UNIT – III

5. (a) What are the different types of lasers ? Describe construction and working of He-Ne laser. **[7M]**
   (b) Calculate the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 1.68eV. **[7M]**
6. (a) Why all the light rays incident on optical fiber cannot propagate through fiber? Obtain the maximum angle of acceptance of a step index fiber. **[7M]**
   (b) Calculate the fractional index change for a given optical fiber, if the refractive indices of the core and the cladding are 1.563 and 1.498 respectively. **[7M]**

UNIT – IV

7. (a) How Newton's rings are formed? Obtain the expressions for diameters of dark rings and bright rings. Why center spot of the newton rings always dark in reflected light **[7M]**

   (b) Newton's rings are observed in the reflected light of wavelength $5900A^o$. The diameter of fifth ring and tenth dark ring is 0.2 cm and 0.5 cm. Find the radius of curvature of the lens used. **[7M]**

8. (a) Explain construction and working of Michelson interferometer. Discuss about fringe pattern. **[7M]**

   (b) Two slits separated by a distance of 0.2 mm are illuminated by a monochromatic light of wavelength 550 nm. Calculate the fringe width on a screen at distance of 1 m from the slits. **[7M]**

UNIT – V

9. (a) What are the conditions for a particle to be in SHM. Distinguish between free and forced oscillations. **[7M]**

   (b) An oscillator is subjected to external periodic force and damping force proportional to its velocity. Set up differential equation of the oscillator. What is steady state solution to this differential equation. **[7M]**

10. (a) Explain diagrammatically, how are first three harmonics produced in a wire fixed at two ends and plucked. **[7M]**

    (b) A body of mass 0.05kg executes SHM. When the displacement from the center of motion is 0.04m, the force acting on the body is 0.018N. If the maximum velocity is 2m/s, find the amplitude. **[7M]**

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INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech II Semester End Examinations (Regular) - May, 2019

Regulation: IARE – R18

WAVES AND OPTICS

Time: 3 Hours **(Common to EEE | CE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Discuss the de-Broglie's hypothesis of duality of material particles. Describe Davisson and Germer's experiment to prove the existence of matter waves. **[7M]**
   (b) Calculate the wavelength associated with an electron having energy 2000 eV. **[7M]**
2. (a) Explain the concept of Black body radiation, Photoelectric effect and Compton effect. **[7M]**
   (b) Calculate the energies that can be possessed by a particle of mass 8.50 x10^{-31} kg which is placed in an infinite potential box of width 10^{-9}m. . **[7M]**

UNIT – II

3. (a) Define a semiconductor and draw its band diagram to explain its electronic behavior. Explain the origin of energy band formation in solids. **[7M]**
   (b) In Intrinsic semi conductor Si at 300 K, n_i= 2.4 x 10^{19} / m^3 and mobilities of electron and holes are 0.135 m^2/Vs and 0.048 m^2/Vs. Calculate conductivity of the sample. **[7M]**
4. (a) Distinguish between intrinsic and extrinsic semiconductors. Indicate on an energy level diagram, the conduction and valence bands, donor and acceptor levels for intrinsic and extrinsic semiconductors. **[7M]**
   (b) Calculate the density of charge carriers of semiconductor, given the Hall efficient is -6.85 $\times$ 10^{-5} m^3/Coulomb. **[7M]**

UNIT – III

5. (a) Outline the characteristics of laser. Explain construction and working of Ruby laser with neat diagrams. **[7M]**
   (b) Calculate the fractional index change for a given optical fiber if the refractive indices of the core and the cladding are 1.563 and 1.498 respectively. **[7M]**
6. (a) Define acceptance angle and numerical aperture. Deduce the expressions for acceptance angle and numerical aperture. **[7M]**
   (b) An optical fiber has refractive index of core and cladding 1.48 and 1.45 respectively. Find the acceptance angle in water which has refractive index of 1.33. **[7M]**

UNIT – IV

7. (a) Explain how Newton's rings are formed in reflected light. Derive an expression for diameters of bright and dark rings. **[7M]**

   (b) In Newton's rings system if the diameter of 4th and 6th dark rings are 3 mm and 3.6 mm, calculate the wavelength of the light used. The radius of curvature of the convex surface of the lens is 0.9 m. **[7M]**

8. (a) What is plane diffraction grating? Explain how it is used to determine the wavelength of a spectral line of a given source of light. **[7M]**

   (b) A plane diffraction grating has the value of grating constant equal to $15x10^{-4}$ cm. Calculate the position of the third order maximum for $\lambda = 2.4 \times 10^{-4}$ cm. **[7M]**

UNIT – V

9. (a) Define simple harmonic motion. Derive the equation of SHM. **[7M]**

   (b) A spring is stretched by 8 cm by a force of 10 N. Find the force constant. What will be the period of 4 kg mass suspended by it? **[7M]**

10. (a) Explain damped oscillation and forced oscillation. **[7M]**

    (b) A particle of mass 5 gm executes SHM and has amplitude of 8 cm. If it makes 16 vibrations per second, find its maximum velocity and energy at mean position. **[7M]**

Constants

Mass of Electron: 9.1×10^{-31} Kg

Mass of neutron: 1.676×10^{-27} Kg

Planck's constant: 6.625×10^{-34} joule-seconds

Velocity of light: 3×10^{8} m/s

Permittivity of free space: 8.85×10^{-12} F/m

Permeability of free space: $4\pi \times 10^{-7}$ N A^{-2}

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INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech I Semester End Examinations (Supplementary) - January, 2019

Regulation: IARE – R18

WAVES AND OPTICS

Time: 3 Hours **(Common to AE | ME | ECE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Considering dual nature of electron, Derive Schrodinger's time independent wave equation for the motion of an electron. **[7M]**

   (b) An electron is accelerated by a potential difference of 150V. what is the wavelength of that electron wave. **[7M]**

2. (a) Using Planck's and Einstein's theory of radiation, Show that the wavelength associated with an electron of mass 'm' and kinetic energy 'E' is given by $\frac{h}{\sqrt{2mE}}$. **[7M]**

   (b) Calculate the minimum energy of an electron that can possess in an infinitely deep potential well of width 4nm. **[7M]**

UNIT – II

3. (a) On the basis of band theory classify the solids into conductor, semiconductor and insulator.**[7M]**

   (b) Calculate Hall voltage developed across the width of the slab of a metallic slab carrying a current of 30A is subjected to a magnetic field of 1.75T. The magnetic field is perpendicular to the plane of the slab and to the current. The thickness of the slab is 0.35cm. The concentration of free electrons in the metal is 6.55 x 10^{28}electrons/m^3. . **[7M]**

4. (a) Describe an experimental setup for the measurement of hall voltage and give its applications. **[7M]**

   (b) Calculate the density of charge carriers of semiconductor, given the Hall coefficient is -6.85 × 10^{-5} m^3/Coulomb. **[7M]**

UNIT – III

5. (a) Explain the working of ruby laser with a neat diagram. Mention its advantages and disadvantages. **[7M]**

   (b) Calculate the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 1.44eV. **[7M]**

6. (a) With a neat diagram discuss principle and construction of optical fibre **[7M]**

   (b) An optical fibre has a core material of refractive index of 1.55 and cladding material of refractive index of 1.50. The light is lunched into in air. Calculate its numerical aperture. **[7M]**

UNIT – IV

7. (a) State and explain Huygens principle with a neat diagram. **[7M]**

   (b) Two slits 0.125mm apart are illuminated by a light of wavelength 4500 A°. The screen is 1m away, from the plane of the slit. Find the separation between 2nd bright fringe on both sides of the central maximum. **[7M]**

8. (a) What are Newton's rings and how are they formed ? Explain how Newton's rings setup can be used for the determination of wavelength of monochromatic source of light? **[7M]**

   (b) In a grating, which spectral line in 4th order will overlap with 3rd order line of 5419 A^0? **[7M]**

UNIT – V

9. (a) What is damped oscillation? Derive equation of motion for damped Oscillation. Discuss condition for over damped motion. **[7M]**

   (b) A body of mass 5 gms is subjected to an elastic force of 40 dyne/cm, and a frictional force of 5 dyne-sec/cm. If it is displaced through 2 cm and then released. Find whether the resulting motion is oscillatory or not? Also find the time period if it is oscillatory. **[7M]**

10. (a) Distinguish between free and forced oscillations. **[7M]**

    (b) The wave function for a light wave is given by E(z,t) = 103 sin π(3 x 10^6X - 9 x10^{14} t) Determine the speed, wavelength and frequency of the wave? **[7M]**

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INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech I Semester End Examinations (Regular) - November, 2018

Regulation: IARE – R18

WAVES AND OPTICS

Time: 3 Hours **(Common to AE | ME | ECE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Describe Davisson-Germer experiment to demonstrate the wave character of electrons. **[7M]**
   (b) What will be the KE of an electron if its de Broglie wavelength equals the wavelength of the yellow line of sodium 5896^0A. The rest mass of electron is $m_0 = 9.1\text{x}10^{-31}$kg and h = $6.63\text{x}10^{-34}$ J-s. **[7M]**

2. (a) Show that the energy of a particle enclosed in a rigid one dimensional infinite potential box is quantized. **[7M]**
   (b) Find the lowest energy that an electron (mass =9.1 x 10^{-31} Kg) can have if confined to move along the edge of an impenetrable box of length 4 x 10^{-10}m. **[7M]**

UNIT – II

3. (a) Discuss Kronig Penney model and hence show that the energy spectrum of an electron contains a number of allowed energy bands separated by forbidden bands **[7M]**
   (b) Draw Energy band diagram for conductor, semiconductor and insulator. **[7M]**

4. (a) What is Hall effect? Show that the Hall coefficient is $R_H = \frac{V_H t}{IB}$ **[7M]**
   (b) A silicon plate of thickness 1 mm, breadth 10mm and length 100mm is placed in a magnetic field of 0.5 Wb/m^2 acting perpendicular to its breadth. If 10^{-2} A current flows along its length. Calculate hall voltage developed. R_H = 3.66 x $10^{-4}m^3$/C. **[7M]**

UNIT – III

5. (a) With a neat diagram discuss construction, working and uses of He-Ne Laser. **[7M]**
   (b) Calculate the wavelength of emission from GaAs semiconductor laser whose band gap energy is 1.44 ev (Plank's constant is 6.625 x 10^{-34}Js and charge of an electron is 1.6 x 10^{-19} C.) **[7M]**

6. (a) Define numerical aperture. Derive an expression for acceptance angle of an optical fiber. **[7M]**

   (b) Discuss the classification of optical fiber based on the refractive index **[7M]**

UNIT – IV

7. (a) Derive an expression for fringe width from Young's double slit experiment. Show that fringe width of bright and dark fringe is equal. **[7M]**

   (b) In Young's double slit experiment a 2cm space on the screen placed at 200cm contains 20 fringes. Find the fringe width and slit separation if the wave length of light used is 5100^0A. **[7M]**

8. (a) Describe Fraunhofer diffraction due to a single slit and deduce the position of the maxima and minima. **[7M]**

   (b) Explain the construction and working of Michelson interferometer. **[7M]**

UNIT – V

9. (a) What is simple harmonic motion? Derive a relation for displacement, time period, velocity and acceleration of a particle executing simple harmonic motion. **[7M]**

   (b) Define damped harmonic oscillation? Derive wave equation for damped oscillation. **[7M]**

10. (a) What are transverse and longitudinal wave? Give one example of each. Discuss the terms associated with a wave **[7M]**

    i. Frequency
    ii. Time period
    iii. Wave length

    (b) The equation of certain traveling waves is y(x,t) = 0.0450 sin(25.12x - 37.68t - 0.523) where x and y are in meters, and t in seconds. **[7M]**

    Determine

    i. Amplitud
    ii. Wave number
    iii. Wavelength
    iv. Angular frequency
    v. Frequency
    vi. Phase angle

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