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F.E. Semester-I (Revised Course 2019-20)
EXAMINATION MARCH 2021
Physics

[Duration : Two Hours] **[Total Marks : 60]**

Instructions:
1. Answer THREE FULL QUESTIONS with ONE QUESTION FROM EACH PART.
2. **Assume** additional data, if required.
3. **Draw** diagrams **wherever** required.

Physical constants:

Planck's constant	=	6.626×10^{-34} J-s
Electron charge	=	1.6×10^{-19} C
Boltzmann's constant	=	1.38×10^{-23} J/K
Electron mass	=	9.1×10^{-31} kg
Rydberg constant	=	1.097×10^{7}/m
Velocity of light	=	3×10^{8} m/s

PART-A

1. a) Based on the band theory of solids distinguish between the different types of materials. Give two examples of each. **(5)**

   b) With neat ray diagram explain the experimental setup to determine wavelength of monochromatic light using Newton's Rings. **(5)**

   c) Explain diamagnetism. Give 4 properties of diamagnetic materials. **(5)**

   d) Calculate the velocity of ultrasonic waves in a liquid used in an acoustic diffraction experiment using the following data: **(5)**
   Wavelength of light used = 6328 Å
   Frequency of ultrasonic transducer = 200 MHz
   Angle of diffraction for 1st order maxima = 10°15'

2. a) Explain interference in wedge shaped film and hence derive expression for fringe width. Draw diagrams where necessary. **(5)**

   b) Explain the acoustic diffraction grating method to find velocity of ultrasonic waves in a liquid. **(5)**

   c) Define the term: Magnetizing field, magnetization, magnetic susceptibility, Magnetic **(5)**

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induction. Write their units.

d) What is drift current in a semiconductor? Calculate the concentration of acceptor atoms to produce p-type material with resistivity of 0.2 Ω-m and hole mobility of 0.14 m^2/V.s **(5)**

3. a) Derive an expression for conductivity of a semiconductor in terms of mobility of charge carriers. **(5)**

b) In Newton's Rings experiment the diameter of the 5^{th} and 20^{th} dark rings formed due to reflected light were measured as 0.3 cm and 0.6 cm respectively. What is the radius of curvature of the plano-convex lens if wavelength of light used in 6000 Å? What will the diameter of the 5^{th} ring change to if a liquid of a refractive index 1.33 is introduced between the lens and plate? **(5)**

c) Draw a neat block diagram of Cathode Ray Oscilloscope and explain its various sections. **(10)**

PART-B

4. a) With diagram explain four-level pumping scheme. What are its advantages? **(5)**

b) With neat diagrams explain the different types of optical fibres. **(5)**

c) Describe the Davisson-Germer experiment to prove that electrons behave like waves. **(5)**

d) Monochromatic X-rays of wavelength 1.54 Å are made to reflect from a crystal with interplanar spacing of 3.9 Å. Determine the highest order of reflection that can be observed with this radiation. Also calculate the 3^{rd} order glancing angle. **(5)**

5. a) Derive expression for acceptance angle of an optional fibre. What is acceptance cone? **(5)**

b) What is x-ray diffraction? Derive expression for Bragg's Law. **(5)**

c) Explain the process of stimulated emission of radiation and how it can be used for light amplification. **(5)**

d) A photon of wavelength 0.03 Å strikes an electron at rest and is scattered at an angle of 60° to the original direction. Find the wavelength of the scattered photon. Also calculate the Compton shift. **(5)**

6. a) With block diagram explain the use of optical fibres in communication. What are the advantages of optical fibres over copper wires for communication? **(5)**

b) The mode separation of a 5 mW He-Ne laser operating at 6328 Å is 1500 MhZ. What must be the length of the laser cavity to ensure that only one longitudinal mode **(5)**

oscillates. How many photons will be emitted from the laser in one second?

c) Using the theory of elastic collisions derive the expression for Compton shift. Show that the wavelength of modified component is greater than that of unmodified component. **(10)**

PART-C

7. a) Show that the diameter of dark rings in Newton's Rings for transmitted light is proportional to the square root of odd natural numbers. **(5)**

b) What is an optical resonator and why is it required in a laser? **(5)**

c) Explain the following applications of US waves: **(5)**
i) Detection of flaws in metal casting
ii) SONAR

d) Identify the target element used in the x-ray tube if the wavelength of the Kα line emitted is 1.55 Å. Take nuclear screening constant as unity. **(5)**

8. a) Give four points of difference between paramagnetic and ferromagnetic substances. Also give two examples of each. **(5)**

b) A step-index fibre in air has N.A. of 0.21, core R.I. of 1.54 and core diameter of 50μm. Determine the V-number for the fibre when light of wavelength 0.96 μm is transmitted. Also estimate the number of modes the fibre will support. **(5)**

c) With neat diagrams explain the construction and working of He-Ne laser. What are the advantages of He-Ne laser over ruby laser. **(10)**