National Institute of Technology Raipur

End Semester Examination, AUTUMN 2019

B. Tech. I Semester

Sub.: PHYSICS II (PH10I006PH)

CBCS SCHEME

Time: 3 Hrs. Max. Marks: 50

Q. 1 (a) An N-type Germanium sample has a donor density of 10^{21} m^{-3}. It is arranged in a Hall Effect experiment having B=0.5 Wb/m^2 and J= 500A/m^2. Find the Hall voltage, if the sample is 3 mm thick. **2**

(b) Mark the position of Fermi level in (i) an intrinsic semiconductor and (ii) an extrinsic (N and P both) semiconductor. **2**

(c) What is meant by density of states in a metal? **1**

Q. 2 (a) A Hartley oscillator is to span a frequency range from 50 kHz to 150 kHz. The variable capacitor has capacity in the range from 50 pF to 450 pF. If the feedback ratio L_2/L_1 is 0.01, find the values of inductances L_1 and L_2. Neglect the mutual inductance between the coils. **2**

(b) What are the important characteristics of an ideal operational amplifier? **2**

(c) State the Bark-Hausen's criterion for sustained oscillations. **1**

Q. 3 (a) Verify the divergence theorem for the function $\mathbf{F}= 2x^2y\hat{i} - y^2\hat{j} + 4xz^2k$ taken over the region in the first octant bounded by $y^2+z^2 = 9$ and $x = 2$. **7**

(b) Derive differential form of Faraday's law of electro-magnetic induction. Explain how Maxwell modified Ampere's law, and also explain its physical significance. **7**

(c) (i) State and derive equation of continuity. **3**

(ii) State and derive Stoke's Theorem. **3**

Q. 4 (a) How does the laser light differ from ordinary light? Explain the construction and working of a He-Ne laser using schematic diagram and energy levels involved. Why a narrow tube is used to construct a He-Ne laser? **7**

(b) What are the advantages of optical fibres over normal cable system? Derive an expression for the acceptance angle and numerical aperture of an optical fibre. **7**

(c) (i) In a laser system, there are only two energy states of atoms in which the energy difference is equivalent to the radiation of frequency (4.7×10^{14} Hz). Compare the number of atoms in these energy states at room temperature. **3**

(ii) The refractive index of the core material in a step-index fibre is 1.50 and the relative refractive index difference between the core and cladding materials of the fibre is 1.8%. Estimate (a) the numerical aperture and (b) the critical angle at the core cladding interface within the fibre. **3**