This question paper contains **4+2** printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **7807**

Unique Paper Code : **2511103** **F-1**

Name of the Paper : **Applied Physics [DC–1.2]**

Name of the Course : **B.Tech. Electronics**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all including Question No. **1** which is compulsory.

Use of non-programmable scientific calculator is allowed.

1. (*a*) A radio station operates at a frequency of 103.7 MHz with a power output of 200 kW. Determine the rate of emission of quanta from the radio station.

(*b*) Define the characteristic impedance of a string and obtain an expression for the same.

(*c*) Define 'entropy'. How is a phonon different from a photon ?

P.T.O.

(*d*) An electron is trapped in a one-dimensional infinite potential well of width 1 Å. Calculate the wavelength of the photon emitted when the electron makes a transition from a higher state of quantum number $n = 2$ to the lower state of quantum number $n = 1$.

(*e*) A perfectly elastic material is subjected to a tensile load. Show that the work done per unit volume is

$$W = 0.5 \text{ (stress) (strain).}$$ 5×3=15

2. (*a*) X-rays with $\lambda = 2.0$ Å are scattered from a carbon block. The scattered radiation is viewed 90° to the incident beam. Calculate :

(*i*) the wavelength of the scattered photon

(*ii*) the energy imparted to the recoiling electrons.

(*b*) What is the relation between probability density and wave function Ψ ? Obtain an expression for the momentum operator and energy operator starting from free particle wave function.

(*c*) Calculate the expectation value of position <x> and of the momentum $<p_x>$ of the particle trapped in one-dimensional box that is L wide. 5+4+6

3. (*a*) Plot the inter-atomic potential as a function of inter-atomic distance and discuss how it explains the concept of thermal expansion for any material with increase in temperature.

(*b*) Derive the value of specific heat at constant volume of any solid much above Debye's temperature.

(*c*) The universal gas constant is 8.3 J/mole/k. Calculate the value of specific heat at constant volume of any solid at temperature much above Debye's Temperature.

5+8+2

4. (*a*) A metal wire of length 50 cm and radius 5 mm is subjected to tensile force of 8000 N. Given Young's modulus of metal Y = 207 GPa and Poisson's Ratio = 0.3.

Find :

(*i*) Elongation and

(*ii*) Lateral contraction in the wire.

P.T.O.

(*b*) Define creep in a material. Plot strain versus time graph to discuss three stages of creep.

(*c*) A cylindrical specimen of steel having an original diameter of 13 mm is tensile tested to fracture and found to have engineering fracture stress $\sigma_f = 460$ MPa. If its cross-sectional diameter at fracture is 10.7 mm, determine :

(*i*) The ductility in terms of percent reduction in area;

(*ii*) True stress at fracture. 5+4+6

5. (*a*) Two simple harmonic vibrations are acting simultaneously on a particle in x-direction having equal frequencies and initial phases 30° and 60°, their corresponding amplitudes being 2 cm and 3 cm respectively. Find the resultant amplitude and phase. Write the corresponding equations of resultant SHM.

(*b*) Define group velocity and dispersion. Draw $\omega(k)$ versus k graph for no dispersion, normal dispersion and anomalous dispersion, where k is the wave number and ω is the angular frequency.

(*c*) Obtain the reflected and transmitted intensity coefficients of waves on a string at a boundary in terms of characteristic impedance of the string. Show that if the characteristic impedance of the string is the same across the boundary, then there is no reflection. 5+5+5

6. (*a*) Obtain the wave equation for the transverse wave on a string in one dimension.

(*b*) A gas expands by 1.2×10^{-3} m^3 at a constant pressure of 2.5×10^5 Pa. During the expansion 500 J of heat is added. Find the change in the internal energy of the gas.

(*c*) What is impedance matching ? Why is it necessary ? 5+5+5

7. (*a*) A particle of mass m is trapped between infinitely hard walls of a square well potential of width L and is restricted to move along X-axis only between x = 0 and x = L. Solve the Schrödinger equation to obtain eigen-functions and show that the eigen-values are discrete.

(*b*) Electrons with energy 1.0 eV are incident on a barrier that is 10.0 eV high and 1.0 nm wide. Find the probability that the electrons may tunnel through the barrier.

(*c*) What is more effective in preventing tunneling, the barrier potential height or the barrier width ? Justify your answer. 6+6+3

Relevant Physical Constants :

(1) Planck constant : $h = 6.6 \times 10^{-34}$ Js

(2) Rest mass of the electron $m_0 = 9.1 \times 10^{-31}$ kg

(3) Velocity of light $c = 3 \times 10^{8}$ m/s

(4) Charge on electron $e = 1.6 \times 10^{-19}$C