61502

Fifth Semester B.Sc. Degree Examination, March/April 2021

(CBCS Scheme – Freshers)

Physics

Paper VI — ASTROPHYSICS, SOLID STATE PHYSICS AND SEMICONDUCTOR PHYSICS

Time : 3 Hours] *[Max. Marks : 70*

Instructions to Candidates :

1) *Answer any five questions from each Part.*

2) *Non-programmable scientific calculators are allowed.*

PART – A

Answer any **FIVE** of the following. Each question carries **8** marks : **(5 × 8 = 40)**

1. (a) Define apparent magnitude and absolute magnitude of a star.

   (b) Derive an expression for the distance of a star in terms of its apparent and absolute magnitudes. **(2 + 6)**

2. Obtain an expression for the gravitational potential energy of a star based on linear density model. **(8)**

3. What is Compton effect? Derive an expression for Compton shift. **(8)**

4. (a) Define Fermi level and Fermi energy.

   (b) Obtain an expression for Fermi energy of an electron in metals at absolute zero based on free electron theory of metals. **(2 + 6)**

5. (a) Define :

   (i) The phenomenon of superconductivity

   (ii) Critical magnetic field

   (iii) Critical temperature

   (iv) Meissner's effect.

   (b) Give any four differences between Type-I and Type-II superconductors. **(4 + 4)**

6. (a) What are intrinsic semiconductors?

   (b) Derive an expression for the density of electrons in the conduction band of an intrinsic semiconductor. **(1 + 7)**

7. (a) Give any two differences between zener diode and ordinary diode.

   (b) With a neat circuit diagram explain the working of a zener diode as a voltage regulator and obtain an expression for the minimum value of series resistance. **(2 + 6)**

8. What is a transistor? With a neat circuit diagram explain the working of NPN transistor in CE mode as an amplifier. **(8)**

PART – B

Solve any **FIVE** of the following. Each problem carries **4** marks : **(5 × 4 = 20)**

9. A star has luminosity 10^4 times that of the sun with a surface temperature 2000 K. Find the radius of the star. Given : ($T_\odot$ = 6000 K and $R_\odot = 7 \times 10^8$ m).

10. Calculate the temperature and pressure of a star at a distance 4×10^8 m from its center. ($T_c = 20 \times 10^6$ K, $P_c = 1.08 \times 10^{15}$ Nm^{-2} and $R = 8 \times 10^8$ m)

11. The absolute magnitude of a white dwarf is 10 and its surface temperature is 12000 K. Compare its radius with that of Sun. Given absolute magnitude of Sun = 4.7 and its surface temperature = 6000 K.

12. The voltage applied to an X-ray tube is 60 kV. What is the minimum wavelength emitted? If this radiation is incident on a crystal of interplanar spacing 1.6 Å, what is the smallest angle at which Bragg reflection may be observed?

13. A copper slab of 0.5 m thick and 0.02 m wide carrying a current of 50 A is placed in a transverse magnetic field of 1.8T. Calculate the magnitude of hall voltage. (Free electron concentration in copper is 8.48×10^{28} m^{-3})

14. Calculate the current produced in a small Ge plate of area 10^{-4} m^2 and of thickness 0.2×10^{-3} m when a p.d. of 4 V is applied across the faces. (Concentration of free electrons in Ge is 2×10^{19} m^{-3}, mobilities of electrons and holes are 0.36 $m^2/V-S$ and 0.17 $m^2/V-S$ respectively)

15. For a transistor in CE mode $V_{CC} = 12$ V and $R_c = 5$ kΩ. Calculate the values of cutoff and saturation points to draw dc load line.

16. The *h*-parameters are $h_{ie} = 2$ kΩ, $h_{re} = 3 \times 10^{-4}$, $h_{fe} = 60$ and $h_{oe} = 30 \times 10^{-6}$ mho. Calculate the current gain and voltage gain. ($R_S = 1$ kΩ and $R_L = 2$ kΩ)

PART – C

Answer any **FIVE** of the following. Each question carries **2** marks : **(5 × 2 = 10)**

17. (a) Does more massive star has shorter life time? Explain.

(b) Can all stars have equal masses? Explain.

(c) Is neutron star a black hole? Explain.

(d) Is penetrating power of X-rays is greater than that of visible light? Explain.

(e) Is electrical conductivity of metals depend on temperature? Explain.

(f) Good conductors like copper and silver do not show superconductivity. Justify.

(g) The depletion region of a p-n junction diode becomes wide when it is reverse biased. Justify.

(h) The base of a transistor is very thin and lightly doped. Justify.

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