B.Sc. 4th Semester (Honours) Examination, 2023 (CBCS)

Subject : Physics

Course : CC-X

Time: 2 Hours **Full Marks: 40**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Group-A

1. Answer *any five* questions from the following: 2×5=10

(a) What is a hole in semiconductor? How does it move through a crystal?

(b) What are direct and indirect band gap semiconductors? Give example.

(c) The mobility of electron is Si at 300 K is 0·130 m^2/Vs Calculate the diffusion constant of electron.

(d) Write down the principle of a photo diode.

(e) The value of α of a transistor is 0·98. If it changes by 0·5% what would be the corresponding percentage change in the value of β?

(f) The power gain of an amplifier is 30 dB. If the input power is 1 mW, what is the output power?

(g) What do you mean by class A, class B and class C amplifiers?

(h) What is thermal runway in transistors and how can it be avoided?

Group-B

Answer *any two* questions from the following. 5×2=10

2. Explain the concept of diffusion and drift current in a semiconductor. Find the concentration of holes and electrons in a *p*-type germanium if the conductivity is $100\,(\Omega m)^{-1}$. [Given: $n_i = 2{\cdot}5\times10^{19}$ electrons/m^3, hole mobility $\mu_p = 0{\cdot}18\ m^2/Vs$] (1½+1½)+2

3. Draw a neat circuit diagram for the collector to base bias arrangement of an *n-p-n* transistor in CE mode. Obtain an expression for its stability factor. What is the advantage of this circuit? 1+3+1

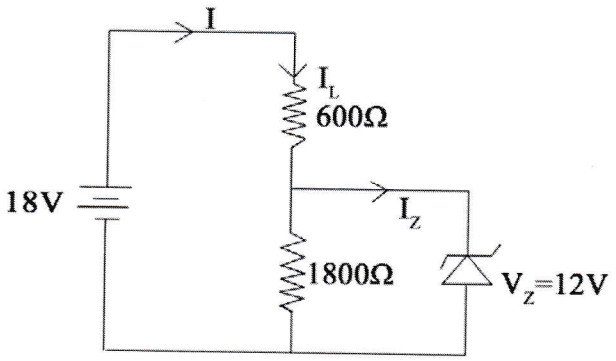
4. Define the four *h*-parameters used in an *h*-parameter equivalent circuit of a transistor. Which of them can be neglected in a simplified model and why? Why *h*-parameter model is not valid at high frequencies? 3+1+1

5. Draw a neat diagram of a two stage RC coupled transistor amplifier. Derive an expression for mid frequency voltage gain. What are the effects of coupling capacitor (C_C) and bypass capacitor (C_E) in the low frequency range? 1+3+1

Group-C

Answer *any two* questions from the following. 10×2=20

6. Draw the circuit diagram of a full wave rectifier with a resistive load, using junction diodes. Calculate the ripple factor. Does it give a perfect dc? What is a filter circuit? Using an ideal zener diode, determine whether the zener diode in the circuit is biased properly. If so, find I_Z and I_L. (1+4)+1+1+3



7. With proper diagram, show different current components in a *p-n-p* (or *n-p-n*) transistor under normal biasing condition. Draw the output characteristics of that transistor in CE configuration. Identify and explain different regions in the graph. What is Early effect? 3+2+4+1

8. Explain the concept of virtual ground in an OP-AMP. Is there a virtual ground in non-inverting mode of operation? Explain how an OP-APM can be used as an integrator.

   Consider an OP-AMP integrator circuit, with input resistance R = 100 kΩ, feedback capacitor C = 1μF and power supplies = ±12V. If input voltage 1 volt is applied at the input inverting terminal determine the nature of output. (2+1)+4+3

9. Describe the working principle of a feedback amplifier with the help of a block diagram. Derive an expression for overall transfer gain.

   State Barkhausen Criterion for oscillation.

   With a suitable diagram, explain the operation of an R–C phase shift oscillator.

   An RC amplifier has mid-frequency gain of 100 and bandwidth of 20kHz. If the amplifier is now provided with a negative feedback network with $|\beta| = 0{\cdot}02$, what will be the new bandwidth? (2+2)+1+4+1
