2023
B.A./B.Sc.
Third Semester
CORE – 7
PHYSICS
Course Code: PHC 3.31
(Analog Systems & Applications)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) Explain the working of forward biased and reverse biased PN junction using energy band diagrams. 6
   (b) Discuss the formation of *n* type semi-conductor and its energy band. 5
   (c) A silicon diode having a doping concentration of $N_A = 9\times10^{16}\ \text{cm}^{-3}$ on p-side and $N_D = 1\times10^{16}\ \text{cm}^{-3}$ on n-side is reverse biased with a total depletion width of 3 μm. Given that the permittivity of silicon is $1.04\times10^{-12}\ \text{F cm}^{-1}$, find the depletion width on the p-side and the maximum electric field in the depletion region. 3
2. (a) What is the difference between static and dynamic resistance of a PN junction diode? 4
   (b) A small concentration of minority is injected into a homogenous semiconductor crystal at one point. An electric field of 10 V cm^{-1} is applied across the crystal and this moves the minority carriers to a distance of 1 cm in 20 μ sec. Calculate the mobility (in $\text{cm}^2\ \text{V}^{-1}\text{s}^{-1}$). 4
   (c) Discuss I-V characteristics of a p-n junction diode and obtain an expression for its static and dynamic resistance from the diode equation. 6

UNIT–II

3. (a) Draw the common emitter characteristic using a p-n-p transistor. Explain the input and output characteristics. 2+4=6

   (b) What is a load line? Explain how a load line is plotted. What is the significance of points of interception of a load line with the curves of output characteristics? 1+2=3

   (c) In a centre tap full wave rectifier, each diode has a forward dynamic resistance $r = 10\,\Omega$ and load resistance $R_L = 1\text{k}\Omega$. The voltage across each half of the secondary winding is $220 \sin 314t$.
   Find: 5
   (i) the peak value of current
   (ii) the dc or average value of current
   (iii) the rms value of current
   (iv) the ripple factor
   (v) the rectification efficiency

4. (a) What do you mean by power dissipation and breakdown voltage range in Zener diode? 2

   (b) Draw the circuit diagram of a half wave rectifier and explain its working. Calculate the efficiency and value of ripple factor. 1+3+2+2=8

   (c) A transformer is applied with rms voltage of 230 V across a diode ($r = 500\Omega$) in a circuit of half wave rectifier. If the rated output current is 80 mA, calculate the regulation and fall in its efficiency with the use of full load. 4

UNIT–III

5. (a) Determine the current gain, input resistance and voltage gain of a Common Emitter transistor amplifier, in terms of *h*-parameters. 6

   (b) Show that the maximum collector efficiency in class A amplifier is 50% only. 4

   (c) The overall gain of an amplifier is 140, with negative feedback the gain gets reduced to 17.5. Find the fraction of the output that is fedback to the input? 4

6. (a) Draw the circuit diagram to explain the working of class B amplifier. 1+4=5

(b) A transistor amplifier in CE configuration couples a source of internal resistance 1 $k\Omega$ to a load of 20 $k\Omega$. Find the input and the output resistances if $h_{ie} = 1 k\Omega, h_{re} = 2.5 \times 10^{-4}, h_{fe} = 150$ and $\frac{1}{h_{oe}} = 40\ k\Omega$. 4

(c) Explain how the frequency response of two staged RC coupled transistor amplifier varies with low, mid and high frequency signal. 5

UNIT–IV

7. (a) What is the difference between closed loop and open loop gain? 3

(b) The frequency of a Hartley oscillator is to vary from 60 kHz to 120 kHz. The tunning capacitor can be changed from 100 pF to 400 pF. The transistor employed in the circuit has $h_{fe} = 90$ and $h_{re} = 0.2$. Find the values of the inductance, neglecting the mutual inductance between them. 4

(c) In a phase shift oscillator with $R_1 = R_2 = R_3 = 800\ k\Omega$ and $C_1 = C_2 = C_3 = 100$ pF, calculate the frequency of the oscillator. 2

(d) What is Barkhausen's criterion? Explain the basic requirements for a feedback amplifier to generate the oscillations. 1+4=5

8. (a) What is the principle of phase shift oscillator? Derive an expression for the frequency of oscillations and the conditions for sustained oscillations. 1+5+2=8

(b) Discuss the effect of input impedance for voltage-series and current-shunt feedback. 2+2=4

(c) Find the operating frequency of transistor Colpitts's oscillator if $C_1 = 0.001\ \mu F, C_2 = 0.01\ \mu F$ and $L = 15\ \mu F$. 2

UNIT–V

9. (a) Explain the operation of zero-crossing detector. 6

(b) Discuss the op-amp when it used as an inverting and non-inverting amplifier. 3+3=6

(c) For a given operational amplifier, CMMR $= 10^4$ and differential gain $= 10^4$. Determine common mode gain A_{CM} of the op-amp. 2

10. (a) Draw a neat diagram for 4-bit R-2R ladder and explain the operation of DAC. 2+4=6

(b) Calculate the output voltage of an op-amp summing amplifier for following sets of voltages and resistor. Use $R_f = 1\ \text{M}\Omega, V_1 = 1\ V$, $V_2 = 2V, V_3 = 3V, R_1 = 500\ \text{k}\Omega, R_2 = 1\ \text{M}\Omega, R_3 = 1\ \text{M}\Omega$. 4

(c) Determine the full-scale output and the percentage resolution for an 8-bit DAC having step size of 5 mV. 4