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3 (Sem-4/CBCS) PHY HC 3

2023

PHYSICS

(Honours Core)

Paper : PHY-HC-4036

(Analog Systems and Applications)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions as directed :

1×7=7

(i) The random motion of holes and free electrons due to thermal agitation is called _____. (Fill in the blank)

(ii) A photodiode is normally

(a) forward biased

(b) reverse biased

(c) emitting light

(d) neither forward nor reverse biased

(Choose the correct option)

Contd.

(iii) The voltage gain of a transistor connected in _____ arrangement is the highest.

- (a) common base
- (b) common collector
- (c) common emitter
- (d) None of the above

(Choose the correct option)

(iv) Which of the following amplifiers has the highest linearity and lowest distortion ?

- (a) Class A
- (b) Class B
- (c) Class C
- (d) Class AB

(Choose the correct option)

(v) In an RC phase-shift oscillator, the frequency determining elements are _____.

(Fill in the blank)

(vi) Negative feedback in an OP-Amp increases the input impedance and bandwidth.

(Write True or False)

(vii) A voltage follower has a voltage gain of _____.

(Fill in the blank)

2. Give short answers of the following questions : $2 \times 4 = 8$

(i) How are potential barrier and depletion region formed in a $p-n$ junction ?

(ii) Draw a capacitor filter circuit. How the value of capacitor is chosen in a shunt capacitor filter ?

(iii) In a CB transistor amplifier, if the collector current $I_C = 2 \text{ mA}$ and the base current $I_B = 0.04 \text{ mA}$, calculate the current amplification factors α and β respectively.

(iv) What are d.c and a.c load lines ? What do they specify ?

3. Answer the following questions : **(any three)**

$5 \times 3 = 15$

(i) Draw a fixed biased circuit. Derive the expression for its stability factor. Mention the disadvantage of this circuit.

$2 + 2 + 1 = 5$

(ii) State Barkhausen criterion for self-sustained oscillations. Explain the conditions that must be satisfied for a sinusoidal oscillators to produce steady oscillations. $2+3=5$

(iii) Write two advantages of negative feedback. The gain of an amplifier is 150. When negative feedback is applied, the voltage gain is reduced to 50.

(a) Determine the percentage of feedback. (b) If the gain of the amplifier with feedback is 80, calculate the gain of the amplifier without feedback.

$$2+1\frac{1}{2}+1\frac{1}{2}=5$$

(iv) Write down the characteristics of an ideal Op-Amp. With the help of a circuit diagram, describe the non-inverting Op-Amp with feedback. $2+3=5$

(v) Write short notes on : **(any one)**

(a) Fullwave bridge rectifier

(b) Class AB amplifier

4. Answer the following questions : **(any three)**

$$10 \times 3 = 30$$

(i) What are intrinsic and extrinsic semiconductors ? Define mobility of a charge carrier and mention its unit. Derive an expression for the conductivity of an extrinsic semiconductor in terms of the concentration n and P and the mobilities μ_n and μ_p . $2+2+6=10$

(ii) Draw the circuit diagram of a fullwave rectifier and calculate its ripple factor and efficiency.

A halfwave rectifier uses an internal resistance $r_f = 20 \Omega$. If the applied voltage is $V = 40 \sin \omega t$ and load resistance is 780Ω , then find —

(i) I_m , I_{dc} and I_{rms} ;

(ii) ac power input and dc power input. $(1+2+2)+(3+2)=10$

- (iii) State and explain the characteristics of CE transistor amplifier. What is meant by the leakage current in transistor ?

Show that $I_C = \beta I_B + I_{CBO}$, where

I_C , I_B and I_{CBO} are collector current, base current and collector to base leakage current respectively.

$$(1+2)+1+6=10$$

- (iv) Draw a neat diagram of two stage RC coupled transistor CE amplifier. Derive the expression for the voltage gain of RC coupled amplifier for high frequency range by drawing its ac equivalent circuit. What is half-power frequency ? Why it is called 3 db frequency ?

$$2+6+2=10$$

- (v) Explain how an OP-Amp can be used as (a) a summing amplifier, and (b) logarithmic amplifier.

A non-inverting amplifier has $R_1 = 20 \text{ k}\Omega$ and $R_f = 100 \text{ k}\Omega$. What would be the output voltage for an input voltage of 1 V if the power supply voltage is $\pm 12 \text{ V}$?

$$(4+4)+2=10$$

- (vi) Write short notes on : (any two)

$$5 \times 2 = 10$$

- (a) Colpitt's oscillator
(b) Analog to digital converter
(c) Wien bridge oscillator