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3 (Sem-4/CBCS) PHY HC 3

2025

PHYSICS

(Honours Core)

Paper : PHY-HC-4036

(Analog System 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 :
 $1 \times 7 = 7$

(i) In a $P-N$ junction with no external voltage, the electric field between acceptor and donor ion is called a

- (a) Peak
- (b) Barrier
- (c) Threshold
- (d) Path

(Choose the correct option)

(ii) A zener diode is specially designed to _____.

- (a) increase the forward current
- (b) enhance power dissipation
- (c) operate in the forward-biased region
- (d) operate in the reverse breakdown region

(Fill in the blank)

(iii) In a class-A amplifier, the transistor is biased in the active region, meaning it conducts current for the entire input signal cycle (360°).

(Write True or False)

(iv) The emitter-base junction of a transistor is _____ biased while the collector-base junction is _____ biased.

- (a) reverse, forward
- (b) reverse, reverse
- (c) forward, reverse
- (d) forward, forward

(Fill in the blanks)

(v) What happens to the bandwidth of an amplifier when negative feedback is applied ?

- (a) It decreases
 - (b) It increases
 - (c) It remains the same
 - (d) It fluctuates randomly
- (Choose the correct option)*

(vi) An inverting amplifier configuration has a gain of _____, where R_f is the feedback resistance and R_i is the input resistance.

(a) R_f / R_i

(b) $-R_f / R_i$

(c) R_i / R_f

(d) $-R_i / R_f$

(Fill in the blank)

(vii) Resolution of a DAC is equal to the weight of

- (a) LSB
- (b) MSB
- (c) 1 volt
- (d) 10 volt

(Choose the correct option)

2. Give short answer of the following questions :

2×4=8

- (i) What is ripple factor ? What is the value of ripple factor of a half-wave rectifier ?
- (ii) Explain Barkhausen's criterion for self-sustained oscillation.
- (iii) In a Common Base (CB) connection, current amplification factor is 0.9. If the emitter current is 1mA, determine the value of base current.
- (iv) Define CMRR of an OP-AMP. Express it in dB form.

3. Answer the following questions : (any three)

5×3=15

- (i) Explain the formation of barrier potential in P-N junction. What are static and dynamic resistance of a P-N junction diode ? 3+2=5
- (ii) Define *three* different modes of a bipolar junction transistor. Derive a relation between α and β . 3+2=5
- (iii) Write down the characteristics of an ideal OP-AMP. What do you mean by virtual ground in the OP-AMP ? Define the term Slew Rate. 2+2+1=5
- (iv) Draw the circuit diagram of an RC-phase-shift oscillator. Find an expression for the frequency of oscillation of it. 1+4=5
- (v) What is drift current in semiconductor ? In a full-wave rectifier with a resistive load of 500 ohms, the input signal is given by $50 \sin 100 \pi t$ Volts. Find the average output voltage and the average DC power output. 1+4=5

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

10×3=30

(i) Describe the working of a bridge full-wave rectifier. Find the expression for Peak Inverse Voltage (PIV), rectification efficiency and ripple factor. 4+6=10

(ii) Draw the Circuit diagram of a two-stage RC coupled amplifier and the h -parameter equivalent circuit for one stage. Obtain expression for voltage gain in the mid frequency, low frequency and high frequency range. An amplifier with a resistive load of 100 ohms has a voltage gain 40dB. If the input signal is 10 mV, find the output voltage and load power.

2+6+2=10

(iii) Discuss the effect of negative feedback on :

2+2+2+2+2=10

(a) Input impedance

(b) Output impedance

(c) Gain Stability

(d) Distortion and

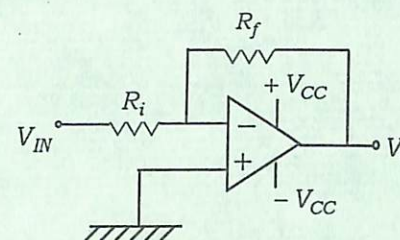
(e) Noise of an amplifier

(iv) Define h -parameters for a transistor in a CE-configuration. Derive the expression for its current gain, voltage gain, input impedance and power gain.

2+2+2+2+2=10

(v) What is an OP-AMP buffer ? Draw its circuit diagram. With the help of circuit diagram find the output voltage for integrator and differentiator amplifier. Calculate the output voltage for the circuit shown below, where $V_{IN} = 0.5$ volt, $R_i = 2.2k\Omega$ and $R_f = 22k\Omega$.

1+1+3+3+2=10



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

5×2=10

(a) Colpitts Oscillator

(b) De Load Line

(c) R- 2R Ladder

(d) Wien Bridge Oscillator