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 :

1×7=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 πt Volts. Find the average output voltage and the average DC power output.   1+4=5

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

$10 \times 3 = 30$

(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 $40 dB$. 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 $V_{iN} = 0 \cdot 5$ volt, $R_i = 2.2 k\Omega$ and $R_f = 22 k\Omega$.

$1+1+3+3+2=10$
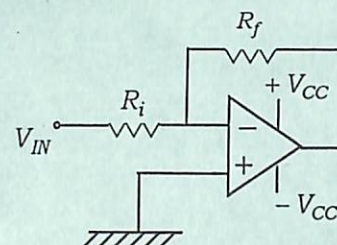
(vi) Write short notes on : *(any two)*

$5 \times 2 = 10$

(a) Colpitts Oscillator

(b) De Load Line

(c) $R-2R$ Ladder

(d) Wien Bridge Oscillator