# 2024

# 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) For a PN junction, barrier potential _____ with increase in junction temperature. *(Fill in the blank)*

(ii) Zener breakdown occurs in heavily-doped junction, whereas avalanche breakdown occurs in lightly-doped ones. *(Write True **or** False)*

(iii) LEDs emit light only when _____ biased. *(Fill in the blank)*

(iv) The leakage currents in a transistor are due to _____ carriers.

*(Fill in the blank)*

(v) Multistage amplifiers are used in order to achieve greater

(a) voltage gain

(b) power gain

(c) frequency response

(d) All of the above

*(Choose the correct option)*

(vi) For class A operation of an amplifier, Q-point is located at the ____ of the load line. *(Fill in the blank)*

(vii) The analog to digital converter are employed in

(a) voltmeter

(b) wattmeter

(c) energy meter

(d) digital multimeter

*(Choose the correct option)*

2. Give short answer of the following questions : 2×4=8

(i) Define ripple as referred to in a rectifier circuit. What is meant by filter ?

(ii) What does common-mode rejection ratio (CMRR) of a differential amplifier physically signify ? Express CMRR in dB form.

(iii) Draw a fixed-bias circuit of a transistor.

(iv) Explain the need for regulated power supply.

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

$5 \times 3 = 15$

(i) The signals applied to be inverting and non-inverting terminals of a differential amplifier are $-0.40\,mV$ and $-0.42\,mV$ respectively. If the differential gain and the CMRR are $10^5$ and $80\,dB$ respectively, find the total output voltage. 5

(ii) Explain with circuit diagram how an op-amp can be used as an adder or summing amplifier. 5

(iii) Define common-base current amplification factor $(\alpha)$ and common-emitter current amplification factor $(\beta)$. Derive the relation between them.

$2 + 3 = 5$

(iv) Using h-parameter, draw the two-generator form of the equivalent circuit. Define the four h-parameters. Why are the h-parameters very useful for circuit analysis ? $2 + 2 + 1 = 5$

(v) Write short notes on : $2\tfrac{1}{2} + 2\tfrac{1}{2} = 5$

(a) Zener diode

(b) Solar cell

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

$10 \times 3 = 30$

(i) Sketch the output characteristics of a transistor in its CB mode. Explain the active, cut-off and saturation regions.

A transistor in a CB mode, with $\alpha = 0.98$ gives a reverse saturation current $I_{CBO} = 12\,\mu A$. When used in a CE mode, it gives the base current of $0.2\,mA$. Calculate its total collector current in a CE mode. $6 + 4 = 10$

(ii) Draw circuit diagram of a full-wave bridge rectifier and explain its operation. What are its ripple factor, maximum rectification efficiency and peak inverse voltage ? $7 + 3 = 10$

*(iii)* Explain the term 'feedback'. What are positive and negative feedbacks ? Derive an expression for the voltage gain of an amplifier with feedback. Give the advantages of negative feedback.

2+2+3+3=10

*(iv)* Draw a circuit diagram of a single-stage CE transistor amplifier as well as its equivalent circuit. Derive the expressions for current gain and voltage gain of such an amplifier.

4+6=10

*(v)* With the help of a neat diagram, explain the working of a weighted registor DAC. What are its advantages and disadvantages ? Write any two major applications of D/A converters.

4+(2+2)+2=10

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

5×2=10

*(a)* RC phase-shift oscillator

*(b)* Hartley oscillator

*(c)* Logarithmic amplifier using OPAMP

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