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**3 (Sem-4/CBCS) PHY HC 3**

**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 :

$1 \times 7 = 7$

(i) For a PN junction, barrier potential  
\_\_\_\_\_ with increase in junction  
temperature. (Fill in the blank)

Contd.



(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 :

$2 \times 4 = 8$

(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)**

5×3=15

(i) The signals applied to be inverting and non-inverting terminals of a differential amplifier are  $-0.40\text{mV}$  and  $-0.42\text{mV}$  respectively. If the differential gain and the CMRR are  $10^5$  and  $80\text{dB}$  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:  $2\frac{1}{2}+2\frac{1}{2}=5$

(a) Zener diode

(b) Solar cell

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

10×3=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  $I_{CBO} = 12\mu\text{A}$ . When used in a CE mode, it gives the base current of  $0.2\text{mA}$ . 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 resistor 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*)

$$5 \times 2 = 10$$

- (a) RC phase-shift oscillator  
(b) Hartley oscillator  
(c) Logarithmic amplifier using OPAMP