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3 (Sem-4/CBCS) PHY HC3

2022

**PHYSICS**

(Honours)

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 **any seven** questions from the following : 1×7=7

(i) Resistivity of a semiconductor \_\_\_\_\_  
with increase in temperature.

*(Fill in the blank)*

(ii) Potential barrier across a p-n junction diode is due to accumulation of

(a) electrons

(b) opposite ions

(c) space charges

(d) holes *(Choose the correct option)*

Contd.

- (iii) Class-C amplifier produces the least efficiency but exhibits good linearity.

(Write True or False)

- (iv) RC-coupled amplifier is used for

- (a) current amplification
- (b) power amplification
- (c) voltage amplification
- (d) None of the above

(Choose the correct option)

- (v) In a transistor amplifier, lower value of the stability factor indicates the better stability of the quiescent point.

(Write True or False)

- (vi) Bandwidth of an amplifier increases by employing

- (a) positive feedback
- (b) all types of negative feedback
- (c) current-series positive feedback
- (d) voltage-series negative feedback

(Choose the correct option)

- (vii) In an op-amp the input stage is usually a \_\_\_\_\_ amplifier.

(Fill in the blank)

- (viii) If a sine wave is applied to the input of an op-amp differentiator circuit, the output would be a

- (a) cosine wave
- (b) triangular wave
- (c) square wave
- (d) pulse (Choose the correct option)

- (ix) Wien bridge oscillator is an audio frequency sine wave oscillator of high \_\_\_\_\_ .

(Fill in the blank)

- (x) Resolution of a DAC is equal to the weight of

- (a) LSB
- (b) MSB
- (c) 1 V
- (d) 15 V (Choose the correct option)

2. Answer **any four** questions :  $2 \times 4 = 8$

- (i) What is ripple factor? What is the value of ripple factor of a half-wave rectifier?

(ii) The current amplification factor of a transistor in common emitter configuration is  $\beta = 30$ . Calculate collector current  $I_C$  and emitter current  $I_E$  if the base current is  $I_B = 10 \mu A$ .

(iii) What is positive feedback? Why is positive feedback most commonly used in oscillator?

(iv) Define CMRR of an op-amp. Express it in dB form.

(v) In a non-inverting op-amp with  $R_1 = 1k\Omega$  and  $R_F = 100k\Omega$ , find the closed-loop voltage gain of the op-amp.

(vi) Draw the circuit diagram of a two-stage RC-coupled transistor CE amplifier.

(vii) Write the applications of Hartley and Colpitt oscillators.

(viii) What are the advantages of R-2R ladder DAC over weighted-resistor DAC?

3. Answer **any three** questions :  $5 \times 3 = 15$

(i) A full-wave rectifier with an applied voltage of  $400 \sin \omega t$  is centre-tapped with a load resistance of  $2k\Omega$ . If the resistance of the diodes are  $100 \Omega$  each, determine (a) peak value of current, (b) dc value of output current in the load, and (c) rectification efficiency of the rectifier.  $1+2+2=5$

(ii) What do you mean by class A, class B and class C amplifiers? Why is the efficiency of class B amplifier more than that of class A amplifier?  $3+2=5$

(iii) Derive the expression for the voltage gain of RC-coupled transistor amplifier for mid-frequency range.

(iv) Explain how an op-amp can be used as (i) a differentiator, and (ii) an integrator.

(v) Find the operating frequency of a Hartley oscillator if  $L_1 = 10 \mu H$ , mutual inductance between the coils  $M = 15 \mu H$ ,  $L_2 = 2mH$  and  $C = 10 \mu F$ . Find also the  $hFE$  value for sustained oscillations.

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

$$2+3=5$$

- (vii) The total linear distortion of an amplifier is reduced from 10% to 2% when 4% negative feedback is applied. Find voltage gain of the amplifier without feedback and with feedback.

- (viii) Write short notes on :

(a) Photodiode

(b) Light emitting diode

4. Answer **any three** questions :  $10 \times 3 = 30$

- (i) What are drift current and diffusion current in a semiconductor? How are the potential barrier and depletion region formed in a p-n junction? Derive the p-n diode equation for determining the current through the junction.

$$2+2+6=10$$

- (ii) Distinguish between Zener diode and ordinary p-n junction diode. Explain the action of Zener diode as voltage regulator with circuit diagram. Draw the V-I characteristic curve of a Zener diode.

$$2+6+2=10$$

- (iii) Draw the  $h$ -parameter equivalent circuit of a CE transistor amplifier and derive the expressions for its current gain, voltage gain, input impedance and power gain.

$$2+2+2+2+2=10$$

- (iv) What is transistor biasing? Discuss the fixed bias and self bias methods of transistor biasing. Calculate the stability factor of a fixed bias method. What are the disadvantages of a fixed bias method?

$$1+(3+3)+2+1=10$$

- (v) What is negative feedback? Discuss the effect of negative feedback on (a) input impedance, (b) output impedance, (c) non-linear distortion, and (d) noise of an amplifier.

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

- (vi) Draw the circuit diagram of an RC-phase shift oscillator and explain its operation. Find an expression for the frequency of oscillations and the condition of sustained oscillations.

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

(vii) What are inverting and non-inverting op-amps? With the help of a circuit diagram describe the inverting op-amp with feedback. Derive the expression for the closed loop voltage gain of this amplifier. What do you mean by virtual ground in this op-amp?

$$2+3+3+2=10$$

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

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