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3 (Sem-4/CBCS) PHY HC 3

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) 1V
- (d) 15V (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 $R_1 = 1 k\Omega$ and $R_F = 100 k\Omega$, 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 $2 \text{ k}\Omega$. If the resistance of the diodes are 100Ω 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 $L_1 = 10 \mu\text{H}$, mutual inductance between the coils $M = 15 \mu\text{H}$, $L_2 = 2 \text{ mH}$ and $C = 10 \mu\text{F}$. Find also the h_{FE} value for sustained oscillations.

(vi) Define common-base current amplification factor (α) and common emitter current amplification factor (β). Derive the relation between α and β .

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 : 10×3=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.

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

