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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 : $1 \times 7 = 7$

(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 : 2×4=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 $2 k\Omega$. 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 $L_1 = 10 \mu H$, mutual inductance between the coils $M = 15 \mu H$, $L_2 = 2 mH$ and $C = 10 \mu F$. Find also the hFE 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 : $10 \times 3 = 30$

(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.

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