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)*

(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 : 2×4=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 : 5×3=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 Ω 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 (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 registor DAC. What are its advantages and disadvantages? Write *any two* major applications of D/A converters.

4+(2+2)+2=10
