Total number of printed pages–9

63/1 (SEM–4) CC10/PHYHC4106

2025

PHYSICS

Paper : PHYHC4106

(Analog Systems and Applications)

Full Marks : 60

Pass Marks : 24

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer for following questions : ***(any five)*** 1×5=5

   (a) Depletion region is a zone that contains

   (i) electrons only

   (ii) holes only

   (iii) ions only

   (iv) both electrons and holes

(b) In a transistor biased in common emitter mode, the emitter current is

(i) nearly equal to the base current

(ii) much larger than base current

(iii) much smaller than the collector current

(iv) much smaller than the base current

(c) The ripple factor of a bridge rectifier is

(i) 1.21 (ii) 0.812

(iii) 0.482 (iv) 0.406

(d) The Voltage divider circuit is used in amplifiers, because it

(i) limits the ac signal going to the base

(ii) reduces the base current

(iii) makes the operating point independent of β

(iv) makes the circuit simple

(e) A multistage amplifier has two stages. The voltage gains of the stages are 10 and 20 respectively. Overall gain of the amplifier is

(i) 100 (ii) 150

(iii) 200 (iv) 250

(f) By introducing negative feedback in an amplifier there is increase in

(i) noise level

(ii) bandwidth

(iii) harmonic distortion

(iv) voltage gain

(g) An oscillator differs from an amplifier because it

(i) has more gain

(ii) requires no input signal

(iii) requires no d.c. supply

(iv) always has same input

(h) With zero volts on both the inputs, an ideal OPAM should have an output

(i) equal to CMRR

(ii) equal to the positive supply voltage

(iii) equal to the negative supply voltage

(iv) equal to zero

(i) The input stage of an OPAM is usually

(i) a differential amplifier

(ii) an integrator

(iii) CE amplifier

(iv) common mode amplifer

(j) The most popular type of DAC (Digital to Analog Converter) is

(i) R-2R ladder type

(ii) weighted resistor type

(iii) switch current source type

(iv) switch capacitor type

2. Answer ***any five*** of the following questions : 2×5=10

(a) Mention two differences between a photo-diode and solar cell.

(b) For a transistor, define DC load line and operating point. 1+1=2

(c) Sketch a neat circuit diagram of a RC phase-shift oscillator. How is the positive feedback realized in this oscillator ? 1+1=2

(d) Explain the concept of virtual ground in case of OPAM.

(e) An OPAM has a slew rate of 0.5 V/μs and peak output voltage of 100 mV. What is the maximum operating frequency of the OPAM ?

(f) How will you use an OPAM as an inverting adder ?

(g) What is an ADC ?

3. Answer the following questions : ***(any five)*** 5×5=25

(a) What are extrinsic and intrinsic semiconductors ? How are *n*-type and *p*-type semiconductors prepared ? 2+(1½+1½)=5

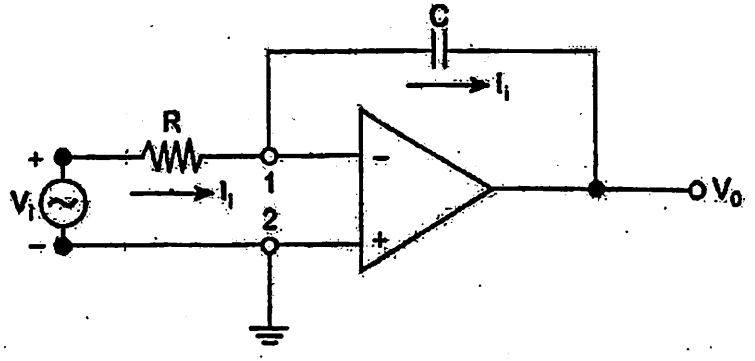
(b) Draw the circuit diagram of a full-wave rectifier and explain its operation. Obtain an expression for its rectification efficiency. 3+2=5

(c) Draw the circuits in common emitter, common base and common collector configurations for an NPN transistor with proper bias. A transistor is connected in common base configuration. If I_C = 1.9 mA and I_B = 0.05 mA, find the current amplification factor in common base and common emitter connection of this transistor. 3+2=5

(d) What are active region, situation region, and cut-off region in transistor operation ? Mark these regions in a diagram of output characteristics of common emitter transistor configuration. 3+2=5

(e) Draw the circuit diagram of a Hartley oscillator and explain its operation.

(f) In the following circuit, show that the output voltage is the integral of input voltage :



If a sinusoidal voltage V_i = 10 sin 2000 πt mV is applied to the input of an OPAM as a differentiator with C = 1 μF and R = 100 kΩ, what would be the output voltage ? 3+2=5

(g) Write a short note on either 'Zero Crossing Detector' or 'Wien Bridge Oscillator'.

(h) Explain mathematically why the gain of a RC-coupled amplifier decreases in low frequency region.

(i) Write down two advantages of negative feedback in an amplifier ? A transistor amplifier has a voltage gain of 100. The input resistance of the amplifier is 10 kΩ and the output reistance is 100Ω. The amplifier is provided with negative feedback with feedback fraction 0.1. Calcutta the voltage gain, input resistance and output resistance after application of negative feedback. 2+3=5

4. Answer ***any two*** of (a), (b), (c) and (d) : 10×2=20

(a) (i) Explain the working principle of an LED. Mention two advantages of LED lamps over conventional lamps. The band gap of Gallium Phosphide is 2.26 eV. Determine the wavelength and colour emitted by an LED made of this material. 2+2+2=6

(ii) Explain how stability is achieved in voltage divider bias with a proper circuit diagram. 4

(b) Draw the block diagram of a two-port four-terminal network and mention the voltage and current equations assuming a hybrid parameter model. Draw hybrid parameter equivalent model of a transistor in common emitter configuration and derive the expressions for its current gain, input impedance and voltage gain. 2+(2+2+2+2)=10

(c) (i) Draw the frequency response curve of a two-stage RC-coupled amplifier clearly showing the half power frequencies and width. Mention one advantage and one disadvantage of a RC-coupled amplifier. 2+2=4

(ii) Obtain the expresssion of voltage gain of an amplifier with positive feedback including proper block diagram. What is return difference ? 3+1=4

(iii) Find the operating frequency of a Colpitts Oscillator if $C_1 = 0.001\ \mu F$, $C_2 = 0.01\ \mu F$ and $L = 15\ \mu H$. 2

(d) (i) Explain the working of *p-n* junction in forward biased condition. Draw its V-I characteristics curve. What are static and dynamic resistances ? 3+1+2=6

(ii) Define mobility of a charge carrier. Obtain the conductivity expression for an extrinsic semiconductor. 2+2=4
