2022

B.A./B.Sc.

Fourth Semester

CORE – 10

PHYSICS

Course Code: PHC 4.31

(Analog Systems & Applications)

Total Mark: 70 *Pass Mark: 28*

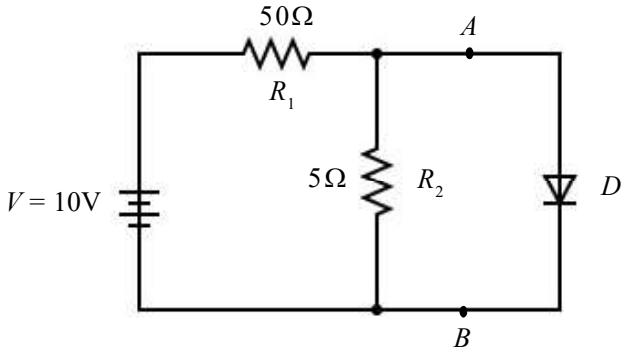
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) What is an intrinsic semiconductor? Show that, for pure semiconductor the conductivity is given by $\sigma_i = en_i\left(\mu_n + \mu_p\right)$, where symbols have their usual meanings. 5

   (b) Find the current through the diode in the circuit shown in the figure. Assume the diode to be ideal. 4



   (c) Show that for p-n junction diode, the electrostatic potential (V) across the barrier is given by $V\left(x\right) = -\int_{x_0}^{x} F dx$, where F is the barrier field. 5

2. (a) Prove that the dynamic resistance of p-n junction diode is given by $r_{ac} = \frac{dv}{di} = \frac{\eta}{39\left(I + I_s\right)}$, where the symbols have their usual meanings. 4

(b) The current flowing through a silicon p-n junction diode is 60 mA for a forward bias of 0.9 volt at a temperature $\left(V_{cf}\right)$ 300 K.

Determine the static resistance. 3

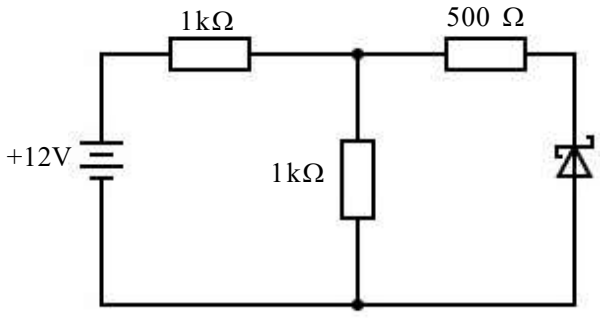
(c) The concentration of electrons n and holes p for an intrinsic semiconductor at a temperature T can be expressed as

$n = p = AT^{\frac{3}{2}} \exp\left(\frac{-E_g}{2K_B T}\right)$; where E_g is band gap and A is a constant. If the mobility of both type of carrier is proportional to $T^{\frac{-3}{2}}$, and logarithm of the conductivity is a linear function of $1/T$, find the slope of the linear equation. If the slope is 2/5, what is the band gap? 7

UNIT–II

3. (a) What is the basic difference between rectifier diode and Zener diode? Explain the use of Zener diode as a voltage regulator. 5

(b) In the circuit, the Zener diode has a breakdown voltage $V_Z = 3$ V. Find whether the power dissipated in the Zener diode exceeds the maximum power limit of 20 mW specified for it. 4



(c) Define ripple factor for a rectifier. Find the ripple factor of a rectifier with respect to the r.m.s. values of voltage and current. 5

4. (a) Define current amplification factors α and β. Prove that, for a transistor, $\beta = \frac{\alpha}{1-\alpha}$, where symbols have their usual meanings. 5

(b) Consider an n-p-n transistor in common base mode with base current $I_B = 0.05$ mA and reverse saturation current is 10 μA. If the DC current gain is 0.98, find the emitter current and collector current. 4

(c) Draw and explain the input and output characteristics of common emitter transistor. 5

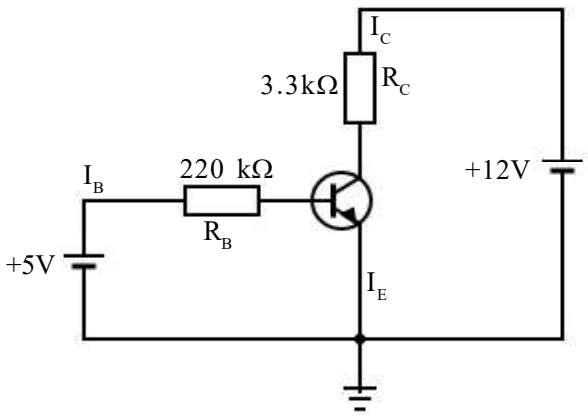
UNIT–III

5. (a) Explain briefly load and quiescent point for a transistor amplifier. Write down the factors determining the choice of quiescent point and its stability factors. What is thermal run away? 7

(b) Explain transistor as a two port device and find h-equivalent circuit. Determine the h-parameters from transistor characteristics. 7

6. (a) What do you mean by transconductance of a transistor? If the input impedance, forward current gain of a CB transistor are h_{ib} and h_{fb}, find the conversion formulae for the CE configuration. 7

(b) A silicon transistor having β = 1000 and $I_{CO} = 22$ nA is operated in the CE configuration. Assuming $V_{BE} = 0.7$ V, determine the transistor current and region of operation. What happens if the load resistance R_C is indefinitely increased? 7



UNIT–IV

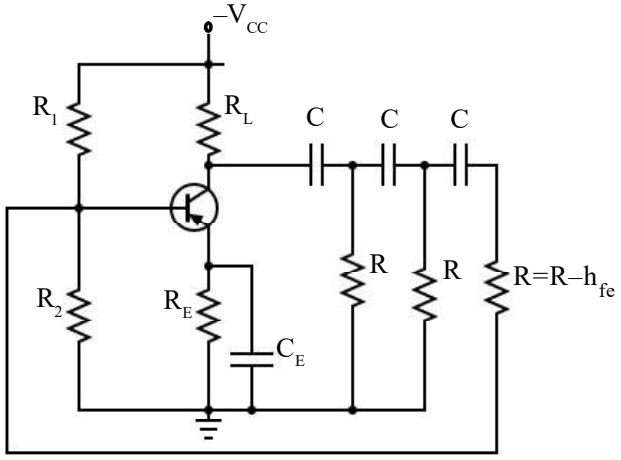
7. (a) What do you mean by feedback in amplifier? Mention different types of feedback networks. Find the expression for transfer gain of a voltage series feedback amplifier in CE configuration. 5

(b) Explain briefly the effect of negative feedback on the performance of an amplifier. 3

(c) Define transconductive and transresistive feedback fractions. Explain with mathematical expressions, how stability of gain can be increased by using negative feedback in electronic circuit? 6

8. (a) Define the Barkhausen criterion for sustained oscillations. Derive the condition for sustained oscillation and frequency of oscillation for Wien bridge oscillator. 7

(b) Find the frequency of oscillation for sustained oscillation for the given RC oscillator circuit. 7



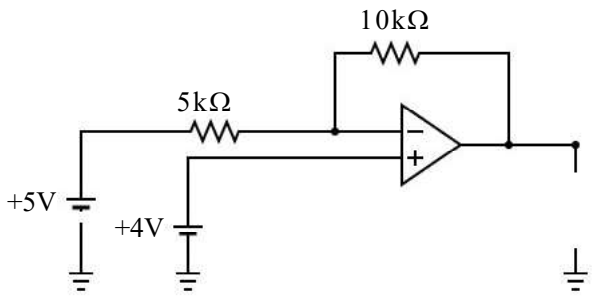
UNIT–V

9. (a) Write the characteristics of ideal and practical op-amps. What is CMRR? Find its expression. 4

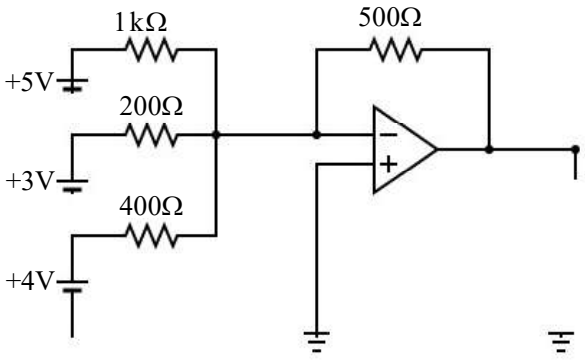
(b) Explain with proper diagram and expression, the use of op-amps as a differentiator. 4

(c) What is virtual ground for an op-amp circuit? Calculate the output voltage V_o for the following circuits. 6

(i)

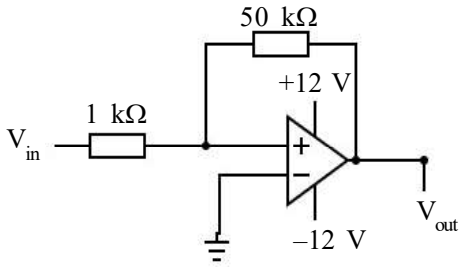


(ii)



10. (a) Define offset error voltage and current for an open loop op-amp. 2

(b) Compute the voltage gain for the op-amp as shown in the figure. Find the output voltage V_{out} if the input voltage is $V_{in} = 0.5 \sin(100\pi t)$. Draw the corresponding input and output signals. 7



(c) Find the output for the different stages of op-amp. 5