Ref. No.: Ex/ME(M2)/ES/B/ET/T/113/2022
B.E. MECHANICAL ENGINEERING FIRST YEAR FIRST SEMESTER - 2022
Subject: ELECTRONICS Time: 3Hrs Full Marks :100

Instructions: Use Separate Answer scripts for each Group / answer any five questions etc.

Different parts of the same question should be answered together.

Answer any **two(2)** from **(a), (b) and (c)**:

1. (a) i. Forbidden energy gap for silicon is _____.
ii. Semiconductors have _____ temperature coefficient of resistance.
iii. The conductivity of an intrinsic semiconductor _____ with temperature.
iv. The mobility of charge carriers has the unit _____.
v. Why intrinsic semiconductors behave like an insulator at low temperatures?
vi. Define diffusion current and drift velocity in a semiconductor. [1+1+1+1+3+3]

(b) i. An ideal diode offers _____ resistance when forward biased and _____ resistance when it is reverse biased.
ii. Draw and explain the VI characteristics of a PN junction diode. Write the volt-ampere equation for a PN diode (explain meaning of each symbol)
iii. What is forbidden energy gap? Explain.
iv. Draw the energy band diagram for a PN junction diode under open circuited condition.

[2+4+2+2]

(c) i. What is Fermi level? What happens to Fermi level when temperature is increased?
ii. Name the elements which are used as N-type impurities and P-type impurities.
iii. What do you mean by transition capacitance in PN-junction?
iv. What is meant by the term "Barrier potential"? What is the value for Germanium diode? [3+2+3+2]

Answer any **three(3)** from (a), (b), (c) and (d):

2. (a) i. Draw the circuit diagram of bridge rectifier and explain its operation.
ii. Discuss the working of full-wave rectifier circuit with shunt capacitor filter, give the output voltage waveform.
iii. Define clamper. [4+4+2]

(b) i. An n-channel depletion type MOSFET is operated in the pinch off region. If I_{DSS}=15mA and V_P=-4V, calculate I_D when : V_{GS}=-3V and V_{GS}=+2.5V.
ii. Compare depletion type MOSFET and enhancement type MOSFET.
iii. Draw and explain different operating regions in the drain characteristics of depletion type MOSFET. [3+2+5]

(c) i. Draw an emitter bias circuit and obtain the value of d.c. voltage and currents in the circuit.
ii. For a fixed bias circuit using silicon npn transistor, the value of β is 100. If V_{CC}=6V, R_C=2KΩ and R_B=530KΩ then determine its operating point.
iii. Define stability factor. [4+4+2]

(d) i. State whether the statement is true or false:
i.i In P-type semiconductor, the majority carriers are hole.
i.ii A full-wave rectifier utilizes only positive half cycle.
i.iii For a half-wave rectifier : PIV = $2V_m$.
i.iv A transistor can be treated as a two port network.
ii. Distinguish between zener breakdown and avalanche breakdown.

[Turn over

iii. What is I_{CBO} and I_{CEO}? Define thermal runway in BJT. [4+3+3]

Answer any **one(1)** from (a), (b) and (c) *in this block:*

3. (a) i. Define IC.
   ii. What is differential inputs and common inputs in op-amp?
   iii. Define slew rate.
   iv. Draw and explain the subtractor circuit using an op-amp. [2+2+2+4]

   (b) i. Write the properties of an ideal op-amp.
   ii. Explain virtual ground in an op-amp.
   iii. Draw the circuit diagram of an op-amp integrator and show that output voltage is an integration of the input voltage. [3+3+4]

Answer any **three(3)** from (a), (b), (c) and (d):

4. (a) i. Convert base of the following numbers:
   i.i. $(65.35)_{10} \equiv (?)_{16}$
   i.ii. $(7CA3)_{16} \equiv (?)_{10}$
   i.iv. $(1745.246)_8 \equiv (?)_{16}$
   ii. Obtain 2's complement of $(111010)_2$ and $(101011)_2$.
   iii. Subtract $(10010)_2$ from $(110101)_2$ and $(1001)_2$ from $(1101)_2$ (without converting base). [6+2+2]

   (b) i. State De-Morgan's theorem. Show its logic implementation.
   ii. Simplify the following Boolean expression:
   $f = \left(A + \overline{B}C\right) + \left(\overline{A + \overline{B}C}\right)$ and $f = AB + ABC + \overline{A}B + A\overline{B}C$ [4+6]

   (c) i. Realize the Boolean expressions using basic gates $f = \left(D\left(\overline{A} + B\right) + \overline{B}CD\right)$ and $f = \left(\overline{AB} + A + \overline{B + C}\right)$
   ii. Add $(48)_{10}$ and $(27)_{10}$ using BCD numbers.
   iii. Convert $(1001)_2$ to gray code and $(1100)_2$ gray code to binary code. [6+2+2]

   (d) i. Draw the symbols of universal gates. Write their truth table (for 2-input gate).
   ii. Realize AND, OR and X-OR using only NAND gates. [4+6]

Answer any **one(1)** from (a) and (b):

5. (a) i. Distinguish between combinational circuit and sequential circuits.
   ii. What is flip-flop?
   iii. Describe the working of SR flip-flop with circuit diagram and truth table. [3+3+4]

   (b) i. What is the difference between latch and flip-flop?
   ii. What is clock? What is the purpose of the clock signal?
   iii. Draw the circuit diagram of JK flip-flop.
   iv. What is race around in JK flip-flop? [2+3+2+3]