INTRODUCTION TO ELECTRONIC DEVICES AND CIRCUITS
(ECE1001)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The conductivity of semiconductors depends on
(a) number of current carriers present per unit volume
(b) the mobility of the current carriers
(c) both (a) and (b)
(d) none of the above

(ii) Reverse saturation current in a p-n junction diode
(a) does not depend on temperature
(b) becomes double with every 10° C temperature enhancement
(c) increases with temperature
(d) decreases with temperature

(iii) In a BJT with $\beta = 100$, α equals
(a) 99 (b) 0.99 (c) 1.0 (d) 1.01

(iv) The Q-point in a voltage amplifier is selected in the middle of the active region because
(a) It gives better stability
(b) The circuit needs a small dc voltage
(c) The biasing circuit then needs a smaller number of resistors
(d) It gives distortion less output.

(v) When emitter base junction is forward biased, and collector base junction is reverse biased in CB mode operation then the transistor operates in
(a) active (b) Saturation (c) Cut-off mode (d) None of the above

(vi) The polarity of voltage that is not applied to the gate terminal of p-channel JFET is
(a) negative (b) positive (c) zero (d) none of the above

(vii) MOSFET uses the electric field of
(a) gate capacitance to control the channel current
(b) barrier potential of p-n junction to control the channel current
(c) both (a) and (b)
(d) none of these

(viii) An inverting OP-AMP with feedback resistance, R_f and an input resistance,R_1 connected to the inverting terminal has a gain
(a) $1+R_f/R_1$ (b) $-(1+R_f/R_1)$
(c) R_f/R_1 (d) $-R_f/R_1$

(ix) For an ideal OP-AMP which of the following statement is correct?
(a) Zero input impedance and infinite bandwidth
(b) Infinite input impedance and infinite bandwidth
(c) Zero input impedance and zero bandwidth
(d) Zero input impedance and zero output impedance

(x) What would be the value of feedback voltage in a negative feedback amplifier with A=100; β =0.03 and input signal voltage = 40mv?
(a) 0.03V (b) 0.06V
(c) 0.09V (d) 0.12V

Fill in the blanks with the correct word

(xi) The ripple factor value for a full-wave rectifier is____.

(xii) If α=0.95 then the value of β of the transistor is _____.

(xiii) The depletion voltage of p-channel depletion type MOSFET is of _____ sign.

(xiv) A non-inverting OP-AMP with feedback resistance, R_f and an input resistance, R_1 connected to the inverting terminal has a gain _____.

(xv) In an OP-AMP, the input impedance is_____.

Group - B

2. (a) Explain the difference among metal, insulator and semiconductor with proper band diagram. *[(CO1)(Understand/LOCQ)]*
(b) The reverse saturation current at 300K of a p-n junction Ge diode is 5 μA. Find the voltage to be applied across the junction to obtain a forward current of 50 mA. *[(CO2)(Analyse/IOCQ)]*
(c) Explain current voltage characteristic of a p-n junction diode with a proper diagram. *[(CO3)(Understand/LOCQ)]*

4 + 4 + 4 = 12

3. (a) Draw and explain the operation of a full-wave rectifier circuit with proper circuit diagram and waveforms. *[(CO3)(Remember/LOCQ)]*
(b) Derive the ripple factor and rectification efficiency of simple full-wave diode rectifier circuit. *[(CO3)(Analyse/IOCQ)]*

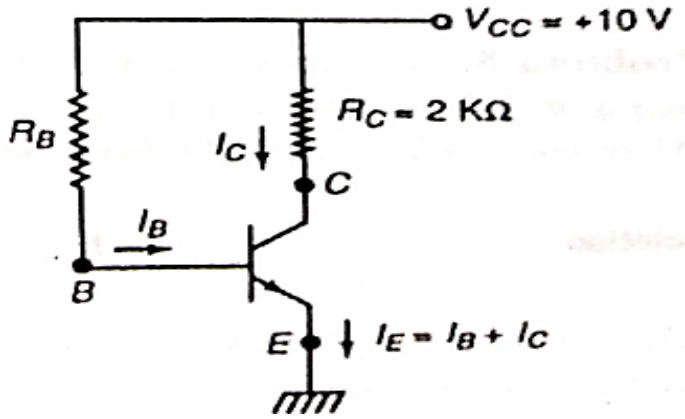
6 + 6 = 12

Group - C

4. (a) Explain Thermal Runaway. *[(CO4)(Understand/IOCQ)]*
   (b) Explain base width modulation and its effects. *[(CO4)(Understand/LOCQ)]*
   (c) 'Two diode connected back to back does not form a transistor.' Explain. *[(CO4)(Understand/LOCQ)]*
   (d) Derive the relation between α and β. A n-p-n BJT has α = 0.99 and reverse saturation current I_{CEO}= 100μA. If the base current is 10μA, calculate the emitter current and collector current. *[(CO4)(Apply/IOCQ)]*

2 + 3 + 2 + 5 = 12

5. (a) Assuming β =100, V_{BE}=0.7V, R_B= 500kΩ, Calculate I_C, I_B, V_{CE} for the following amplifier circuit. *[(CO6)(Evaluate/HOCQ)]*



   (b) Draw the energy band diagram of a p-n-p transistor with proper biasing. *[(CO4)(Remember/LOCQ)]*
   (c) Mention the factors responsible for the stability of Q-point. Why BJT is called bipolar device? *[(CO4)(Understand/LOCQ)]*

6 + 3 + 3 = 12

Group - D

6. (a) Describe the working principle of n-channel JFET along with relevant circuit diagram. *[(CO5)(Analyze/IOCQ)]*
   (b) The drain current of a JFET is about 5mA. When I_{DSS} is equal to 10mA and V_p=-5V. Determine the value of V_{GS}. *[(CO5)(Understand/LOCQ)]*
   (c) Mention the differences between BJT and FET. *[(CO5)(Remember/LOCQ)]*

6 + 3 + 3 = 12

7. (a) Find the transconductance by assuming the reverse gate voltage of a JFET changes from 5.0V to 4.9V and the drain current changes from 1.2mA to 1.5mA. *[(CO5)(Analyze/IOCQ)]*
   (b) Prove that $g_m = g_{m0}\left(1 - \frac{V_{GS}}{V_P}\right)$, where symbols have their usual meanings. *[(CO5)(Analyze/IOCQ)]*
   (c) An n-channel JFET has I_{DSS} =10mA and V_p=-4V. Determine the minimum value of V_{DS} for pinch off region and drain current I_D for V_{GS}=-2V in pinch off region. *[(CO5)(Remember/LOCQ)]*

(d) Mention differences between depletion type and enhancement type of MOSFET. *[(CO5)(Remember/LOCQ)]*

2 + 4 + 4 + 2 = 12

Group - E

8. (a) Explain the operation of an OP-AMP as an integrator with proper circuit diagram. *[(CO6)(Remember/LOCQ)]*

(b) Explain virtual ground in OP-AMP. *[(CO6)(Understand/LOCQ)]*

(c) Explain Barkhausen criteria. *[(CO6)(Remember/LOCQ)]*

(d) Sketch the output waveform of an OP-AMP differentiator with a triangular input. Justify your answer. *[(CO6)(Apply/IOCQ)]*

3 + 3 + 3 + 3 = 12

9. (a) Design a circuit to obtain $V_{out}=-2V_1+3V_2+4V_3$, using an OP-AMP, where V_1, V_2, V_3 are the input voltages taking minimum value of resistance as 10kΩ. *[(CO6)(Create/HOCQ)]*

(b) Explain the characteristics of an ideal OP-AMP. *[(CO6)(Remember/LOCQ)]*

(c) Explain the significance of negative feedback on high-gain amplifiers. *[(CO6)(Remember/LOCQ)]*

6 + 4 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	54.17	33.33	12.5