INTRODUCTION TO ELECTRONICS DEVICES AND CIRCUITS
(ECE 1001)

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) An electron in the conduction band
(a) is bound to its parent atom
(b) has no charge
(c) is located near the top of the crystal
(d) has a higher energy than an electron in the valence band.

(ii) If both junction of transistor operated in forward bias, then transistor operated in
(a) cut off region (b) active region
(c) inverted region (d) saturation region.

(iii) 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.

(iv) Current flow in a semiconductor depends on the phenomenon of
(a) drift (b) diffusion (c) recombination (d) all of the above.

(v) Mobility of the charge carrier is given by
(a) v/E (b) E/v (c) D_n (d) D_p.

(vi) Avalanche breakdown primarily depends on the phenomenon of
(a) ionization (b) doping (c) collision (d) recombination.

(vii) Ripple factor of a full wave rectifier without filter will be
(a) 0.2 (b) 0.48 (c) 0.24 (d) 1.21.

(viii) The correct relation between β and α is
(a) $\beta = \alpha/(1+\alpha)$ (b) $\beta = (1+\alpha)/\alpha$ (c) $\beta = \alpha/(1-\alpha)$ (d) $\alpha = 1+\alpha$.

(ix) 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) $-R_f/R_1$

(x) The change of the effective base width by the collector voltage is termed
(a) punch-through (b) early effect
(c) thermal runaway (d) none of these.

Fill in the blanks with the correct word

(xi) The semiconductors containing donor type impurities are referred to as _____ .

(xii) The peak inverse voltage is _____to which the diode is subjected when it is non conducting..

(xiii) On increasing the temperature of extrinsic semiconductor, it behaves as _____.

(xiv) In a BJT, if $\beta = 100$ and collector current, I_C is 10 mA, then emitter current, I_E is_____.

(xv) The field effect transistor is a _____ controlled device.

Group - B

2. (a) Draw and explain the difference between metal, insulator and semiconductor with proper band diagram. *[(CO1)(Analyse/IOCQ)]*
(b) Define Fermi energy at 0K. What is Fermi level for a finite non zero temperature? *[(CO1)(Understand/LOCQ)]*
(c) Find the conductivity and resistivity of an intrinsic semiconductor at a temperature of 300^0K. It is given that ni = 2.5 x $10^{13}/cm^3$, μ_n = 3800 $cm^2/(V.s.)$, μ_p = 1800 $cm^2/(V.s.)$, q=1.6x10^{-19} C. *[(CO1)(Apply/IOCQ)]*

4 + (2 + 2) + 4 = 12

3. (a) Explain the V-I characteristics of pn junction diode in both forward and reverse bias with a neat diagram. *[(CO2)(Understand/LOCQ)]*
(b) Differentiate between avalanche breakdown and Zener breakdown in pn junction diode. *[(CO2)(Analyze/IOCQ)]*
(c) A half-wave rectifier with a diode having forward resistance 20 ohm, is fed with a sinuisoidal voltage of 40V(amplitude) and frequency 50 Hz. The load resistance is 200 ohm. Evaluate (i) dc load current (ii) dc power output (iii) ripple voltage across load resistance. *[(CO3)(Apply/IOCQ)]*

(2 + 2) + 4 + 4 = 12

Group - C

4. (a) What is a load line of transistor. Explain its significance. *[(CO4)(Analyse/IOCQ)]*
(b) What is early effect? *[(CO4)(Remember/LOCQ)]*
(c) Draw and explain the biasing of a n-p-n transistor with proper circuit diagram. *[(CO4)(Apply/IOCQ)]*

(2 + 2) + 2 + 6 = 12

5. (a) Draw and explain the output characteristics of a CE n-p-n transistor. Also, indicate the active, saturation and the cut off regions in it. *[(CO3)(Analyse/IOCQ)]*

(b) A transistor is operating in CE mode as shown in the Fig. 1. Calculate V_{CE} if β= 125. Assuming V_{BE}=0.6 V. *[(CO4)(Evaluate/HOCQ)]*

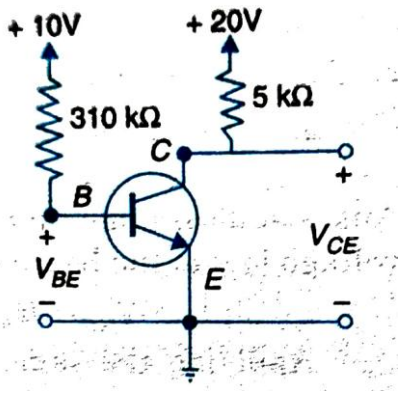

Fig. 1

6 + 6 = 12

Group - D

6. (a) Define transconductance and amplification factor of JFET. *[(CO5)(Remember/LOCQ)]*

(b) Derive the relation of $g_m=g_{mo}(1-V_{GS}/V_P)$. *[(CO5)(Analyse/IOCQ)]*

(c) As V_{GS} changed from -1V to -1.5V keeping V_{DS} constant, I_D of a FET drop 7 to 5 mA. What is the transconductance of the FET. *[(CO5)(Apply/IOCQ)]*

(2 + 2) + 4 + 4 = 12

7. (a) Sketch the transfer characteristics and drain characteristics of an n-channel JFET. *[(CO5)(Understand/LOCQ)]*

(b) Explain the operation of an n-channel enhancement type MOSFET. *[(CO5)(Understand/LOCQ)*

(c) Given for a JFET, I_{DSS}=9 mA and V_P= -2.5V, determine I_D when (i) V_{GS}=0V and (ii) V_{GS}= -2V. *[(CO5) (Analyze/IOCQ)]*

4 + 5 + 3 = 12

Group - E

8. (a) Explain the effects of negative feedback in a system. *[(CO6)(Understand/LOCQ)]*

(b) Derive the expression for voltage gain for the circuit given in the Fig. 2 below (assuming ideal OP-AMP conditions).

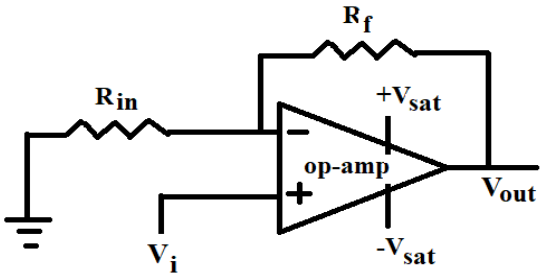

Fig. 2

[(CO6)(Analyse/IOCQ)]

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

4 + 5 + 3 = 12

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

(b) An inverting OP-AMP circuit has an input resistance of 10 Ω and a feedback resistance of 50 Ω. Draw the circuit and calculate the gain of OP-AMP. *[(CO6)(Evaluate/HOCQ)]*

(c) Given a summing amplifier designed using inverting OP-AMP with feedback resistance, R_f=12 kΩ. The output voltage obtained from the summing amplifier is given as, V_{out}=-(2V_1+3V_2+4V_3), where V_1, V_2, V_3 are the input voltages as indicated in Fig. 3 below. Evaluate R_1, R_2, R_3.

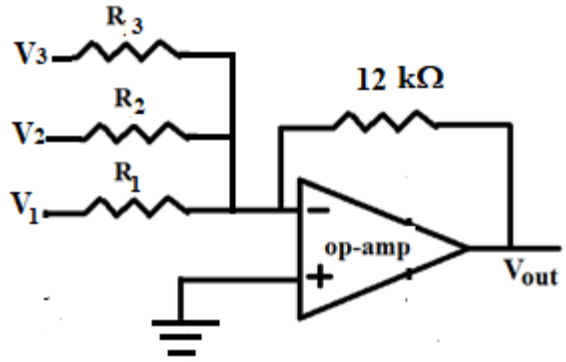

Fig. 3

[(CO6)(Evaluate /HOCQ)]

(2 + 3) + 3 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.46	50	13.54

Course Outcome (CO):

After going through this course, the students will be able to:

1. Categorize different semiconductor materials based on their energy bands and analyze the change in characteristics of those materials due to different types of doping.
2. Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode.
3. Design different application specific circuits using diodes.
4. Analyze various biasing configurations of Bipolar Junction Transistor.
5. Categorize different field-effect transistors and analyze their behavior.
6. Design and implement various practical electronic circuits.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*