BASIC ELECTRONICS
(ECEN 1011)

Time Allotted : 3 hrs.   **Full Marks : 70**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.*

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

    (i)   Semiconductors have
           (a) Zero Temperature Coefficient of Resistance
           (b) Positive Temperature Coefficient of Resistance
           (c) Negative Temperature Coefficient of Resistance
           (d) None of the above.

    (ii)   Avalanche breakdown is primarily dependent on the phenomenon of
           (a) Collision   (b) Doping
           (c) Ionization   (d) Recombination.

    (iii)   Reverse saturation current in silicon PN junction diode nearly doubles for every
           (a) 20°C rise in temperature   (b) 50°C rise in temperature
           (c) 60°C rise in temperature   (d) 10°C rise in temperature.

    (iv)   The Fermi level of an n-type semiconductor lies
           (a) near the conduction band-edge
           (b) near the valence band-edge
           (c) in the middle of the forbidden gap
           (d) none of these.

    (v)   What is the maximum efficiency of a half wave rectifier?
           (a) 81.2%   (b) 50%   (c) 20.3%   (d) 40.6%

    (vi)   The doping of the emitter region of a transistor is ____ that of the base region
           (a) greater than   (b) equals to   (c) less than   (d) none of these

    (vii)   The JFET is
           (a) a unipolar device   (b) a voltage-controlled device
           (c) a current controlled device   (d) both (a) and (b)

(viii) A sinusoidal signal applied to the inverting terminal of an op-amp will experience at the output terminal, a phase shift of
(a) 270°   (b) 90°   (c) 180°   (d) 0°.

(ix) The feedback must be _____ and the loop gain must be _____ for oscillations in a feedback amplifier
(a) positive, unity   (b) negative, unity
(c) zero, unity   (d) zero, zero

(x) In an integrator, the feedback element is a
(a) Resistor   (b) Capacitor
(c) Zener diode   (d) p-n junction diode.

Group – B

2. (a) Explain the difference between a metal, an insulator and a semiconductor.
[(CO1)(Understand/LOCQ)]
(b) Explain with a circuit diagram the use of a zener diode as a voltage reference diode. *[(CO1,CO2)(Analyze/IOCQ)]*
(c) Show the circuit diagram for both forward bias and reverse bias p-n junction diode (only drawing). Draw the V-I characteristic curve for both forward bias and reverse bias p-n junction diode. *[(CO1,CO2)(Analyze/IOCQ)]*
4 + 4 + 4 = 12

3. (a) Explain the working principle of a full wave rectifier with the help of a circuit diagram and relevant waveforms. *[(CO1,CO2)(Analyze/IOCQ)]*
(b) What are the differences between half wave and full wave rectifiers?
[(CO3)(Understand/LOCQ)]
(c) A diode having forward resistance of 50 Ω supplies power to a load resistance 1200 Ω from a 20 V (rms) source. Calculate the dc load current and the dc output power. *[(CO3)(Evaluate/HOCQ)]*
4 + 4 + 4 = 12

Group – C

4. (a) Draw the output characteristics of an n-p-n transistor in CE mode showing different regions of operation. *[(CO4)(Analyze/IOCQ)]*
(b) Why BJT is a bipolar device and why it is a current control device.
[(CO4)(Remember/LOCQ)]
(c) A transistor having $\alpha = 0.975$ and a reverse saturation current $I_{CO} = 10uA$, is operated in CE configuration. What is β for the configuration? If the base current is 250 uA, calculate the collector current. *[(CO4)(Evaluate/HOCQ)]*
4 + 4 + 4 = 12

5. (a) What is base width modulation for a transistor? *[(CO4)(Understand/LOCQ)]*
(b) What is the need for biasing in transistor? Define stability factors in BJT.
[(CO4)(Analyze/IOCQ)]

(c)   What is thermal runaway for BJT and how it can be prevented?

[(CO4)(Analyze/IOCQ)]

3 + (2 + 3) + 4 = 12

Group – D

6. (a)   What is the significance of the term field-effect transistor? Why the field - effect transistor is called a unipolar transistor? *[(CO5)(Understand/LOCQ)]*

    (b)   When is the channel of a JFET said to be pinched off? *[(CO5) (Analyze/IOCQ)]*

    (c)   The pinch off voltage of a p-channel JFET is V_p=5V, and I_{DSS}= -40mA. The Drain – source voltage V_{DS} is such that the a saturation drain current I_{DS} =-15mA is maintained. Find the gate-source voltage V_{GS}. *[(CO5)(Evaluate/HOCQ)]*

4 + 4 + 4 = 12

7. (a)   Explain with a diagram the structure of an n-channel Enhancement Type MOSFET. *[(CO5)(Understand/LOCQ)]*

    (b)   What is the constructional difference between enhancement and depletion type MOSFET? *[(CO5)(Analyze/IOCQ)]*

    (c)   Draw the drain characteristics of an n-channel MOSFET operated in both enhancement and depletion modes. *[(CO5)(Analyze/IOCQ)]*

5 + 3 + 4 = 12

Group – E

8. (a)   What is the Criteria of Oscillation (or Barkhausen Criterion).

[(CO6)(Remember/LOCQ)]

    (b)   State the merits and demerits of negative feedback over positive feedback?

[(CO6)(Analyze/IOCQ)]

    (c)   An amplifier has a voltage gain of 1000. The feedback ratio is 0.01. Find (i) the voltage gain with feedback, (ii) the amount of feedback in dB, (iii) the output voltage of the feedback amplifier for an input voltage of 40 mV, (iv) the feedback factor and (v) the feedback voltage. *[(CO6)(Evaluate/HOCQ)]*

3 + 4 + 5 = 12

9. (a)   State the characteristics of ideal operational amplifier. *[(CO6)(Remember/LOCQ)]*

    (b)   Derive the expression for voltage gain for OPAMP as adder with circuit diagram.

[(CO6)(Apply/IOCQ)]

    (c)   The inverting amplifier circuit has input resistance R_1 = 1 Kohm and feedback resistance R_f = 2 Kohm. Determine the output voltage and output current for an input voltage of 2V. *[(CO6)(Evaluate/HOCQ)]*

4 + 4 + 4 = 12

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31	47	22

Course Outcome (CO) :

After the completion of the course students will be able to:
1) Categorize different semiconductor materials based on their energy bands and analyse the characteristics of those materials for different doping concentrations based on previous knowledge on semiconductors acquired.
2) Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode both from device and circuit perspectives.
3) Design different application specific circuits associated with diodes operating both in forward and reverse bias.
4) Analyse various biasing configurations of Bipolar Junction Transistor and categorize different biasing circuits based on stability.
5) Categorize different field-effect transistors based on their constructions, physics and working principles and solve problems associated with analog circuits based on operational amplifiers.
6) Design and implement various practical purpose electronic circuits and systems meant for both special purpose and general purpose and analyse their performance depending on the type of required output and subsequently the applied input.

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