INTRODUCTION TO ANALOG CIRCUITS
(ECEN 2105)

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 forward biased current in a p-n junction is caused by
(a) diffusion of majority carriers (b) diffusion of minority carriers
(c) drift of majority carriers (d) drift of minority carriers

(ii) A bipolar junction transistor is cut off when
(a) both the emitter and the collector junctions are forward biased
(b) both the emitter and the collector junctions are reverse biased
(c) the emitter junction is reverse biased and the collector junction is forward biased
(d) the emitter junction is forward biased and the collector junction is reverse biased

(iii) The temperature coefficient of avalanche breakdown voltage of p-n diode is
(a) Zero (b) Positive
(c) Negative (d) Infinity

(iv) The JFET is
(a) A bipolar device (b) A voltage-controlled device
(c) A current controlled device (d) None of these

(v) Which of the following circuit can convert a square wave into triangular wave?
(a) Differentiator (b) Integrator
(c) Comparator (d) Logarithmic amplifier.

(vi) Which of the following phenomena is related with BJT?
(a) Impact ionization (b) Channel length modulation
(c) Early effect (d) Direct rupture of bonds.

(vii) The phase difference between input and output voltage signals of a common emitter BJT amplifier circuit is
(a) 0° (b) 90°
(c) 180° (d) 270°

(viii) Field Effect Transistor is advantageous in comparison with Bipolar Junction Transistor because of
(a) High input impedance (b) High current Gain
(c) High output impedance (d) None of these.

(ix) Ideal OpAmp offers
(a) infinite slew rate (b) high output impedance
(c) low CMRR (d) low input impedance

(x) Which of the following concept is not related with OpAmp?
(a) Offset voltage (b) Virtual ground
(c) Base width modulation (d) Input bias current.

Fill in the blanks with the correct word

(xi) Semiconductor material have _____ temperature coefficient of resistance.

(xii) Reverse saturation current in silicon PN junction diode nearly doubles for every _____°C rise in temperature.

(xiii) A JFET can be used as an amplifier in _____ region of operation.

(xiv) A Schmitt trigger circuit with OpAmp uses _____ type feedback.

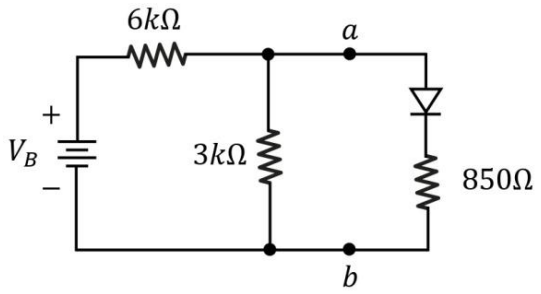
(xv) For n-channel MOSFET _____-type substrate is used.

Group - B

2. (a) Derive the concept of Fermi Energy Level from Fermi Dirac distribution function for both absolute zero and non-zero temperatures. *[(CO1)(Apply/IOCQ)]*

(b) Draw and explain the V-I characteristic of a p-n junction for both the forward and reverse bias. *[(CO2)(Understand/LOCQ)]*

(c) The p-n junction diode used in the given diagram has a cut-in voltage of 0.6V and a forward resistance of 150Ω. If the diode can dissipate a maximum power of 200mW, evaluate the maximum permissible value of the battery voltage V_B. *[(CO2)(evaluate/HOCQ)]*



5 + 3 + 4 = 12

3. (a) Explain the operation of a full wave diode rectifier circuit with proper waveforms. *[(CO2)(Understand/LOCQ)]*

(b) Derive the expression of rectification efficiency for diode full wave rectifier. *[(CO2)(Apply/IOCQ)]*

(c) In a half wave rectifier circuit a diode having forward resistance of 50 Ω, supplies power to a load resistance 1200Ω from a 20V(rms) source. Calculate the dc load current and rectification efficiency of the circuit. *[(CO2)(Apply/IOCQ)]*

5 + 3 + 4 = 12

Group - C

4. (a) What is Early effect? Draw the input and output characteristics of an n-p-n transistor operated in CE mode. *[(CO3)(Apply/IOCQ)]*

   (b) Derive the relationship between α and β for a BJT. *[(CO3)(Remember/LOCQ)]*

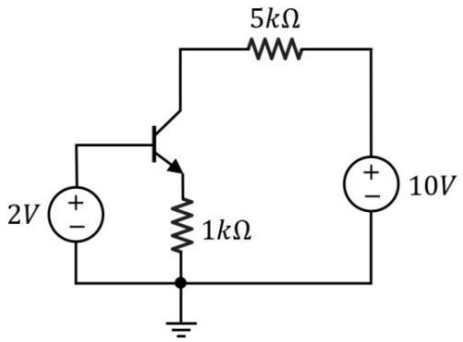
   (c) A transistor having α=0.975 and a reverse saturation current I_{CO}=10μA, is operated in CE configuration. What is β for the configuration? If the base current is 250μA, calculate the collector current. *[(CO3)(Evaluate/HOCQ)]*

(2 + 4) + 3 + 3 = 12

5. (a) What is thermal runaway in BJT? *[(CO3)(Understand/LOCQ)]*

   (b) Describe the fixed bias circuit for an npn BJT with proper circuit diagram and analyze the same to derive expressions of base and collector currents. *[(CO3)(Analyze/IOCQ)]*

   (c) For the BJT circuit shown in the figure, assume that the β of the transistor is very large and V_{BE} = 0.7V. Evaluate the values of collector current I_C and output voltage V_{CE}. *[(CO3)(Evaluate/HOCQ)]*



3 + 5 + 4 = 12

Group - D

6. (a) Draw the schematic structure of an n-Channel JFET and describe its working principle. *[(CO4)(Understand/LOCQ)]*

   (b) Draw the drain characteristic of n-Channel JFET and mark the operating regions. *[(CO4)(Analyze/IOCQ)]*

   (c) An n-channel JFET has I_{DSS} = 12mA and pinch-off voltage V_p = -4V. Evaluate the drain current for V_{GS} = -2V and transconductance g_{mo} at V_{GS} = 0V. *[(CO4)(Evaluate/HOCQ)]*

5 + 3 + 4 = 12

7. (a) Explain the operation of an n-channel depletion type MOSFET with proper schematic structure. *[(CO4)(Understand/LOCQ)]*

   (b) How can you use an n-channel depletion type MOSFET in enhancement mode? *[(CO4)(Analyze/IOCQ)]*

   (c) Draw both the drain and transfer characteristics of n-channel depletion type MOSFET and mark both the depletion and enhancement mode operating regions in the plots. *[(CO4)(Analyze/IOCQ)]*

5 + 3 + 4 = 12

Group - E

8. (a) Explain the operation of the followings using OPAMP with circuit diagram and derive the expression for gain
   (i) Inverting adder
   (ii) Integrator. *[(CO5, CO6)(Apply/IOCQ)]*

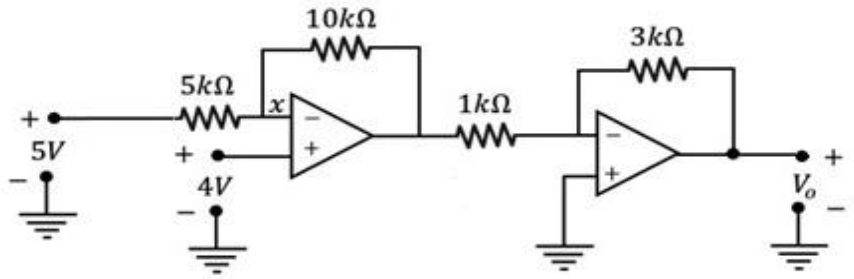
   (b) Write down the characteristics for ideal and practical OPAMP. *[(CO6) (Remember/LOCQ)]*

(4 + 4) + 4 = 12

9. (a) Draw a Schimitt Trigger circuit and explain its operation. Draw the output waveform for a sinusoidal input applied to the same. *[(CO6)(Analyze/IOCQ)]*

   (b) Show how a logarithmic amplifier can be built with an OPAMP. *[(CO5, CO6)(Apply/IOCQ)]*

   (c) Calculate the voltage V_0 in the circuit drawn below.



[(CO5, CO6)(Evaluate/HOCQ)]

5 + 3 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.17	51.04	19.79

Course Outcome (CO):

After the completion of the course students will be able to:-
1. Classify different semiconductor materials based on their conductivity.
2. Understand P-N Junction characteristics and circuit applications.
3. Understand Bipolar Junction Transistor characteristics and applications.
4. Categorize different Field Effect Transistors based on their structure and working principle
5. Understand feedback and its effects.
6. Apply basic concepts of feedback and design operational amplifier based circuits.

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