ANALOG ELECTRONIC CIRCUITS
(AEIE 2101)

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

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one 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) A BJT can be made to operate as a switch by operating it in the _____ region(s).
(a) active (b) active and cut-off
(c) active and saturation (d) cut-off and saturation

(ii) An ideal operational amplifier has
(a) Zero output impedance (b) Infinite input impedance
(c) Infinite bandwidth (d) All of (a), (b) & (c).

(iii) A Zero-crossing detector using a symmetrical Sine wave as an input generates a_____.
(a) square wave (b) sine wave
(c) cosine wave (d) triangular wave

(iv) Why inductors are not preferred for a filter circuit?
(a) Prone to pick electromagnetic noise (b) High power dissipation
(c) High input impedance (d) None of the mentioned.

(v) An electrical filter is a _____.
(a) frequency-selective circuit (b) phase-selective circuit
(c) amplitude-selective circuit (d) none of the mentioned

(vi) Recommended frequency range of Harley oscillator is_____.
(a) 2 Hz to 3 MHz (b) 1 KHz to 10 MHz
(c) 0.5 KHz to 40 MHz (d) 30 KHz to 30 MHz

(vii) An Instrumentation amplifier is/has a _____.
(a) Differential amplifier (b) Gain less than 1
(c) Very high output impedance (d) Low CMRR

(viii) Wien-Bridge Oscillators generate frequencies ranging between
(a) 20 Hz – 20 KHz (b) 20 KHz – 20 MHz
(c) 20 MHz – 20 GHz (d) any frequency range.

(ix) The condition of oscillation is
(a) feedback must be positive
(b) phase angle difference between input and output signals should be zero or integral multiple of 360^0
(c) feedback must be regenerative
(d) all of the above.

(x) 555 timer IC may be used to measure
(a) thickness of a polyethylene sheet
(b) temperature of an object
(c) strain on an object
(d) all of the above.

Group- B

2. (a) List the basic steps for a small signal analysis of a BJT based amplifier. [(CO1)(Remember/LOCQ)]

(b) A common emitter, BJT-based amplifier with the voltage divider bias processes a small signal. Analyze the circuit to determine (i) the voltage gain (ii) the input impedance of the amplifier. [(CO2)(Analyze/IOCQ)]

4 + (4 + 4) = 12

3. (a) Design an adder circuit using an op-amp to get the output expressions as **Vout= - (V1+5V2+25V3),**
Where, V1, V2 and V3 are the inputs. Given that the feedback resistor R_f =100 kΩ.
[(CO3) (Create/HOCQ)]

(b) If the input to the ideal comparator in Fig.1 is a sinusoidal signal of 8 V (peak to peak) with no DC component, then evaluate the duty cycle of the comparator's output.
[(CO3)(Evaluate/HOCQ)]

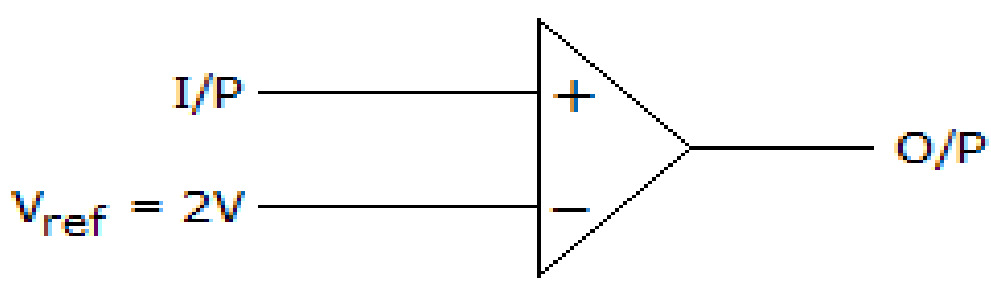

Fig. 1

6 + 6 = 12

Group - C

4. (a) For a Schmitt trigger circuit in Fig.2, Determine R2 if R1 is 100 KΩ and hysteresis voltage width is ± 2V. Assume the saturation voltages to the ideal operational amplifier as ± 12 V. [(CO4) (Evaluate/HOCQ)]

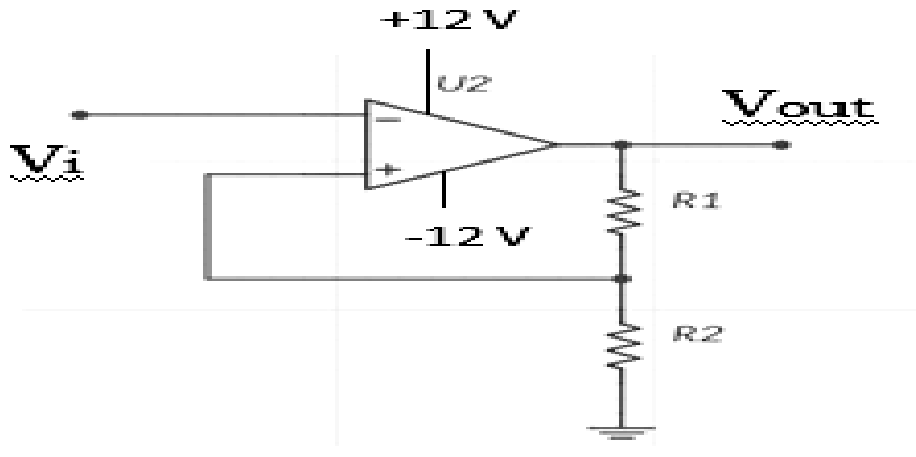

Fig.2

(b) Estimate V_{out} in the circuit of Fig.3. [(CO2)(Create/HOCQ)]

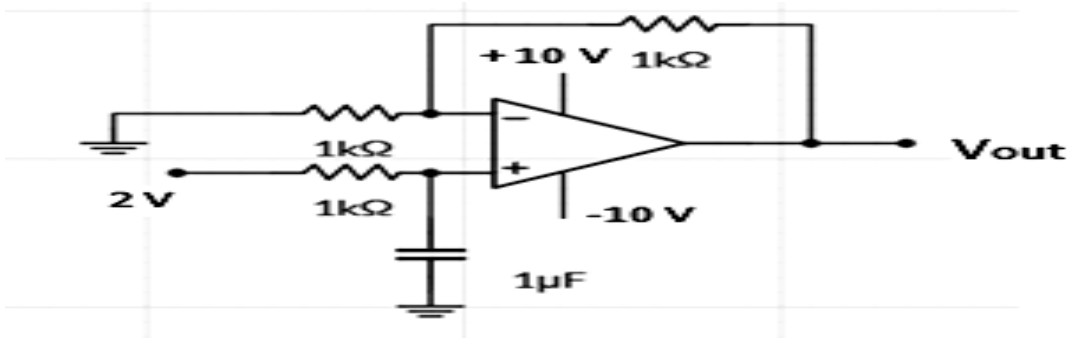

Fig. 3

6 + 6 = 12

5. (a) Develop a circuit using operational amplifiers and associated passive components to get the solution of the following differential equation.

$$\frac{d^3y}{dt^3} + 10\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + y = 5$$ [(CO3)(Apply/IOCQ)]

(b) What is the basic function of a precision rectifier? What is the significance of the term "precision"? [(CO2)(Remember/LOCQ)]

(c) Construct a circuit diagram of a full wave precision rectifier. [(CO1)(Apply/IOCQ)]

6 + (1 + 1) + 4 = 12

Group - D

6. (a) Identify the type of the filter circuit in Fig.4 and calculate its cut-off frequency and gain. Given: R1 = 10 kΩ, R2 = 2 kΩ and C = 0.01 μF. [(CO6)(Apply/IOCQ)]

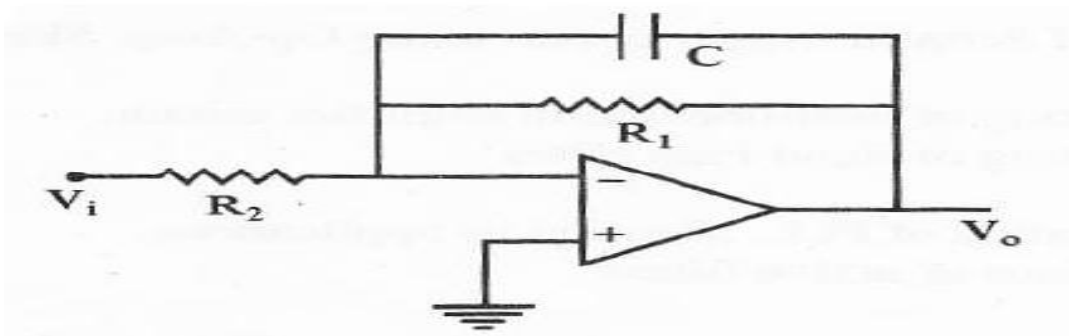

Fig.4

(b) Design a wave generator using op-amp that provides a waveform with equal rising and falling rates. The waveform specifications are (i) V_{pp} = 4 V and (ii) frequency = 1000 Hz. Use ideal operational amplifiers and passive components. [(CO4)(Create/HOCQ)]

(2 + 2) + 8 = 12

7. (a) Show the Barkhausen criteria for Oscillations. Why a phase-shift oscillator needs at least three stage RC-networks? [(CO5)(Remember/LOCQ)]

(b) In a 3 stage RC-phase shift oscillator, each RC combination has Resistive value as 200 KΩ and Capacitive values as 100 pF, show the frequency of oscillation. [(CO6)(Remember/LOCQ)]

(c) If a 4-stage RC-combination is used in a RC phase shift oscillator, what will be expression of the frequency of oscillation? [(CO4)(Remember/LOCQ)]

(3 + 3) + 4 + 2 = 12

Group - E

8. (a) Construct the circuit diagram of an astable multivibrator using a 555 timer IC. [(CO5) (Understand/LOCQ)]

(b) In an astable multivibrator, using a 555 timer IC, the external RC-network components have values of R1 = 22 KΩ, R2 = 39 KΩ, and C = 0.01 μF. Estimate the duty cycle of the output pulse. [(CO3)(Create/HOCQ)]

4 + 8 = 12

9. (a) Compare an Oscillator with an amplifier. Classify an oscillator in terms of passive components. [(CO5)(Understanding/LOCQ)]

(b) Formulate the expression for the frequency of the Wien Bridge oscillator. [(CO5)(Evaluate/HOCQ)]

(2 + 2) + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.09	22.91	50

Course Outcome (CO):

After the completion of the course students will be able to

1. Apply the knowledge of semiconductor fundamentals to analyze simple electronic circuits based on diodes and transistors with special focus on designing different biasing methods of BJT.
2. Design and analyze BJT amplifiers for small and large signal.
3. Learn basic function of operational amplifier, ideal and practical characteristics and their mathematical applications.
4. Design and compare between different types of Oscillators to meet the specified needs with appropriate consideration.
5. Design, analyze and understand the application of different types of multivibrators with and without IC 555.
6. Analyze and design analog electronic circuits using discrete components with specified needs for enhancement of knowledge.

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