ANALOG CIRCUITS
(ECEN 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) Which of the following biasing circuit provides best stability of Q-point?
(a) Fixed bias circuit (b) Self bias circuit
(c) Collector to base bias circuit (d) All of the above.

(ii) The ratio of the total swing of the output of a clamper to its input total swing is
(a) 1 (b) 2 (c) 0.5 (d) 0.

(iii) Which one of the following feedback topologies is used in transconductance amplifiers?
(a) Voltage series (b) Voltage shunt (c) Current series (d) Current shunt.

(iv) A Schmitt trigger can be used to generate a
(a) Triangular Wave (b) Square Wave (c) Sawtooth Wave (d) Sinusoidal Wave.

(v) Which of the following circuit is frequently used in differential amplifier to provide constant current biasing?
(a) Level shifter circuit (b) Current Mirror circuit
(c) Clamper Circuit (d) Voltage doubler circuit.

(vi) The highest frequency stability is obtained by using
(a) Colpitts oscillator (b) Hartley oscillator
(c) Wien Bridge oscillator (d) Crystal oscillator.

(vii) The ideal op amp has the following characteristic
(a) $R_i = \infty, A = \infty, R_o = 0$ (b) $R_i = 0, A = \infty, R_o = 0$
(c) $R_i = \infty, A = \infty, R_o = \infty$ (d) $R_i = 0, A = \infty, R_o = \infty$.

(viii) The Barkhausen criterion is associated with the
(a) negative feedback (b) positive feedback
(c) both positive and negative feedback (d) none of the above.

(ix) Which one of the following circuits is a bistable multivibrator?
(a) Precision rectifier (b) Differentiator
(c) Schmitt trigger (d) Integrator.

(x) Which one of the followings is not a part of the 555 timer IC?
(a) SR latch (b) Comparator (c) Voltage divider (d) Rectifier.

Group - B

2. (a) Draw a Fixed bias BJT amplifier circuit. Derive the stability factor. [(CO2)(Apply/IOCQ)]
(b) What are the factors responsible for shift of the operating point (Q point) of a transistor amplifier? [(CO2)(Evaluate/HOCQ)]
(c) Explain the operation of a positive clipper circuit with the help of a circuit diagram and input output waveforms. [(CO1)(Apply/IOCQ)]

(4 + 2) + 2 + 4 = 12

3. (a) In a collector to base bias circuit indicated in Fig.1, a transistor with $\beta = 50$ is used. Supply voltage $V_{CC} = 10V$, $V_{BE} = 0.7V$, collector resistor $R_C = 2k\Omega$. The bias is obtained by connecting $100k\Omega$ resistor R_B from collector to base. Find the Q-point and stability factor. [(CO2)(Evaluate/HOCQ)]

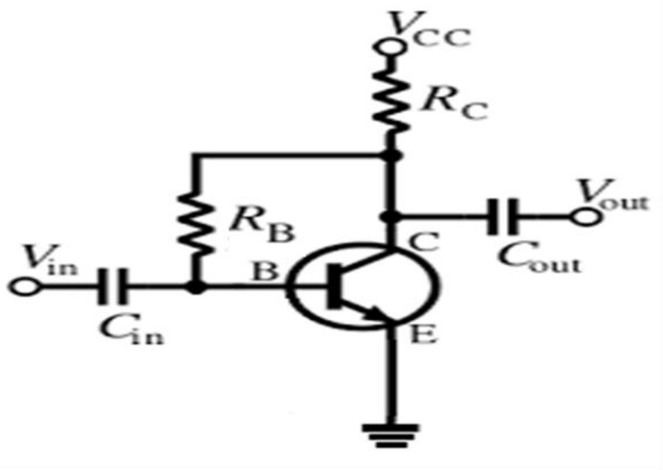

Fig.1

(b) Using the small signal model of BJT, derive expressions of output impedance Z_o, and current gain A_i of a fixed bias amplifier circuit. [(CO3)(Analyse/IOCQ)]

(4 + 4) + 4 = 12

Group - C

4. (a) Explain the effects of external capacitors in the low frequency response of RC-coupled BJT amplifier circuit. [(CO3)(Understand/LOCQ)]
(b) Describe the voltage series and current shunt feedback topologies with proper block schematics. [(CO1)(Remember/LOCQ)]
(c) In the circuit shown in Fig.2, the feedback gain, $\beta = 1/6$. Find the relation of R_1 and R_2 for sustained oscillation. [(CO4)(Evaluate/HOCQ)]

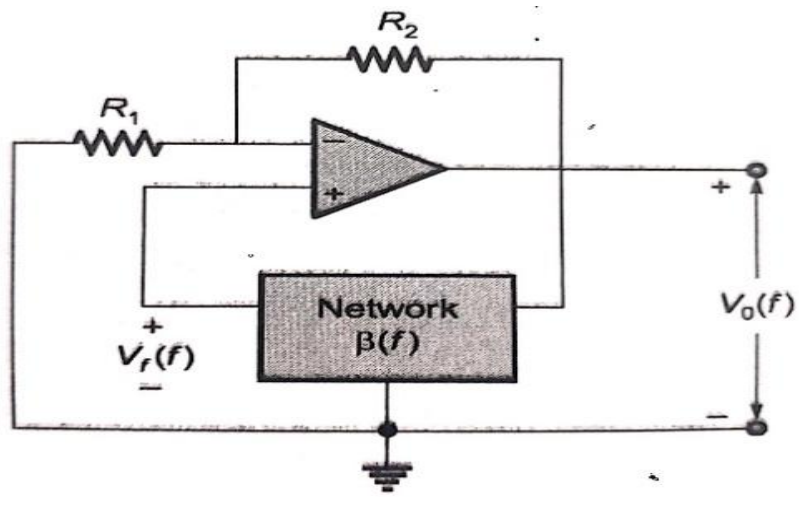

Fig.2

4 + 4 + 4 = 12

5. (a) Derive the frequency and condition of oscillation for Wein-Bridge oscillator circuit. [(CO4) (Understand/LOCQ)]

(b) Describe the effects of negative feedback on input and output impedances of amplifier circuits. [(CO1) (Remember/LOCQ)]

(c) An amplifier has an open loop gain of 100, an input impedance of 1kΩ and an output impedance of 100Ω. A feedback network with a feedback factor of 0.99 is connected to the amplifier in a voltage series feedback mode. Find out the modified input and output impedances of the amplifier with feedback. [(CO4)(Apply/IOCQ)]

6 + 3 + 3 = 12

Group - D

6. (a) Explain the basic operation of a Precision rectifier. [(CO5)(Remember/LOCQ)]

(b) Explain the operation of a Schmitt trigger circuit with the help of a circuit diagram and voltage transfer characteristics. What is hysteresis and how does it help in elimination of noise? [(CO5)(Evaluate/HOCQ)]

4 + (6 + 2) = 12

7. (a) Draw the circuit diagram of a dual input balanced output differential amplifier using BJT and describe it. Explain the concepts of balanced and unbalanced outputs in differential amplifiers. [(CO5)(Understand/LOCQ)]

(b) Define slew rate and CMRR for ideal OPAMP. [(CO5)(Understand/LOCQ)]

(c) Find out the output voltage V_o for the circuit indicated in Fig.3, with V_{s1} = 1V, V_{s2} = 2V and R_2/R_1 = 5. [(CO5)(Evaluate/HOCQ)]

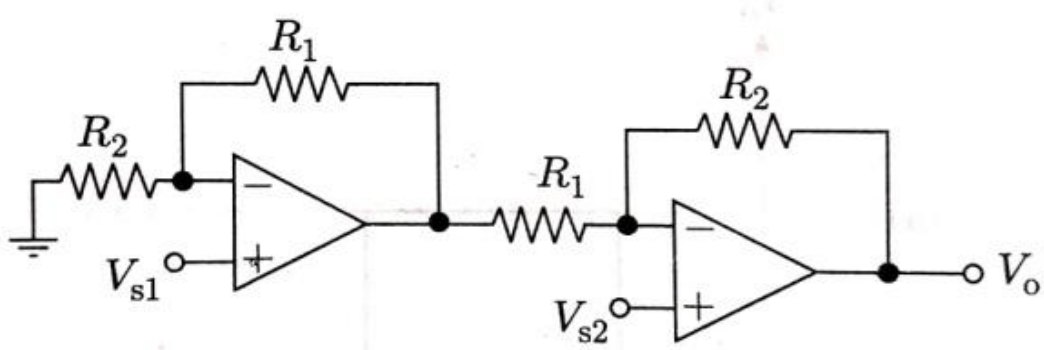

Fig.3

(3 + 2) + (2 + 2) + 3 = 12

Group - E

8. (a) Prove that the maximum efficiency of a power amplifier in class-B configuration cannot exceed 78.5%. [(CO6)(Evaluate/HOCQ)]

(b) Explain the working principle of a push pull amplifier with the help of a circuit diagram. [(CO6)(Remember/LOCQ)]

6 + 6 = 12

9. (a) Draw the circuit diagram and explain the operation of an astable multivibrator using a 555 timer IC. Derive the expression for duty cycle. [(CO4)(Analyse/IOCQ)]

(b) Determine the pulse width of a monostable multivibrator circuit having R = 20kΩ and C=0.1μF. [(CO4)(Evaluate/HOCQ)]

(4 + 4) + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	43.75	26.04	30.21

Course Outcome (CO):

After the completion of the course students will be able to

1. Apply the previous knowledge gathered from Basic Electrical and Basic Electronics papers.
2. Understand the concepts of BJT, MOSFET and biasing techniques of BJT and MOSFET based amplifier circuits.
3. Analyse frequency response of amplifier circuits.
4. Design different types sinusoidal oscillators and multivibrator circuits.
5. Construct algebraic equation-based amplifier and analog computers using OP-AMP
6. Design stable high-gain amplifier circuits.

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