ANALOG CIRCUITS
(ECEN 2101)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> 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) Which of the following biasing circuits is very much prone to thermal runway?
(a) Voltage divider bias   (b) Fixed bias
(c) Self bias   (d) Collector feedback bias.

(ii) The input impedance of a transresistance amplifier with negative feedback
(a) increases   (b) decreases
(c) remains unchanged   (d) increase or decreases

(iii) The bypass capacitor across the emitter resistor in a self-bias circuit
(a) increases voltage gain   (b) decreases voltage gain
(c) decreases both voltage & current gain   (d) does not affect voltage gain

(iv) Maximum efficiency that can be achieved under transformer coupled Class A category is
(a) 25%   (b) 78.5%   (c) 50%   (d) 30%.

(v) The 555 timer IC consists of
(a) SR flip-flop   (b) JK flip-flop   (c) D flip-flop   (d) T flip-flop.

(vi) The voltage follower has a
(a) closed-loop voltage gain of unity   (b) small open-loop voltage gain
(c) closed-loop bandwidth of zero   (d) large closed-loop output impedance.

(vii) Which of the following is the correct relationship between base and emitter current of a BJT?
(a) $I_B = \beta I_E$ (b) $I_B = I_E$ (c) $I_B = (\beta + 1) I_E$ (d) $I_E = (\beta + 1) I_B$

(viii) Crossover distortion can be observed in
(a) class-AB   (b) class-B   (c) class-A   (d) class-C

(ix) A zero-crossing detector is an application of a
(a) Differentiator   (b) Integrator   (c) Summing Amplifier   (d) Comparator.

(x)   An integrator circuit is basically a
       (a) low-pass filter   (b) high-pass filter
       (c) band-pass filter   (d) notch filter.

Fill in the blanks with the correct word

(xi)   The voltage gain of an amplifier decreases at high frequency due to _____ capacitor.

(xii) The signal x(t)=0.1sinωt volt can be rectified using _____ rectifier.

(xiii) For trigger voltage less than $(1/3)V_{cc}$, output of IC 555 is _____.

(xiv) In _____ power amplifiers, the output signal varies for a full 360^0 of the cycle.

(xv)   In small signal analysis the _____ of the input ac signal is very small
       compared to the dc biasing voltages.

Group – B

2. (a) Obtain the output of the following system of Fig.1 with proper explanation for a
        sinusoidal input of frequency 2kHz and amplitude 10V. Consider both D_1 and
        D_2 as ideal diode.

**Fig. 1**   *[(CO3)(Analyse/HOCQ)]*
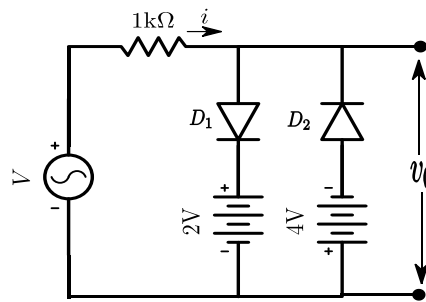
   (b) What is thermal runway? How it gets controlled in a self bias circuit using
        negative feedback?   *[(CO2)(Apply /IOCQ)]*
   (c) What is a load line? Explain the concept of Q-point.   *[(CO2)(Understand /LOCQ)]*

                                                        5 + 4 + 3 = 12

3. (a) In a collector to base bias circuit indicated in Fig.2. a Silicon transistor with
        β=120 is used. Supply voltage V_{CC}=20V, collector resistor R_C=4.7kΩ. The bias is
        obtained by connecting 680kΩ resistor from collector to base. Find the Q-point
        and stability factor.
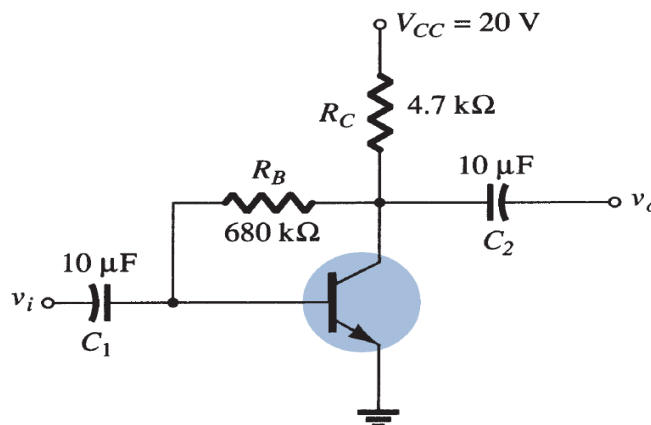
Fig. 2   *[(CO2) (Create/IOCQ)]*

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(b)   For RC coupled amplifiers explain the effect of bypass capacitor on voltage gain. *[(CO2)(Apply/IOCQ)]*

7 + 5 = 12

Group - C

4. (a)   Using suitable diagram explain the factors that influence the lower and higher cut off frequency of BJT based amplifier? *[(CO3) (Create /HOCQ)]*

     (b)   Draw the circuit diagram of Wien bridge oscillator. Find an expression for the frequency of oscillation and the condition for sustained oscillation. *[(CO4)(Apply/IOCQ)]*

6 + 6 = 12

5. (a) Derive the equation $A_f = \dfrac{A}{1+A\beta}$ where, the symbols have their usual meaning. *[(CO4) (Remember/LOCQ)]*

     (b) List the advantages of negative feedback. Sketch the circuit diagram of a Hartley Oscillator. *[(CO4) (Remember/IOCQ)]*

     (c) A phase shift oscillator uses 5pF capacitors. Find the value of R to produce a waveform having frequency of 800kHz. *[(CO4) (Create/IOCQ)]*

3 + (2 + 3) + 4 = 12

Group - D

6. (a)   What is differential amplifier? Explain the advantage of differential amplifier over single ended amplifier. *[(CO3)(Analyse/IOCQ)]*

     (b)   State the characteristics of a practical OPAMP. *[(CO4) (Remember/LOCQ)]*

     (c)   Draw a simple inverting amplifier having a voltage gain of -50. Bias the OPAMP using $\pm12V$. Evaluate the output voltage along with its sketch if an input voltage of $0.5\sin100\pi t$ volt is applied. *[(CO2)(Evaluate/HOCQ)]*

3 + 3 + 6 = 12

7. (a)   Explain with neat circuit diagram how an op amp is used to obtain antilogarithm of a signal, preventing variation due to temperature. *[(CO5) (Remember/IOCQ)]*

     (b)   The circuit shown in the Fig.3, $R_1=100\Omega$, $R_2 =56k\Omega$, $V_{in} =1V$ pp sine wave, and the op-amp is type 741 with supply voltages$=\pm15V$. Determine the upper and lower threshold voltages and draw the output waveform.
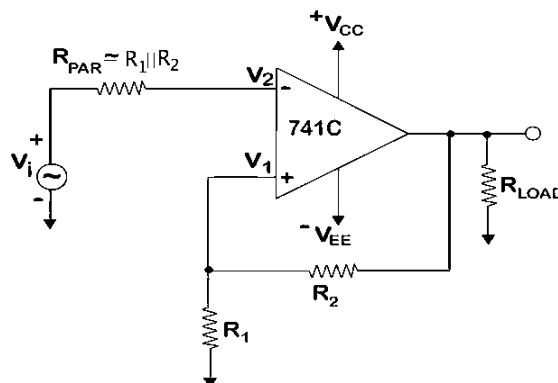

Fig. 3 *[(CO5)(Apply/IOCQ)]*

8 + 4 = 12

Group – E

8. (a) Obtain the expression for efficiency of a class A amplifier and mention its maximum value.
[(CO4) (Remember/LOCQ)]

   (b) Explain cross-over distortion with suitable circuit diagram. Explain how to overcome cross-over distortion.
[(CO2)(Apply/IOCQ)]

8 + 4 = 12

9. (a) Draw the circuit diagram of a monostable multivibrator using 555 IC and evaluate the expression of time duration for the circuit during which it remains in the unstable state when it is triggered from its stable to unstable state.
[(CO3)(Evaluate/HOCQ)]

   (b) The 555 IC is used as an astable multivibrator. It is desired to have square-wave output with 50% duty cycle of 1 kHz. The timing capacitor is of .01μF. Find the values of resistors required and draw the circuit.
[(CO4) (Determine/IOCQ)]

4 + (6 + 2) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	17.71	60.42	21.87

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. Analyze frequency response of amplifier circuits.
4. Design different types sinusoidal oscillators and multivibrator circuits.
5. Construct algebraic equations 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.