7. (a) With appropriate circuit diagram derive the output expression for an instrumentation amplifier. Explain its advantages over an ordinary difference amplifier.

   (b) Find expression of output voltage $v_0$ for the circuit shown in fig. 3. Hence, calculate $v_0$ for $v_i = 200$ mV with reverse saturation current of transistor $I_S = 10$ nA.

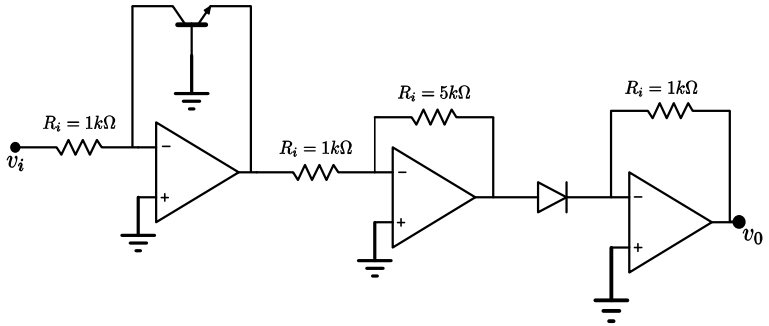


fig. 3

**(4 + 2) + (4 + 2) = 12**

## Group – E

8. (a) Show that the efficiency of an RC-coupled class-A amplifier can not exceed 25%.

   (b) With detailed derivation find the maximum efficiency of a class-B push-pull amplifier.

**6 + 6 = 12**

9. (a) With the help of the internal circuit diagram of IC 555 timer, explain the operation of astable multivibrator. What will be the maximum duty cycle of the wave that is possible from this multivibrator?

   (b) Design an automatic smoke alarm system using 555 timer IC. The circuit will be triggered by an external signal initial alarm. The alarm rings for 1 minute and turn off.

**6 + 6 = 12**





# 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) An integrator circuit is basically a
   (a) low pass filter (b) high pass filter
   (c) band pass filter (d) none of the above.

   (ii) A Schmitt trigger uses
   (a) positive feedback (b) negative feedback
   (c) compensating capacitors (d) pull-up resistors.

   (iii) A circuit that removes positive or negative part of a waveform is called
   (a) clipper (b) clamper
   (c) diode clamp (d) none of these.

   (iv) The bypass capacitor in a self-bias circuit restores
   (a) current gain (b) band-width
   (c) Q-point (d) voltage gain.

   (v) Differential mode voltage gain of a dual-input-balanced-output differential amplifier with $R_C$ connected at the collector is
   (a) $g_m R_C$ (b) $\frac{1}{2} g_m R_C$
   (c) $2 g_m R_C$ (d) $g_m || \frac{1}{R_C}$.

   (vi) For transistor action
   (a) the base region must be very thin and lightly doped
   (b) the emitter junction must be forward biased and collector junction reverse biased
   (c) the emitter junction should be heavily doped to supply the required amount of majority carriers
   (d) all of these.

(vii) An oscillator is a
(a) stable system (b) unstable system
(c) damped system (d) marginally stable system.

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

(ix) Oscillating frequency of an astable multi-vibrator is 11.54 kHz. What will be the value of $R_B$ to achieve 20% duty cycle?
(a) $R_B = 11\ \text{k}\Omega$ (b)$R_B = 10\ \text{k}\Omega$
(c) $R_B = 9\ \text{k}\Omega$ (d)$R_B = 12\ \text{k}\Omega$

(x) Open-loop gain of an amplifier is $10^6$. If the open-loop gain varies 20%, find variation in closed-loop gain for a negative feedback factor of 0.1.
(a) $\cong 0.02\%$ (b) $\cong 0.002\%$
(c) $\cong 0.0002\%$ (d) $\cong 0.00002\%$ .

## Group – B

2. (a) Explain in detail the operation of the circuit, shown in fig. 1. Draw its output waveform for a sinusoidal input of frequency 1 kHz and peak amplitude 10V.

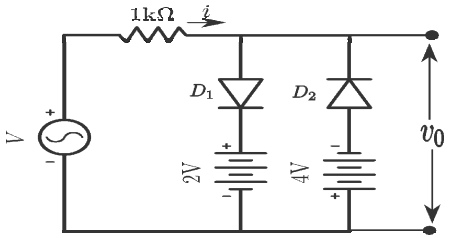


fig. 1

(b) Find expressions for quiescent point value of $I_{BQ}$, $I_{CQ}$ and $v_{CEQ}$ for the biasing configuration shown in fig. 2.

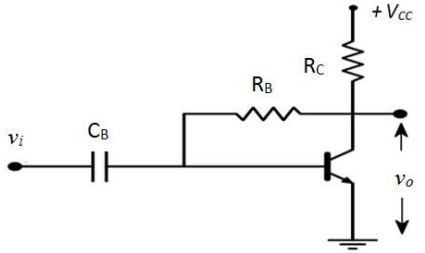


fig. 2

(c) What is 'thermal runway'? How can we control thermal runway in a fixed bias circuit? Justify your explanation with proper circuit diagram.

(d) Using h-parameter model of BJT, the derive the voltage gain for a common emitter voltage divider bias circuit.

**(2 + 1) + 3 + (1 + 2) + 3 = 12**





3. (a) For RC coupled amplifiers explain the effect of bypass capacitor on voltage gain. Determine the lower cut-off frequency caused by the presence of such capacitor.

(b) Using high-frequency model of BJT derive expressions for higher cut-off frequencies due to a combined effect of parasitic and wiring capacitors.

(c) The open-loop gain $A_0$ of an amplifier is 100 for band-width $(\Delta f)10$ MHz. If the closed-loop gain of the amplifier falls at 10, determine the closed-loop bandwidth.

**(2 + 2) + 4 + 4 = 12**

## Group – C

4. (a) With a general block diagram explain the concept of feedback systems. Show that closed-loop gain $A_f$ is related with open-loop gain $A$ as $A_f = \frac{A}{1 \pm Ak}$, where $k$ is the feedback factor.

(b) Derive expressions of input and output impedances for a voltage-series amplifier.

**(2 + 2) + (4 + 4) = 12**

5. (a) State Barkhausen criterion of oscillation that must be satisfied by a feedback amplifier to produce steady state oscillations. How oscillators are classified?

(b) Explain the operation of Wein Bridge oscillator with the help of a neat circuit diagram. Derive the expression for the frequency of oscillation and condition for sustained oscillation.

**(3 + 2) + 7 = 12**

## Group – D

6. (a) What are the advantages of differential amplifier? Find the expression for the differential voltage gain for a dual input balanced output differential amplifier.

(b) Draw the block diagram of an OP-AMP showing the different building blocks. List the characteristics of an ideal OP-AMP.

**(2 + 4) + (3 + 3) = 12**