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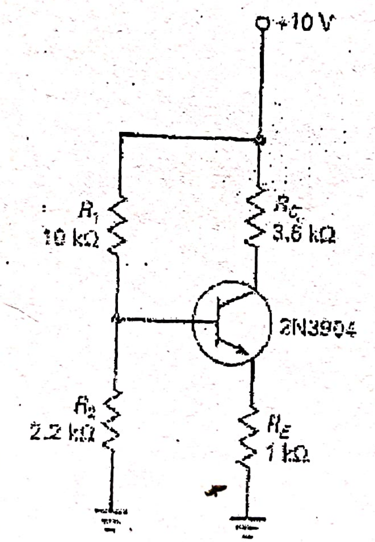
Internal Assessment Test - I

Sub:	Electronic Principles and Circuits						Code:	BEC303
Date:	5/11/2025	Duration:	90 mins	Max Marks:	50	Sem: 3rd	Branch:	ECE

Answer Any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1.	(a) Discuss Emitter feedback bias biasing circuits. (b) Define AC Beta and AC Emitter resistance.	[7+3]	CO1	L1
2.	Determine the collector-emitter voltage, collector current, and collector voltage in the given figure. Also, draw the load line and find the Q-point. 	[10]	CO1	L3
3.	Explain Common collector amplifier with the help of circuit diagram and derive voltage gain.	[10]	CO1	L2
4.	Draw T model and π model of (i)base biased amplifier (ii)Voltage divider bias amplifier	[5+5]	CO1	L2

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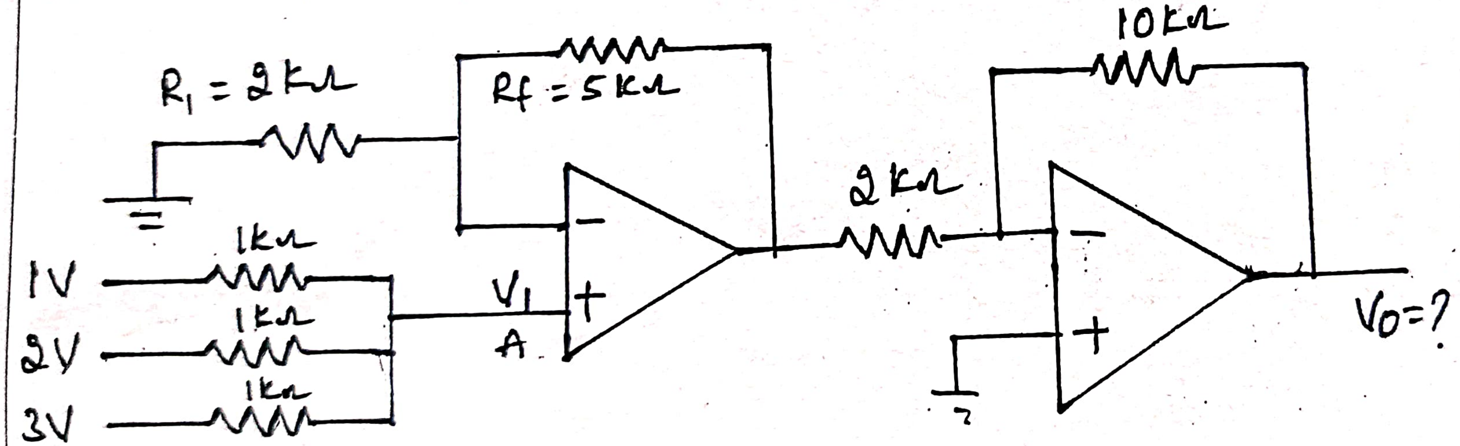
5.	Explain the operation of inverting Schmith Trigger circuit with necessary diagrams.	[10]	CO2	L2
6.	(a) Explain the operation of Hartley Oscillator. (b) Find the output voltage Vo in the following OPAMP circuit. 	[6+4]	CO2	L3
7.	(a) Explain the operation of Wein Bridge oscillator with necessary equations. (b) Explain Barkhausen Criteria for sustained oscillations.	[7+3]	CO2	L3

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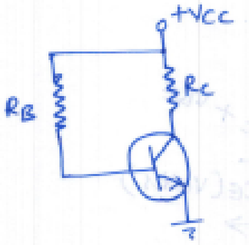
1.	(a) Discuss Emitter feedback bias biasing circuits.	[5+5]	CO1	L1

Emitter - Feedback bias.

(i) Base-bias Circuit :-



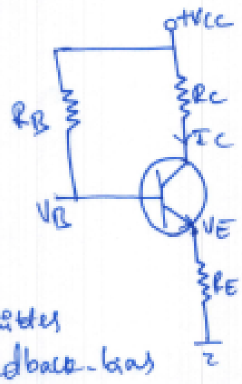
(a) Base-bias

→ Since the base current is fixed, the collector current varies when the current gain varies.

→ ∴ Q point moves all over the load line with the transistor replacement and temperature change.

→ not commonly used configuration.

* The first attempt at stabilizing the Q-point was emitter-feedback bias fig(b)



b) emitter feedback-bias

* An Emitter resistor has been added to the circuit.
* The basic idea is:
  if I_C increases, V_E increases, causing V_B to increase.
* More V_B means less voltage across R_B. This results in less I_B, which opposes the original increase in I_C.

* It is called feedback because the change in emitter voltage is being fed back to the base circuit.
* Also, the feedback is called negative because it opposes the original change in collector current.
* Equations for analyzing the emitter-feedback bias.

$$I_E = \frac{V_{CC} - V_{BE}}{R_E + R_B/\beta_{dc}} \rightarrow ①$$

$$V_E = I_E R_E \rightarrow ②$$

$$V_B = V_E + 0.7V \rightarrow ③$$

$$\boxed{V_C = V_{CC} - I_C R_C} \rightarrow ④$$

if $R_E >> R_B/\beta$

$$\therefore \boxed{I_E = \frac{V_{CC} - V_{BE}}{R_E}} \rightarrow ⑤.$$

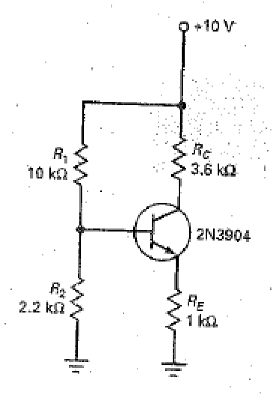
(b) Define AC Beta and AC Emitter resistance.

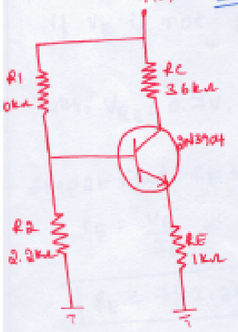
AC Beta: The ac current gain is ratio of ac collector current to the ac base current.

$$\boxed{\beta_{ac} = \frac{i_c}{i_b}}$$

$i_c \rightarrow$ Pure ac collector current

$i_b \rightarrow$ Pure ac base current.

	AC Resistance of Emitter diode (r_e') → The variable resistance or dynamic resistance of the emitter-base junction diode of a transistor is called the AC emitter resistance. → It is defined as the change in the base-emitter voltage divided by the corresponding change in the emitter current. $\boxed{r_e' = \frac{V_{be}}{i_e}}$ → Total emitter current: $I_E = I_{EQ} + i_e$. → Total base-emitter voltage: $V_{BE} = V_{BEQ} + V_{be}$. $\boxed{r_e' = \frac{25mV}{I_E}}$ → ac resistance decreases as dc emitter current increases. $\boxed{r_e' = \frac{V_T}{I_E}}$. $V_T = \frac{kT}{q}$				
2.	Determine the collector-emitter voltage, collector current, and collector voltage in the given figure. Also, draw the load line and find the Q-point.		[10]	CO1	L3



Sol^n Step 1: Find VB.

wkt, $V_B = \frac{R_2}{R_1+R_2} \cdot V_{CC}$

$V_B = \frac{2.2k\Omega}{10k\Omega + 2.2k\Omega} \times 10V$

$\therefore \boxed{V_B = 1.8V}$

wkt $V_{BE} = 0.7V$

Step 2: Find IE.

wkt, $V_E = V_B - V_{BE}$

$V_E = 1.8 - 0.7V$

$\boxed{V_E = 1.1V}$

$\therefore I_E = \frac{V_E}{R_E} = \frac{1.1V}{1k\Omega} = 1.1mA$

$\boxed{I_E = 1.1mA}$ $I_E = 1.1$ mA

→ Since the collector current almost equals the emitter current, we can calculate the collector to ground voltage

$V_C = V - I_C R_C$ $I_C \approx I_E = 1.1mA$

$V_C = 10 - (1.1mA)(3.6k\Omega)$

$\boxed{V_C = 6.04V}$

The collector-emitter voltage is:

$V_{CE} = V_C - V_E$

$= 6.04 - 1.1V$

$\boxed{V_{CE} = 4.94V}$

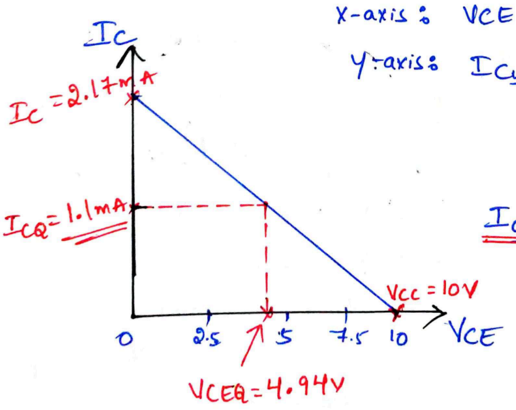
Load line and Q-point.

X-axis: $V_{CE} = V_{CC} = 10V$

Y-axis: $I_{Cy} = \frac{V_{CC}}{R_C + R_E}$

$= \frac{10}{3.6k + 1k\Omega}$

$I_{Cy} = 2.17mA$



3.	Explain Common collector amplifier with the help of circuit diagram and derive voltage gain.	[10]	CO1	L2

CC Amplifier:-

Emitter follower is the circuit in which the output voltage signal at the emitter is approximately equal to the voltage signal input on the base.

It is also called common-collector (CC) amplifier.

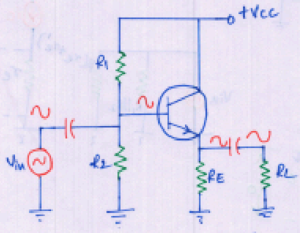
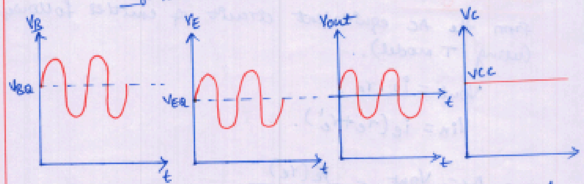


Fig: Emitter follower and waveforms.



1. The output and input voltage are approximately equal and they are in phase with each other.
2. The circuit is called an emitter follower since the output voltage follows the input voltage.
3. Since there is no collector resistor, the total voltage between the collector and the ground equals the supply voltage.
4. The emitter follower uses negative feedback.
5. The voltage gain is ultrastable and has maximum value of 1.
6. The distortion is almost non-existant.

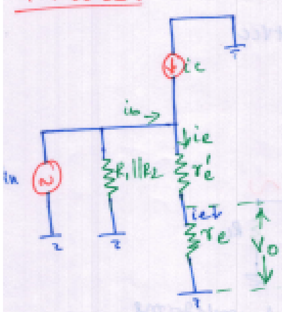
AC Emitter Resistance

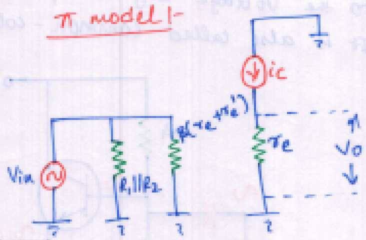
$r_e \rightarrow$ ac emitter resistance.

$r_e = R_E \parallel R_L$.

AC equivalent circuit :-

T model :- $\qquad$ π model :-





Voltage gain :-

From the AC equivalent circuit of emitter follower (using T model).

$$V_{out} = i_e \cdot r_e$$

$$V_{in} = i_e(r_e + r_e')$$

$$\therefore A_V = \frac{V_{out}}{V_{in}} = \frac{\cancel{i_e}(r_e)}{\cancel{i_e}(r_e' + r_e)}$$

$$A_V = \frac{r_e}{r_e' + r_e}$$

Usually $r_e \ggg r_e'$ $\therefore A_V = \frac{\cancel{r_e}}{\cancel{r_e}} = 1$

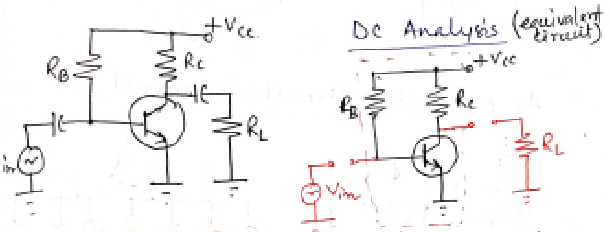
$$\boxed{A_V \simeq 1}$$

- Since gain $\simeq 1$, the output will be same as input.
- Hence it is known as Emitter follower Amplifier.

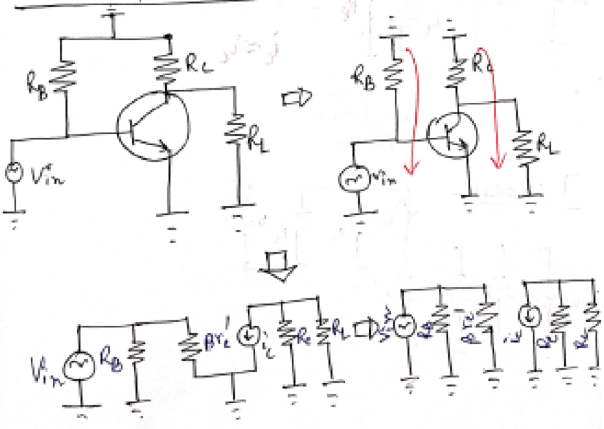
<table>
<tr><td></td><td>input impedance of Base.
$Z_{in}(base) = \beta(r_e + r_e')$
$\boxed{Z_{in} \approx \beta r_e}$ $\because r_e \ggg r_e'$.
input impedance of Stage.
$\boxed{Z_{in}(stage) = R_1 \parallel R_2 \parallel \beta(r_e + r_e')}$.
Advantage:-
- Even though, the output voltage is same as input voltage, the emitter follower can produce large o/p current.
- Emitter follower is not a voltage amplifier but a current (or) power amplifier.
Output impedance
$\boxed{Z_{out} = R_E \parallel \left(r_e' + \frac{R_G \parallel R_1 \parallel R_2}{\beta}\right)}$
(or)
$\boxed{Z_{out} = \frac{R_G}{\beta}}$ → Approximate formula.</td><td></td><td></td><td></td></tr>
<tr><td>4.</td><td>Draw T model and π model of (i)base biased amplifier (ii)Voltage divider bias amplifier</td><td>[5+5]</td><td>CO1</td><td>L2</td></tr>
</table>

Base-Biased Amplifier.

DC Analysis (equivalent circuit)

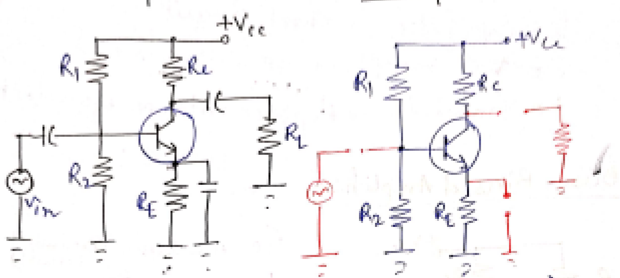


AC Analysis (equivalent circuit) :- (π model)

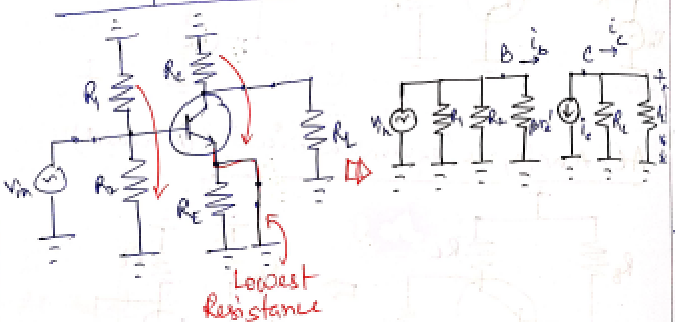


VDB Amplifier:

DC Equivalent

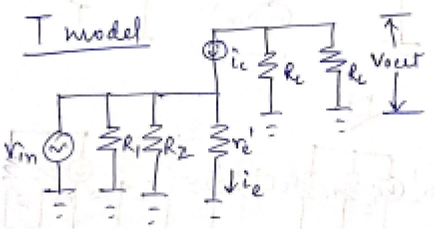


AC Equivalent Circuit: (π model)



Lowest Resistance path.

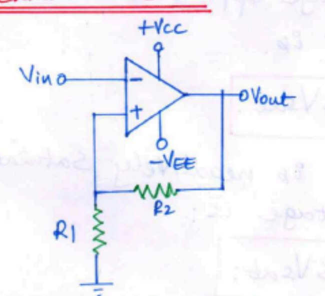
T model



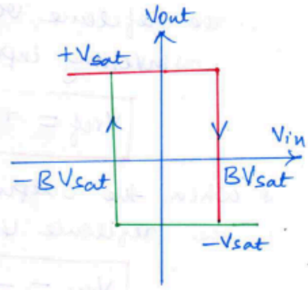
P.T.O

5.	Explain the operation of inverting Schmith Trigger circuit with necessary diagrams.	[10]	CO2	L1

Schmitt Trigger



(a) Inverting Schmitt trigger.



(b) input/out response has hysterisis.

* The input voltage is applied to the inverting input. Because the feedback voltage is aiding the input voltage, the feedback is positive. A comparator using positive feedback is called a Schmitt trigger.
* When the comparator is positively saturated, a positive voltage is fed back to the non inverting input. This +ve voltage holds output in high state.
* Similarly, when the output voltage is negatively saturated, a negative voltage is fed back to the non inverting input, holding the output in low state. In either case, the positive feedback reinforces the existing output state.
* The feedback fraction is,

$$\boxed{B = \frac{R_1}{R_1 + R_2}}$$

* When the output is positively saturated, the reference voltage applied to the noninverting input is.

$$\boxed{V_{ref} = +BV_{sat}}$$

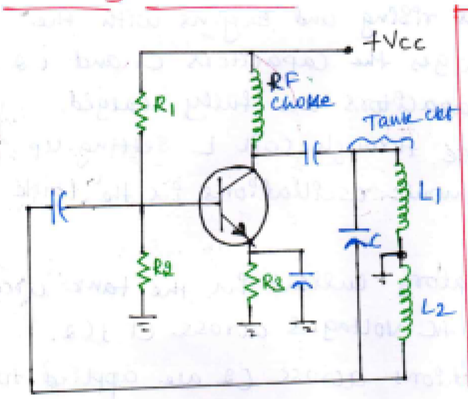
* When the output is negatively saturated, the reference voltage is:

$$\boxed{V_{ref} = -BV_{sat}.}$$

* The output voltage will remain in a given state until the input voltage exceeds the reference voltage for that state.
* To switch states input voltage should be increased more than V_{ref}.

6.	(a) Explain the operation of Hartley Oscillator.	[10]	CO2	L3

Hartley Oscillator



Resonant frequency, $f_r = \frac{1}{2\pi\sqrt{LC}}$

$L = L_1 + L_2$

$B = \frac{L_2}{L_1}$

$A_{V(min)} = \frac{L_1}{L_2}$

* When the LC tank is resonant, the circulating current flows through L1 in series with L2. The equivalent L is: $L = L1 + L2$.
* In a Hartley oscillator, the feedback voltage is developed by the inductive voltage divider, L1, and L2.
* Since the output voltage appears across L1 and the feedback voltage appears across L2, the feedback fraction is,

$\boxed{B = \frac{L2}{L1}}$ $\boxed{A_{V min} = \frac{L1}{L2}}$

* For oscillations to start, the voltage gain must be greater than $\frac{1}{B}$.
* Transistor offers 180° phase shift and LC tank circuit offers another 180° phase shift. Totally 360° of phase shift fulfilled one of the essential conditions for the oscillation.

Working:-

* When the DC supply (Vcc) turned on, the collector current starts rising and begins with the charging of the capacitor C. Once capacitor C is fully charged, it starts discharging through L1 and L2.
* The output of the amplifier is applied across the inductor L1 while the feedback voltage drawn across L2 is applied to the base of the transistor.

(b) Find the output voltage Vo in the following OPAMP circuit.

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<tr>
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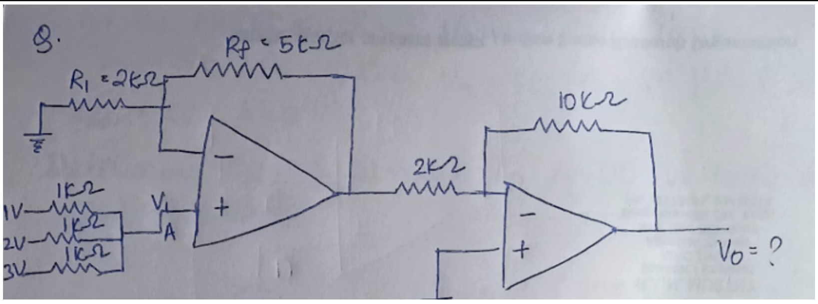


$V_{01} = \left(1+\frac{R_f}{R_1}\right)\left(\frac{V_1+V_2+V_3}{3}\right)$

$V_{01} = \left(1+\frac{5k}{2k}\right)\left(\frac{1+2+3}{3}\right)$

$V_{01} = (3.5)(2) = 7V \rightarrow$ o/p of 1^{st} stage.

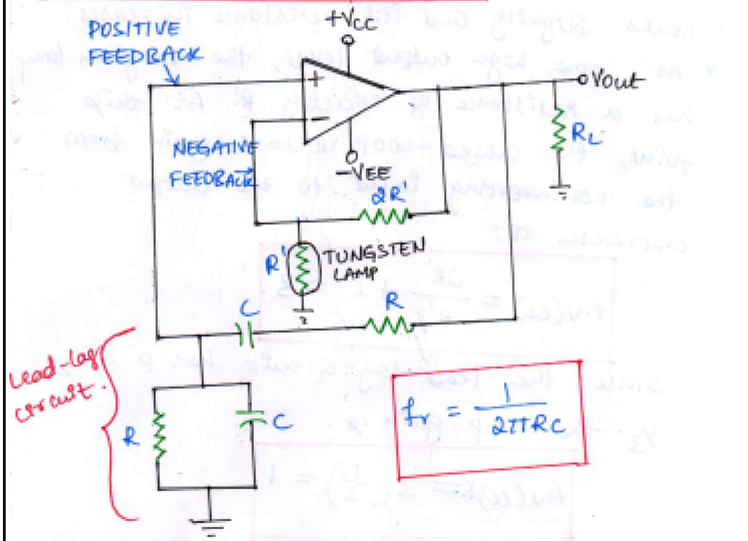
o/p of 2^{nd} stage $V_0 = ?$

$V_0 = -\frac{R_f}{R} \times V_{01}$

$= -\frac{10k}{2k} \times 7V$

$\therefore \boxed{V_0 = -35V.}$
</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>(a) Explain the operation of the Wein Bridge oscillator with necessary equations.</td>
<td>[5+5]</td>
<td>CO2</td>
<td>L3</td>
</tr>
</table>

The Wien-Bridge Oscillator.



$$\boxed{f_r = \frac{1}{2\pi RC}}$$

- Ranges 5HZ to 1MHZ.
- Used in commercial audio generators and is usually preferred for other lower frequency applications.
- Wein bridge oscillator uses a resonant feedback circuit called lead-lag circuit.

* It uses positive and negative feedbacks.

* When the circuit is initially turned on, there is more +ve feedback than -ve feedback. this allows the oscillations to build up.

* After the output signal reaches a desired level, the -ve feedback becomes large enough to reduce loop gain $A_V B$ to 1.

* As the oscillations build up, the tungsten lamp heats slightly and its resistance increases.

* At some high output level, the tungsten lamp has a resistance of exactly R'. At this point, the closed-loop voltage gain from the noninverting input to the output decreases to:

$$\boxed{A_{V(CL)} = \frac{2R'}{R'} + 1 = 3}$$

Since the lead-lag circuit has a B of 1/3. the loop gain is:

$$\boxed{A_{V(CL)}B = 3\left(\frac{1}{3}\right) = 1}$$

* When the resistance of tungsten lamp equals R', the loop gain $A_{V(CL)}B$ is exactly equal to 1.

* At this point, the oscillations become stable, and the output voltage has a constant peak-to-peak value.

(b) Explain Barkhausen Criteria for sustained oscillations.

	Barkhausen Criteria :- 1. Initially, loop gain $A_v B$ is greater than 1 at the frequency where the loop phase shift is 0°. 2. After the desired output level is reached, $A_v B$ must decrease to 1 by reducing either A_v or B.			

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