SRM Institute of Science and Technology
College of Engineering and Technology

DEPARTMENT OF ECE

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu

Academic Year: 2021-2022 (EVEN)

OFFLINE MODE

SET A

Test: CLAT- 1 **Date: 07-04-2022**
Course Code & Title: 18ECC201J – Analog Electronic Circuits **Duration:** 60 minutes
Year & Sem: II / IV **Max. Marks:** 25

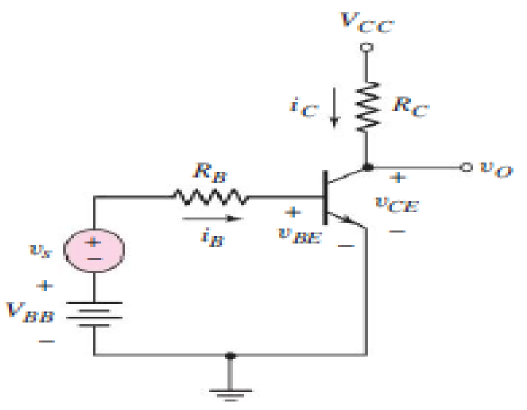
Course Articulation Matrix:

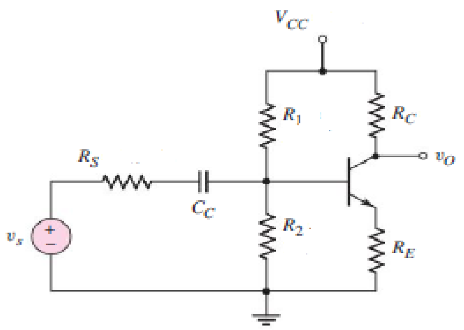
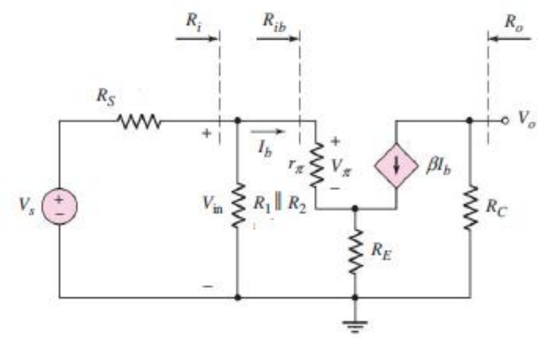
	18ECC201J - Analog Electronic Circuits	Program Outcomes (POs)														
		Graduate Attributes												PSO		
COs	Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1 :	Analyze bipolar amplifier circuits and their frequency response.	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Develop MOSFET amplifier circuits and their frequency response.	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3 :	Compile various negative feedback amplifier and oscillator circuits.	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4 :	Demonstrate the different classes of power amplifiers according to their performance characteristics.	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5 :	Construct the basic circuit building blocks that are used in the design of IC amplifiers, namely current mirrors and sources.	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-6 :	Organize analog electronic circuits using discrete components to measure various analog circuits' performance.	-	-	3	-	-	-	-	-	2	-	-	-	3	1	-

Part - A
(5 x 1 = 5 Marks)
Instructions: Answer any 5

Q. No	Question	Marks	BL	CO	PO	PI Code
1	c. it provides better voltage and current gain	1	1	1	1	
2	d. 90	1	2	1	2	
3	d. 0.95	1	3	1	2	
4	b. 4.35 V	1	3	1	3	
5	d. It is used as a current buffer	1	1	1	1	

Part – B
(2 x 10 = 20 Marks)
Instructions: Answer any TWO

Q. No	Question	Marks	BL	CO	PO	PI Code
6.a.	Calculate the small signal voltage gain of the bipolar transistor circuit shown in Fig A. Assume the transistor and circuit parameters are ; $\beta = 100$, $V_{CC} = 20V$, $V_{BE} = 0.7$, $R_C = 6\ K\Omega$, $R_B = 50\ K\Omega$, and $V_{BB} = 1.2V$. $I_{CQ} = 1$ mA, and $V_{CEQ} = 6V$ (5m)  **Fig. A**	10	3	1	3	

	$r_\pi = \beta V_T / I_{CQ} = (100)(0.026)/1 = 2.6\,k$ $g_m = (I_{CQ}/V_T) = 1/0.026 = 38.5\ mA/V$ $A_v = V_o / V_s$ $= -(g_m R_C)\ (r_\pi / r_\pi + R_B)$ $= -(38.5)(6)\ (2.6/2.6 + 50) = -11.4$ (5m)					
6.b.	Draw the equivalent circuit of the below shown npn common emitter circuit with an emitter resistor, and derive the expression for the input resistance (Rib) and state the resistance reflection rule. (5m)  **Fig. B**  (2m) Assuming that C_C acts as a short circuit Figure shows the small-signal hybrid-π equivalent circuit. As we have mentioned previously, to develop the small-signal equivalent circuit, start with the three terminals of the transistor. Sketch the hybrid-π equivalent circuit between the three terminals and then sketch in the remaining circuit elements around these three terminals. In this case, we are using the equivalent circuit with the current gain parameter β, and we are assuming that the Early voltage is infinite so the transistor output resistance r_o can be neglected (an open circuit). The ac output voltage is $V_o = -(\beta I_b)R_C$ To find the small-signal voltage gain, it is worthwhile finding the input resistance first. The resistance R_{ib} is the input resistance looking into the base of the transistor. We can write the following loop equation $V_{in} = I_b r_\pi + (I_b + \beta I_b)R_E$ The input resistance R_{ib} is then defined as, and found to be, $R_{ib} = \frac{V_{in}}{I_b} = r_\pi + (1+\beta)R_E$ In the common-emitter configuration that includes an emitter resistance, the small-signal input resistance looking into the base of the transistor is r_π plus the emitter resistance multiplied by the factor $(1+\beta)$. This effect is called the **resistance reflection rule.** We will use this result throughout the text without further derivation. (3m)		**2**	**1**	**2**	

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<tr>
<td>7.a.</td>
<td>Determine the small signal current gain of the CB configuration circuit shown in Fig C. (5m)

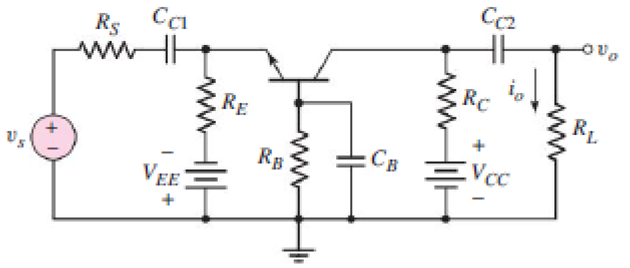

Fig. C

Figure C can also be used to determine the small-signal current gain. The current gain is defined as $A_i = I_o/I_i$. Writing a KCL equation at the emitter node, we have

$$I_i + \frac{V_\pi}{r_\pi} + g_m V_\pi + \frac{V_\pi}{R_E} = 0$$

Solving for V_π, we obtain

$$V_\pi = -I_i\left[\left(\frac{r_\pi}{1+\beta}\right) \Big\| R_E\right]$$

The load current is given by

$$I_o = -(g_m V_\pi)\left(\frac{R_C}{R_C + R_L}\right)$$

Combining Equations (6.93) and (6.94), we obtain an expression for the small-signal current gain, as follows:

$$A_i = \frac{I_o}{I_i} = g_m\left(\frac{R_C}{R_C + R_L}\right)\left[\left(\frac{r_\pi}{1+\beta}\right) \Big\| R_E\right]$$

If we take the limit as R_E approaches infinity and R_L approaches zero, then the current gain becomes the short-circuit current gain given by

$$A_{io} = \frac{g_m r_\pi}{1+\beta} = \frac{\beta}{1+\beta} = \alpha$$

where α is the common-base current gain of the transistor.

(5m)</td>
<td rowspan="2">10</td>
<td>2</td>
<td>1</td>
<td>3</td>
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<td>7.b.</td>
<td>For the common base circuit shown in Fig. B, determine I_C and V_{CB}. Assume the transistor to be of silicon. Given V_{BE} = 0.7 V. (5m)

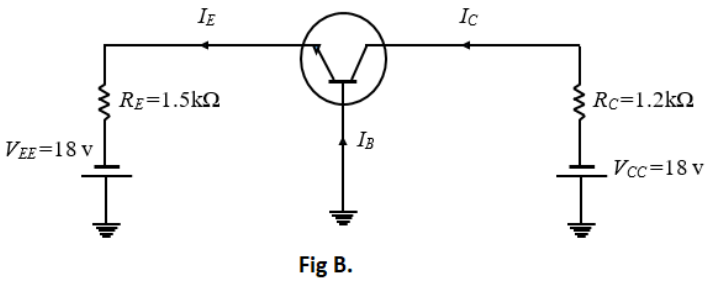

Fig B.

Since the transistor is of silicon, V_{BE} = 0.7V.
Applying Kirchhoff's voltage law to the emitter-side loop, we get,</td>
<td>3</td>
<td>1</td>
<td>3</td>
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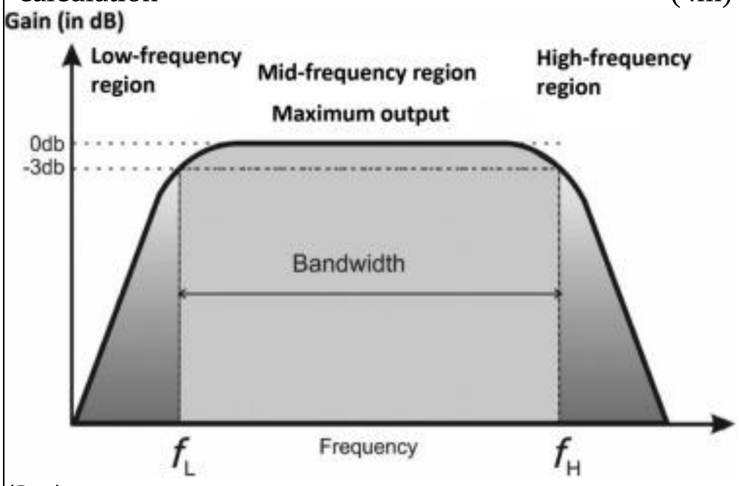
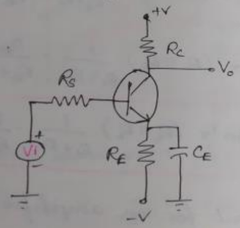
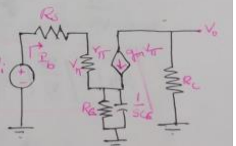
	$V_{EE} = I_E R_E + V_{BE}$ or $I_E = \dfrac{V_{EE} - V_{BE}}{R_E}$ $= \dfrac{8V - 0.7V}{1.5\ k\Omega} = 4.87\ mA$ $\therefore\ I_C \simeq I_E = \mathbf{4.87\ mA}$ Applying Kirchhoff's voltage law to the collector-side loop, we have, $V_{CC} = I_C R_C + V_{CB}$ $\therefore\ V_{CB} = V_{CC} - I_C R_C$ $= 18\ V - 4.87\ mA \times 1.2\ k\Omega = 12.16\ V$ (5m)					
8.a.	Draw the frequency response of an amplifier and give the significance of the 3 dB line in bandwidth calculation (4m)  (2m) 3 dB cutoff frequency is the frequency at which output power is half. So less than 50% output power means you probably are not going to get a useful signal. (2m)	**10**	**1**	**1**	**2**	
8.b.	Explain the impact of bypass capacitor in frequency response of an amplifier (6m)		**3**	**1**	**1**	

BYPASS CAPACITOR EFFECT

- Bypass capacitors are included to stabilize the Q point without sacrificing the small signal gain.
- To choose a bypass capacitor we must determine the circuit response in the frequency range where these capacitors neither open nor short circuit.





The transfer function

$$A_v = \frac{V_o(s)}{V_i(s)}$$

$$V_o = -g_m V_\pi (R_C)$$

$$= -g_m I_b r_\pi R_C \qquad V_\pi = I_b r_\pi$$

$$V_i = I_b \left[R_S + r_\pi + \left(R_E \parallel \frac{1}{sC_E} \right)(1+\beta) \right]$$

$$\Rightarrow I_b = \frac{V_i}{R_S + r_\pi + \left(R_E \parallel \frac{1}{sC_E} \right)(1+\beta)}$$

$$V_o = -g_m \cdot r_\pi \cdot R_C \cdot \frac{V_i}{R_S + r_\pi + \left(R_E \parallel \frac{1}{sC_E} \right)(1+\beta)}$$

$$\frac{V_o}{V_i} = -g_m \cdot r_\pi \cdot R_C \cdot \frac{1}{R_S + r_\pi + \left\{ \frac{R_E \cdot \frac{1}{sC_E}}{R_E + \frac{1}{sC_E}} \right\}(1+\beta)}$$

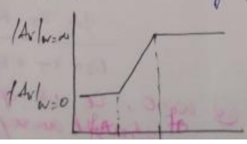
$$= -g_m \cdot r_\pi \cdot R_C \cdot \frac{1}{R_S + r_\pi + \left\{ \frac{R_E \cdot \frac{1}{\cancel{sC_E}}}{\frac{sC_E R_E + 1}{\cancel{sC_E}}} \right\}(1+\beta)}$$

$$= -g_m \cdot r_\pi \cdot R_C \cdot \frac{1}{R_S + r_\pi + \left\{ \frac{R_E}{R_E sC_E + 1} \right\}(1+\beta)}$$

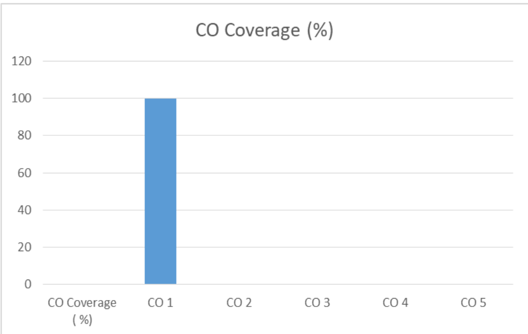
$$= \frac{-g_m \cdot r_\pi \cdot R_C \cdot (1 + sC_E R_E)}{R_S(1 + sC_E R_E) + r_\pi(1 + sC_E R_E) + R_E(1+\beta)}$$

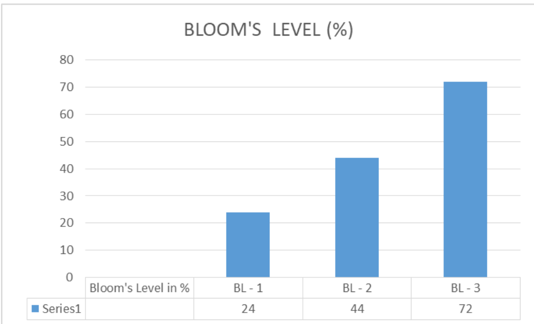
$$= \frac{-g_m \cdot r_\pi \cdot R_C \cdot (1 + sC_E R_E)}{R_S + R_S sC_E R_E + r_\pi + r_\pi sC_E R_E + R_E(1+\beta)}$$

$$= \frac{-g_m \cdot r_\pi \cdot R_C \cdot (1 + sC_E R_E)}{R_S + r_\pi + R_E(1+\beta) + sC_E R_E (R_S + r_\pi)}$$

	Taking $R_s + r_\pi + (1+\beta)R_E$ out, in Dr. $\therefore \frac{V_o}{V_i} = \frac{-g_m \cdot r_\pi \cdot R_C \, (1+sC_E R_E)}{R_s+r_\pi+(1+\beta)R_E\left[1+\frac{sC_E R_E(R_s+r_\pi)}{R_s+r_\pi+(1+\beta)R_E}\right]}$ $\therefore A_v = \frac{-g_m \cdot r_\pi \cdot R_C \cdot (1+\tau_A)}{R_s+r_\pi+(1+\beta)R_E \, (1+\tau_B)}$ where $\tau_A = sC_E R_E$ $\tau_B = \frac{sC_E R_E(R_s+r_\pi)}{R_s+r_\pi+(1+\beta)R_E}$ # At $w=0$, C_E is open circuit. $\therefore \lvert A_v \rvert_{w=0} = \frac{g_m \cdot r_\pi \cdot R_C}{R_s+r_\pi+(1+\beta)R_E}$ At $w=\infty$, C_E is short circuited. $\therefore \lvert A_v \rvert_{w=\infty} = \frac{g_m \cdot r_\pi \cdot R_C}{R_s+r_\pi}$ R_E is short circuited by C_E. corner frequencies $f_A = 1/2\pi\tau_A$ $f_B = 1/2\pi\tau_B$  Bypass capacitors are used to force signal currents around elements by providing a low impedance path at the frequency. A bypass capacitor causes reduced gain at low-frequencies and has a high-pass filter response. (6)					

Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Approved by the Course Coordinator