# 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 B**

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

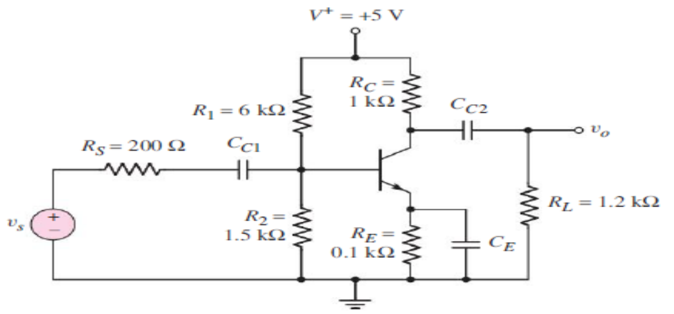
**Course Articulation Matrix:**

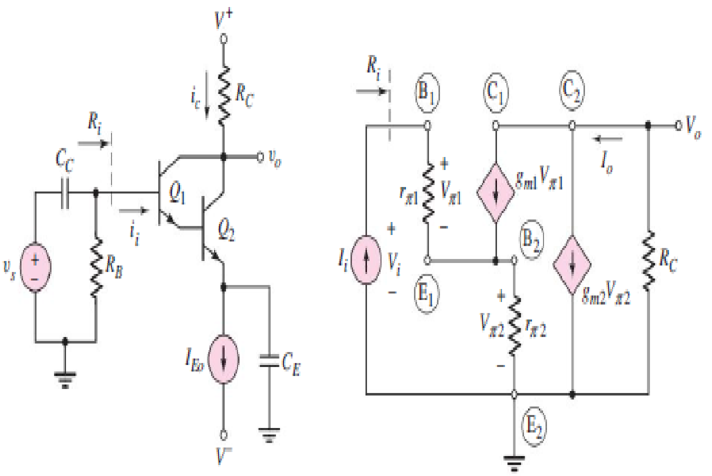
| | 18ECC201J - Analog Electronic Circuits | Program Outcomes (POs) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Graduate Attributes | | | | | | | | | | | | PSO | | |
| COs | Course Outcomes (COs) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 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**

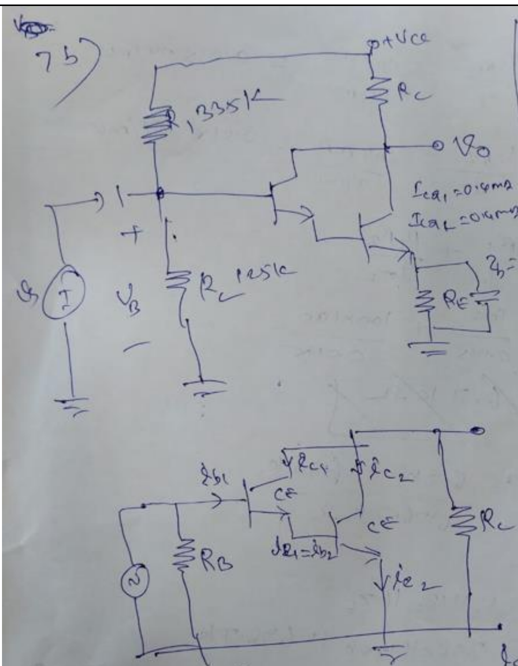
| Q. No | Question | Marks | BL | CO | PO | PI Code |
|---|---|---|---|---|---|---|
| 1 | b. that $I_C$ flows into transistor while $I_E$ flows out it | 1 | 1 | 1 | 1 | |
| 2 | d. 0.002 mA | 1 | 3 | 1 | 2 | |
| 3 | d. Cascode | 1 | 1 | 1 | 1 | |
| 4 | a. Saturation point and Cutoff point | 1 | 2 | 1 | 1 | |
| 5 | c. Stray | 1 | 3 | 1 | 2 | |

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

| Q. No | Question | Marks | BL | CO | PO | PI Code |
|---|---|---|---|---|---|---|
| 6. | For the circuit given below with transistor parameters $I_{CEQ}$ =2.79 mA, $\beta$ =180 and $r_0 = \infty$,<br>a. Determine the Q point values. (4)<br>b. Find the small signal parameters and voltage gain incluing the source resistance ($R_S$). (6)<br> | 5<br>5 | 3<br>2 | 1<br>1 | 3<br>2 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 6. Q point values ($I_{CEQ}, V_{CEQ}$)<br>(a) Given $I_{CEQ} = 2.7mA$, $\beta = 180$ & $r_0 = \infty$<br>⇒ $V_{CEQ} = V_{CC} - I_C(R_C + R_E)$<br>$= 5 - 3.0646 = 1.394V$.<br>∴ Q point = (2.79mA, 1.394V)<br>(b) small signal parameters.<br>$g_m = \frac{I_{CQ}}{V_T} = \frac{2.79}{0.026} = 107.3mA/V$<br>$r_\pi = \frac{\beta V_T}{I_{CQ}} = \frac{180\times0.026}{2.79} = 1.67k\Omega$.<br>$R_i = R_1 \parallel R_2 \parallel R_{ib}$<br>↳ $= r_\pi + (1+\beta)R_E$<br>$= 1.67 + 18.1 = 19.77k\Omega$<br>⇒ $\frac{1.2\times19.77}{1.2+19.77} = 1.131k\Omega$<br>∴ ⇒ $A_v = \frac{-\beta \cdot R_C}{r_\pi + (1+\beta)R_E} \cdot \frac{R_i}{R_s+R_i} = -7.89$.<br>$\boxed{\therefore A_v = -7.89}$ | | | | | |
| **7.a** | **Draw the Darlington amplifier and derive the expression for the current gain and input resistance.**<br><br> | **5** | **2** | **1** | **3** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **INPUT RESISTANCE**<br>$R_i = \frac{V_i}{I_i}$<br>$V_i = V_{\pi_1} + V_{\pi_2}$<br>$\boxed{V_{\pi_1} = I_i r_{\pi_1}}$<br>$V_{\pi_2} = (I_i + g_{m_1} V_{\pi_1}) r_{\pi_2}$<br>$= (I_i + g_m I_i r_{\pi_1}) r_{\pi_2}$ $\boxed{g_m r_\pi = \beta}$<br>$= I_i (1 + \beta_1) r_{\pi_2}$<br>$\boxed{\therefore V_{\pi_2} = I_i (1+\beta) r_{\pi_2}}$<br>sub $V_{\pi_1}$ + $V_{\pi_2}$ in $V_i$<br>$\therefore V_i = I_i r_{\pi_1} + I_i (1+\beta_1) r_{\pi_2}$<br>$= I_i (r_{\pi_1} + [1 + \beta_1] r_{\pi_2})$<br>$\boxed{R_i = \frac{V_i}{I_i} = \left[ r_{\pi_1} + (1+\beta_1) r_{\pi_2} \right]}$<br>$r_{\pi_1} = \frac{\beta_1}{g_{m_1}} = \frac{\beta V_T}{I_{CQ_1}}$ let $I_{CQ_1} = \frac{I_{CQ_2}}{\beta_2}$<br>$r_\pi = \frac{\beta_1 V_T}{I_{CQ_2}} \cdot \beta_2$<br>$r_\pi = \beta_1 r_{\pi_2}$<br>$R_i = \beta_1 r_{\pi_2} + (1+\beta_1) r_{\pi_2}$<br>$\boxed{R_i \approx 2\beta_1 r_{\pi_2}}$ | **5** | **3** | **1** | **3** | |
| **7.b.** | Determine the value of input resistance for the given circuit. Assume β = 100; $I_{C1} = I_{C2} = 4$ mA. | | | | | |




$Z_b = \frac{v_i}{i_{b1}}$

$v_i = i_{b1} r_{\pi 1} + (1+\beta_1) i_{b1} r_{\pi 2}$

$= i_{b1} (r_{\pi 1} + (1+\beta_1) r_{\pi 2})$

$Z_b = \frac{v_i}{i_{b1}} = r_{\pi 1} + (1+\beta_1) r_{\pi 2}$

circuit impedance

$Z_{in} = Z_b \| R_B$

$= R_1 \| R_2 \| Z_b$

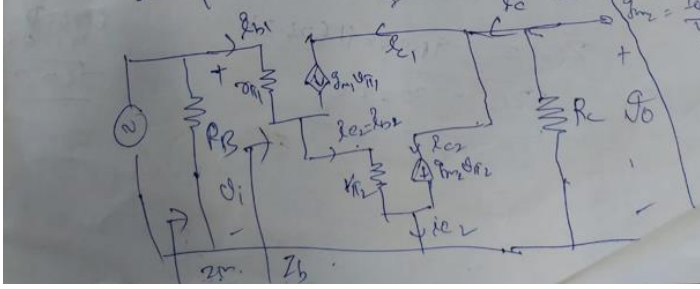
$Z_b = \frac{\beta_1}{g_{m1}} + (1+\beta_1)\frac{\beta_2}{g_{m2}}$

$= \frac{\beta_1}{g_{m1}} + \frac{\beta_1 \beta_2}{g_{m2}}$

$\beta_1 = \beta_2 = \beta = 100$

$g_{m1} = \frac{I_{CQ1}}{V_T}$

$g_{m2} = \frac{I_{CQ2}}{V_T}$




$g_{m1} = \frac{I_{CQ1}}{V_T} = \frac{0.4 mA}{26 mV} = 0.015\ mA/mV$

$g_{m2} = \frac{I_{CQ2}}{V_T} = \frac{0.4 mA}{26 mV} = 0.015\ mA/mV$

$Z_b = \frac{\beta_1}{g_{m1}} + \frac{\beta_1 \beta_2}{g_{m2}}$

$= \frac{100}{0.015} + \frac{100 \times 100}{0.015}$

$\cancel{Z_b = 6.7 k\Omega}$

$= 6.7k + 670k$

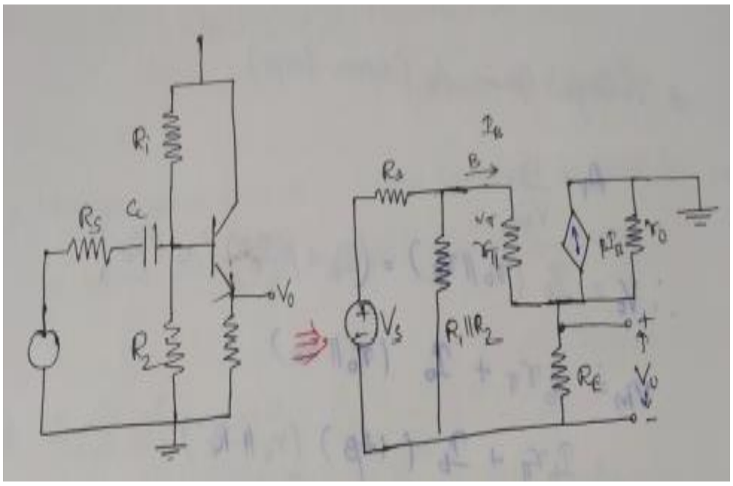
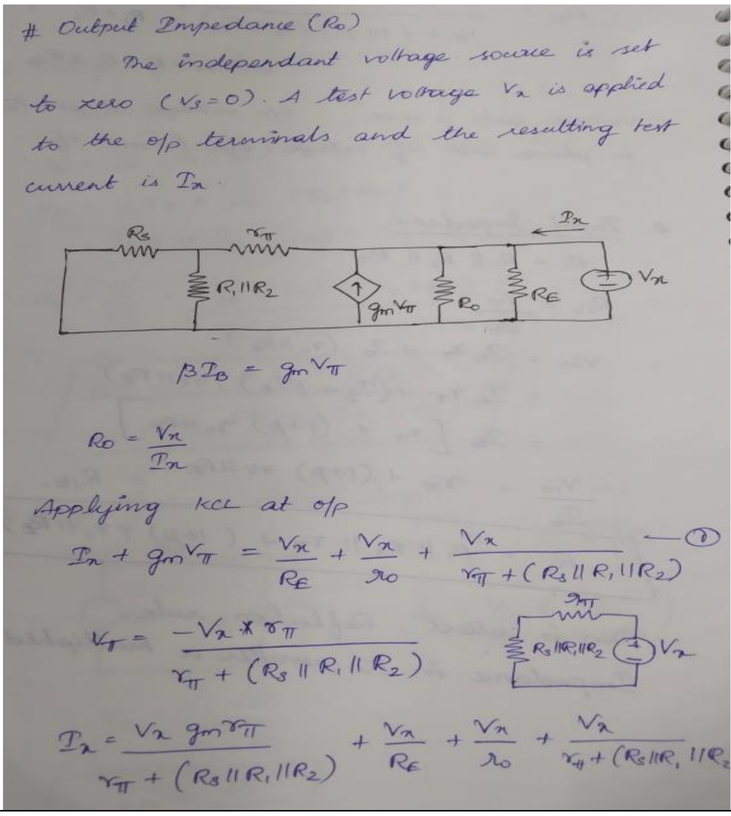
$\boxed{Z_b = 676.7 k\Omega}$

$Z_{in} = R_1 \| R_2 \| Z_b$

$= 335k \| 125k \| 676.7k$

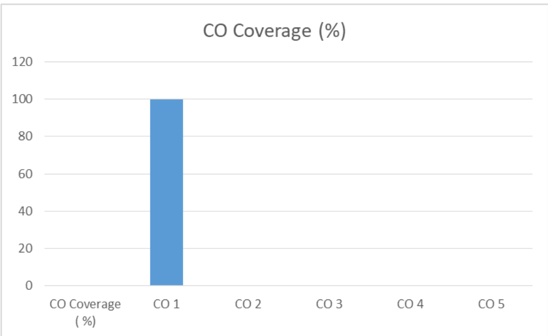
$Z_{in} = 91.03k \| 676.7k$

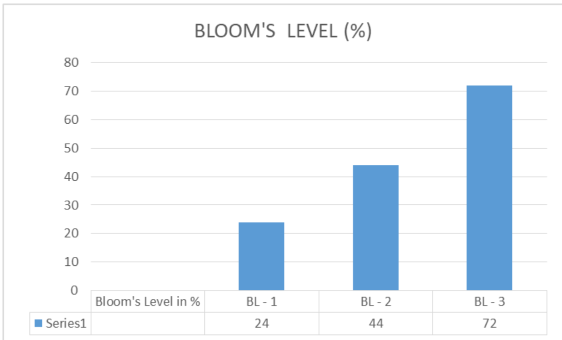
$\boxed{Z_{in} = 80.23k}$

| | | | | | | |
|---|---|---|---|---|---|---|
| **8.a.** | **Why common collector configuration is otherwise called as Emitter Follower?**<br>Common-collector transistor amplifiers are so-called because the input and output voltage points share the collector lead of the transistor in common with each other, not considering any power supplies. The common-collector amplifier is also known as an emitter-follower. **(2)** | **2** | **2** | **1** | **2** | |
| **8.b.** | **Derive the output resistance for a common collector configuration with necessary diagram**<br><br><br><br># Output Impedance ($R_o$)<br>The independant voltage source is set to zero ($V_s = 0$). A test voltage $V_x$ is applied to the o/p terminals and the resulting test current is $I_x$.<br><br>$\beta I_B = g_m V_\pi$<br>$R_o = \frac{V_x}{I_x}$<br>Applying KCL at o/p<br>$I_x + g_m V_\pi = \frac{V_x}{R_E} + \frac{V_x}{r_o} + \frac{V_x}{r_\pi + (R_s \parallel R_1 \parallel R_2)}$ — (1)<br>$V_\pi = \frac{-V_x * r_\pi}{r_\pi + (R_s \parallel R_1 \parallel R_2)}$<br><br>$I_x = \frac{V_x g_m r_\pi}{r_\pi + (R_s \parallel R_1 \parallel R_2)} + \frac{V_x}{R_E} + \frac{V_x}{r_o} + \frac{V_x}{r_\pi + (R_s \parallel R_1 \parallel R_2}$ | **8** | **3** | **1** | **3** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | $I_x = V_x\left[\frac{1}{R_E}+\frac{1}{r_o}+\frac{(1+g_m r_\pi)}{r_\pi+(R_S\|R_1\|R_2)}\right]$<br>$I_x = V_x\left[\frac{1}{R_E}+\frac{1}{r_o}+\frac{1+\beta}{r_\pi+(R_S\|R_1\|R_2)}\right]$<br>$\boxed{R_o = \frac{V_x}{I_x} = R_E \| r_o \| \frac{r_\pi + (R_S\|R_1\|R_2)}{1+\beta}}$<br># Emitter follower is sometimes referred to as an impedance transformer, since the i/p impedance is large and o/p impedance is small<br># This makes it an ideal voltage source, so the o/p is not loaded when used to drive another load<br># This is used as o/p stage in multistage amplifier<br>**(8)** | | | | | |

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




**Approved by the Course Coordinator**