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)

Mode of Exam
OFFLINE
SET B

Test: CLAT- 2 | **Date: 24-05-2022**
Course Code & Title: 18ECC201J – Analog Electronic Circuits | **Duration:** 2 periods
Year & Sem: II / IV | **Max. Marks:** 50

Course Articulation Matrix :

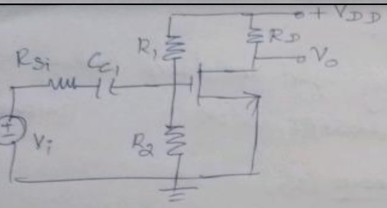
	18ECC201J - Analog Electronic Circuits	Program Outcomes (POs)														
		Graduate Attributes												PSO		
COs	Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1 :	Analyze bipolar amplifier circuits and their frequency response.	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2 :	Develop MOSFET amplifier 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	-

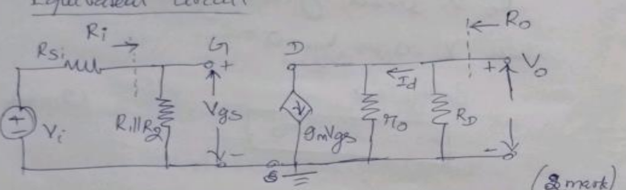
Part - A
(10 x 1 = 10 Marks)
Instructions: Answer ALL the Questions

Q. No	Question	Marks	BL	CO	PO
1.	at negative peak	1	1	2	1
2.	It blocks the noise & for ac signal it acts a short circuit resulting in grounding source terminal.	1	2	2	1
3.	common gate	1	2	2	1
4.	45MHz	1	2	2	2
5.	mid-frequency	1	2	2	1
6.	Shunt-Series	1	2	3	2
7.	Series-Series	1	2	3	1
8.	Shunt-Shunt	1	2	3	1
9.	one frequency	1	2	3	1
10	capacitors	1	2	3	1

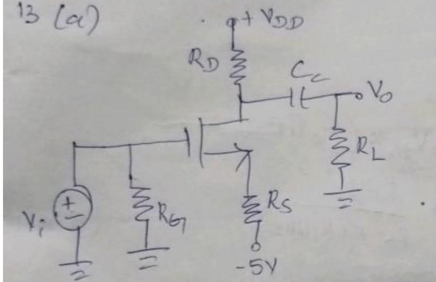
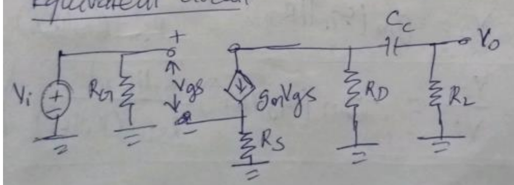
Part – B
(4 x 10 = 40 Marks)

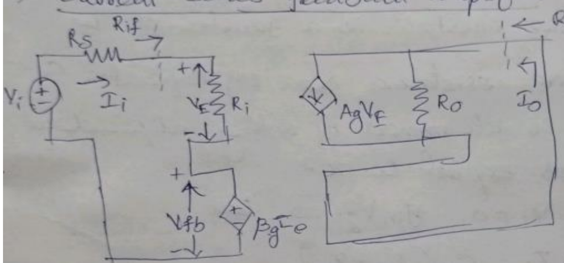
SECTION B1
Instructions: Answer ANY 2 Questions

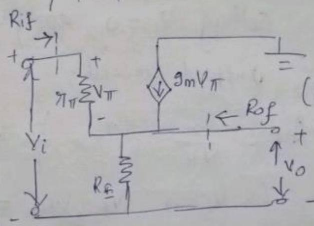
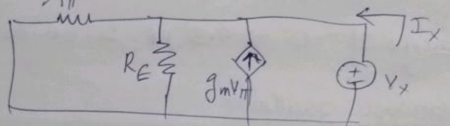
<table>
<tr>
<td>11</td>
<td>$V_{GSQ} = 12 \times \frac{450\times10^3}{(170+450)\times10^3} = 8.70\,V$ —(1mark)
$I_{DQ} = k_n(V_{GSQ}-V_{TN})^2$ —(1mark)
$= 4\times10^{3}(8.7-2.5)^2$
$= 153\ mA$
$g_m = 2k_n(V_{GSQ}-V_{TN})$
$= 2\times4(8.70-2.5)$
$= 49.6\ mA/V$ —(2mark)
$r_o = [\lambda I_{DQ}]^{-1} = [(0.01)(153)]^{-1}$
$= 0.65\,k\Omega = 650\,\Omega$ —(2mark)
$A_V = \frac{g_m(R_S\|r_o)}{1+g_m(R_S\|r_o)} \cdot \frac{R_1\|R_2}{R_S+(R_1\|R_2)}$
$R_1\|R_2 = 123K$
$A_V = \frac{49.6(575.22)}{1+49.6(575.22)} \cdot \frac{123\times10^3}{5k+123\times10^3}$
$= 0.96$ —(5mark)</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>

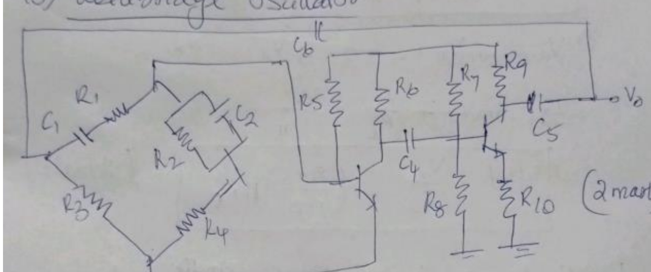
Equivalent circuit


(2mark)
Voltage gain
$A_V = V_o/V_i$
$V_o = -g_m V_{gs} \times (r_o\|R_D)$
$V_{gs} = V_i \times \frac{R_1\|R_2}{R_{Si}+(R_1\|R_2)}$ (5 mark)
Subs V_{gs} in V_o
$\therefore V_o = -g_m(r_o\|R_D)\ V_i \times \frac{R_1\|R_2}{R_{Si}+(R_1\|R_2)}$
$\boxed{A_V = \frac{V_o}{V_i} = -g_m(r_o\|R_D)\frac{(R_1\|R_2)}{R_{Si}+(R_1\|R_2)}}$</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</table>

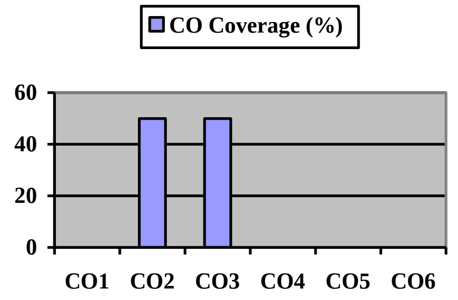
	Input resistance (R_i) $R_i = R_1 \| R_2$ Low frequency input resistance looking into the gate of MOSFET is ∞. (1mark) output resistance (R_o) R_o is found by setting $V_i = 0$ when $V_i = 0 \Rightarrow V_{gs} = 0$ $g_m V_{gs} = 0$ $\therefore \boxed{R_o = R_D \| r_o}$ (2mark)				
13	13 (a)  Equivalent circuit : r_o - assumed to be ∞  (2 mark) The maximum output voltage assuming C_c is a short circuit. $\|V_o\|_{max} = g_m V_{gs} (R_D \| R_L)$ $V_i = V_{gs} + g_m V_{gs} R_s$ $V_{gs} = \frac{V_i}{1+g_m R_s}$ $V_o = g_m \frac{V_i}{1+g_m R_s} (R_D \| R_L)$ $A_{v\,max} = V_o/V_i = \frac{g_m (R_D \| R_L)}{1+g_m R_s}$ The time constant is a function of the effective resistance seen by capacitor C_c which is determined by setting independent sources equal to zero. $V_i = 0$, $g_m V_{gs} = 0$ then $\tau_s = C_c (R_D + R_L)$ $\boxed{f_L = \frac{1}{2\pi \tau_s}}$ (3 mark)	**5**	**2**	**2**	**2**

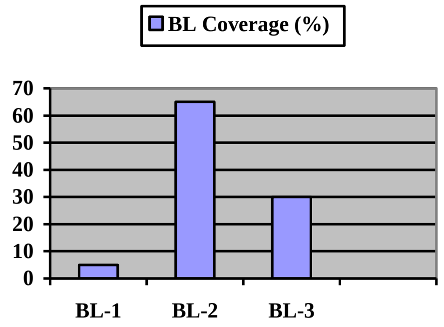
	b. $R_i = 80\,k\Omega \,\|\|\, 30\,k\Omega = 21.81\,k\Omega$ (2 mark) $R_o = R_D \,\|\|\, r_o$ $r_o = [\lambda I_{DQ}]^{-1}$ $I_{DQ} = k_n (V_{GS} - V_{TN})^2$ $= 0.5(2.72 - 1.5)^2 = 0.613\ mA$ $r_o = (\lambda I_{DQ})^{-1} = 163\,k\Omega$ (3 mark) $R_o = R_D \,\|\|\, r_o = 5.78\,k\Omega$	**5**	**3**	**2**	**3**
SECTION B2 **Instructions: Answer ANY 2 Questions**					
14	a. 4) Current series feedback amplifier  (2 mark) Transfer gain (A_{gf}) $A_{gf} = I_o / V_i$ $I_o = A_g V_E \Rightarrow V_E = I_o / A_g$ $V_i = V_E + V_{fb} = \frac{I_o}{A_g} + \beta_g I_o = (1 + \frac{A_g \beta_g}{A_g}) I_o$ $\boxed{A_{gf} = \frac{I_o}{V_i} = \frac{A_g}{1 + A_g \beta_g}}$ (2 mark) ~~Rif~~ Input resistance (R_{if}) $R_{if} = \frac{V_i}{I_i}$, $V_i = V_E + V_{fb}$, $V_{fb} = \beta_g I_o$ $V_{fb} = \beta_g A_g V_E$ Subs in V_i, $V_i = V_E + \beta_g A_g V_E = V_E(1 + A_g \beta_g)$ $V_E = I_i R_i$, $V_i = I_i R_i (1 + A_g \beta_g)$ $\boxed{R_{if} = \frac{V_i}{I_i} = R_i(1 + A_g \beta_g)}$ (2 mark) Output resistance (R_{of}) Setting $V_i = 0$, applying a test current I_x in output circuit. $R_{of} = \frac{I_x}{V_x}$, $I_x = \frac{V_x}{R_o} + A_g V_E$ As $V_i = 0$, $V_E + V_{fb} = 0 \Rightarrow V_E = -V_{fb} = -\beta_g I_x$ Subs V_{fb} in I_x, $I_x = \frac{V_x}{R_o} + A_g(-\beta_g I_x)$ $I_x(1 + A_g \beta_g) = V_x / R_o$ $\boxed{R_{of} = \frac{V_x}{I_x} = R_o(1 + A_g \beta_g)}$ (2 mark)	**8**	**3**	**3**	**2**

	b. 1. The total phase shift around the closed loop should be 0° (or) 360°. (1 mark) $\angle A\beta = 360^\circ / 0^\circ$ 2. The product of open loop gain of the amplifier and the feedback network should be unity. ie $\lvert A\beta \rvert = 1$ (1 mark)	**2**	**2**	**3**	**2**
15	a. 15) (a) Type of feedback topology is Series-shunt topology. (1 mark) The input signal is the voltage V_i, error signal is V_{be}, feedback signal is equal to output voltage. ie $\beta_V = 1$ ~~(1 mark)~~ Transfer gain (A_{vf}) (1 mark)  $A_{vf} = \frac{V_o}{V_i}$ $V_i = V_\pi + \left(\frac{V_\pi}{r_\pi} + g_m V_\pi\right) R_E$ $= V_\pi \left[1 + \left(\frac{1}{r_\pi} + g_m\right) R_E\right]$ (2 mark) $V_o = \left(\frac{V_\pi}{r_\pi} + g_m V_\pi\right) R_E = V_\pi \left(\frac{1}{r_\pi} + g_m\right) R_E$ $A_{vf} = \frac{V_o}{V_i} = \frac{1 + \left(\frac{1}{r_\pi} + g_m\right) R_E}{\left(\frac{1}{r_\pi} + g_m\right) R_E}$ Let $\frac{r_\pi}{1+g_m} = r_e \Rightarrow \boxed{A_{vf} = \frac{R_E / r_e}{1 + R_E / r_e}}$ Input resistance (R_{if}) $R_{if} = \frac{V_i}{I_i} = \frac{I_i r_\pi + (I_i + g_m I_i r_\pi) R_E}{I_i}$ $\boxed{R_{if} = r_\pi + (1 + g_m r_\pi) R_E}$ (2 mark) Output resistance (R_{of})  $V_i = 0$, $V_\pi + V_x = 0 \Rightarrow V_\pi = -V_x$ $I_x + g_m V_\pi = \frac{V_x}{R_E} + \frac{V_x}{r_\pi}$ $\boxed{R_{of} = \frac{V_x}{I_o} = \left(\frac{r_\pi}{1+\beta}\right) \parallel R_E}$ (2 mark)	**8**	**3**	**3**	**3**

	b. b) i) Hartley oscillator – uses tapped inductance Colpitts oscillator – uses tapped capacitance (ii) In Hartley oscillator, the feedback for the active device is taken from a voltage divider made of two inductors in series across the capacitor whereas in Colpitts oscillator, the voltage divider is made of two capacitors in series across the inductor	2	2	3	1
16	a. 16(a) $f_o = \frac{1}{2\pi\sqrt{LC}}$ (or) $C = \frac{1}{(2\pi f_o)^2 L}$ Given $f_o = (540-1650)$ kHz, $L = 1$ mH. $f_o = 540$ kHz $C_{max} = \frac{1}{4\pi^2 \times (540\times10^3)^2 \times 1\times10^{-3}}$ $= 86.86$ pF $f_o = 1650$ kHz $C_{min} = \frac{1}{4\pi^2 \times (1650\times10^3)^2 \times 1\times10^{-3}}$ $= 9.3$ pF The range of C ⇒ 9.3 pF to 86.86 pF.	4	3	3	3
	b. (b) Wein bridge oscillator  (2 marks) $\boxed{f_o = \frac{1}{2\pi\sqrt{R_1C_1R_2C_2}}}$ if $R_1=R_2$, $C_1=C_2$ $\boxed{f_o = \frac{1}{2\pi RC}}$ (1 mark) Condition for oscillation (1 mark) $\boxed{R_3/R_4 = 2}$ Explanation – (2 marks) .	6	2	3	2

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





Evaluation Sheet

Name of the Student: **Register No.:**

Part- A (10 x 1= 10 Marks)					
Q. No	**CO**	**PO**	**Maximum Marks**	**Marks Obtained**	**Total**
1	CO2	1	1		
2	CO2	1	1		
3	CO2	1	1		
4	CO2	2	1		
5	CO2	1	1		
6	CO3	2	1		
7	CO3	1	1		
8	CO3	1	1		
9	CO3	1	1		
10	CO3	1	1		
Part- B (4 x 10= 40 Marks)					
11	CO2	3	10		
12	CO2	2	10		
13.a	CO2	2	5		
13.b	CO2	3	5		
14.a	CO3	2	8		
14.b	CO3	2	2		
15.a	CO3	3	8		
15.b	CO3	1	2		
16.a	CO3	3	4		
16.b	CO3	2	6		

Consolidated Marks:

CO	Maximum Marks	Marks Obtained
2		
3		
Total		

PO	Maximum Marks	Marks Obtained
1		
2		
3		
Total		

Signature of Course Teacher