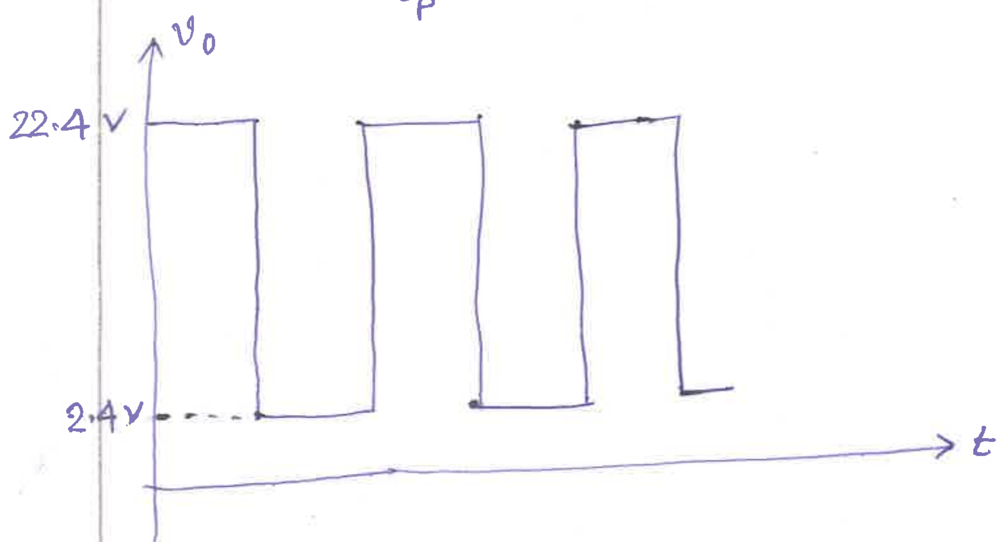
Solution

Q.P. code:- 40504

(1)

Page No............

Q. No.		Marks
1. (a)	Comparison between E-MOSFET and D-MOSFET: working, characteristics, symbol, biasing network, definition (Any five points)	(5M)
(b)	High frequency model of BJT (2M) Explanation on each component (3M)	
(c)	n-channel FET: Diagram (1M) working (3M) characteristics (1M)	
(d)	During negative half cycle, capacitor charges. $V_C = V_m + 3 - 0.6 = 12.4\ V$ (2M)	
	During positive half cycle, diode acts as open circuit. $V_{o_p} = V_m + V_C = 22.4\ V$ (1M)	
		(2M)
2. (a)	$I_{BQ} = \dfrac{V_{CC} - V_{BE}}{R_{B_1} + R_{B_2} + (1+\beta)(R_C + R_E)}$ $= 35.9\ \mu A$	(2M)
	$I_{CQ} = 3.59\ mA$	(1M)
	$I_{EQ} = 3.63\ mA$	(1M)

$V_{CEQ} = V_{CC} - I_E(R_C + R_E) = 7.77\ V$ (1M)

Derivation for(S) (3M)

$$S = \frac{1+\beta}{1 + \frac{\beta(R_C+R_E)}{R_{B_1}+R_{B_2}+R_C+R_E}} = 38$$ (2M)

2. (b) $I_{DSS} = 12\ mA$, $V_P = -3V$, $r_d = 100\ k\Omega$, $v_{in} = 20mV(P-P)$

$$V_G = \frac{V_{DD}R_2}{R_1+R_2} = 1.98\ V \qquad V_{GS} = V_G - I_D R_S = 1.98 - 560 I_D$$

$$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$$

$$= 12\times10^{-3}\left[1 - \frac{1.98 - 560 I_D}{-3}\right]^2$$

$\therefore I_{D_1} = 5.3\ mA$, $V_{GS_1} = -1\ V$

$I_{D_2} = 15\ mA$, $V_{GS_2} = -6.42\ V$

(5M)

$\therefore V_{GSQ} = -1V$ $I_{DQ} = 5.3\ mA$ $g_m = \frac{2I_{DSS}}{|V_P|}\left[1 - \frac{V_{GS}}{V_P}\right]$ (1M)

$g_m = 5.33\ m℧$

$Z_{in} = R_1 \| R_2 = 9\ M\Omega$ $Z_O = r_d \| R_D = 2.15\ k\Omega$ (2M)

$A_v = -g_m(r_d \| R_D) = 11.5$ (1M)

$v_o = A_v v_{in} = 230\ mV(P-P)$ (1M)

3. (a) Circuit diagram of cascode amp - (2M)

$$V_{B_1} = \frac{V_{CC}R_{B1}}{R_{B_1}+R_{B_2}+R_{B3}} = 8\ V \qquad I_{E_1} = I_{E_2} = \frac{V_{B_1} - V_{BE}}{R_E} = 7.4\ mA$$ (3M)

$$r_e = \frac{26\ mV}{I_{EQ}} = 3.5\ \Omega$$

Derivation for A_V and A_i (3M)

$$A_V = -\frac{R_C}{r_e} = -428.6$$ (1M)

$$A_i = \frac{\beta(R_{B_1}\|R_{B_2})}{(R_{B_1}\|R_{B_2}) + \beta r_e} = .185$$ (1M)

Q. No. | Marks

3.(b) Derivation of voltage gain, input impedance, AC equivalent circuit (5M)

$$A_V = \frac{-h_{fe} R_C}{h_{ie} + (1+h_{fe}) R_{E_1}} = -6.8 \quad (1/2 M)$$

$$Z_{in} = [h_{ie} + (1+h_{fe}) R_{E_1}] \| R_1 \| R_2 = 7k\Omega \quad (1/2 M)$$

$$f_{L_{C_{in}}} = \frac{1}{2\pi (R_1 \| R_2 \| h_{ie}) C_{in}} = 3.8 \text{ Hz} \quad (1M)$$

$$f_{L_{C_o}} = \frac{1}{2\pi R_C C_o} = 4.8 \text{ Hz} \quad (1M)$$

$$f_{L_{C_E}} = \frac{1}{2\pi \left[\left(\frac{R_1 \| R_2 \| h_{ie}}{h_{fe}} + R_{E_1} \right) \| R_{E_2} \right] C_E} = 14.27 \text{ Hz} \quad (2M)$$

4e (cc) $\therefore f_L = 14.27$ Hz

4.(a) $|A_V| \geq 150$, $S \leq 10$, $V_O = 5V$, $V_{CC} = 20V$

$f_L \leq 20$ Hz.

Step 1: Select BC147B with potential divider bias. $h_{ie} = 4.5 k\Omega$, $h_{fe_{min}} = 240$, $V_{CE(sat)} = 0.25 V$

$$|A_V| = \frac{h_{fe_{min}} R_C}{h_{ie}} \quad \therefore R_C = 2.8 \ k\Omega$$

Select $R_C = 3 k\Omega$ / $\frac{1}{4}$ ~~R_C =~~

Step 2 $V_{CEQ} = 1.5\,[V_{op} + V_{CE(sat)}] = 6.74\,V$

$$I_{op} = \frac{V_{o(P)}}{R_C} = 2.24\ mA$$

Select $I_{CQ} = 3\ mA$.

~~Let $V_{RE} = 10\%\ V_{CC} = 2\,V$~~

$$V_{RE} = V_{CC} - V_{CEQ} - I_C R_C = 2.26\ V$$

$$R_E = 753\ \Omega$$

Select $R_E = 720\,\Omega$ $\qquad P_{RE} = 6.48\ mW$

$$\therefore R_E = 720\,\Omega / \tfrac{1}{4}\,W$$

Step 3 $S \le 10$ $\therefore$ use $\beta_{max} = 450$

$$R_{th} = \left[\left[\frac{\frac{1+\beta_{max}}{S} - 1}{\beta_{max}}\right]^{-1} - 1\right] R_E = 6.6\ k\Omega$$

$$V_{th} = V_{BE} + I_C\left(\frac{R_{th}}{\beta_{typ}} + R_E\right) = 2.82\ V$$

$$R_1 = \frac{V_{CC} R_{th}}{V_{th}} = 35\ k\Omega$$

$$R_2 = 8.13\ k\Omega$$

Select $R_1 = 33\ k\Omega / \tfrac{1}{4}\,W$

$R_2 = 8.2\ k\Omega / \tfrac{1}{4}\,W$

Step 4

$$C_{C_1} = \frac{1}{2\pi\,(h_{ie} \| R_{th}) f_L} = 3\ \mu F / 30\,V$$

$$C_E = \frac{1}{2\pi\left[\frac{h_{ie}}{1+h_{fe\,typ}} \| R_E\right] f_L} = 600\ \mu F / 30\,V$$

$$C_O = \frac{1}{2\pi R_C f_L} = 2.65\ \mu F / 30\,V$$

Circuit with designed values

Q. No. | Marks

4. (b) Darlington amplifier circuit (2M)
D.C. analysis (2M)
A.C analysis (4M)

5. (a) $V_{th} = \frac{V_{CC} R_2}{R_1 + R_2} = 7.5\ V$ $\quad R_{th} = R_1 \| R_2 = 6.87\ k\Omega$

$I_{BQ} = \frac{V_{th} - V_{BE}}{R_{th} + (1+\beta) R_E} = 52.5\ \mu A$ (2M)

$I_{CQ} = \beta I_{BQ} = 10.5\ mA$ $\quad I_{EQ} = (1+\beta) I_{BQ} = 10.55\ mA$

$r_e = \frac{26\ mV}{I_{EQ}} = 2.46\ \Omega$ (1M) $\quad \alpha = \frac{\beta}{1+\beta} = 0.995$ (1M)

$Z_{in} = r_e \| R_E = 2.45\ \Omega$

$A_V = \frac{\alpha R_C}{r_e} = 485$

$A_I = -\frac{\alpha R_E}{R_E + r_e} = 0.99$

(2M)

Derivation (4M)

5. (b) $A_V = -g_m R_D = -6$ (½M) ⑥ ⑥

$f_{L_{C_{in}}} = \dfrac{1}{2\pi (R_S + R_G) C_{in}} = 1.6\ Hz$ (1M)

$f_{L_{C_o}} = \dfrac{1}{2\pi (R_D + R_L) C_o} = 3.4\ Hz$ (1M)

$f_{L_{C_S}} = \dfrac{1}{2\pi (R_S \| \frac{1}{g_m}) C_S} = 45\ Hz$ (1M)

$\therefore f_L = 45\ Hz$ (½M)

$f_{H_{in}} = \dfrac{1}{2\pi (R_S \| R_G)(C_{W_i} + C_{gs} + (1-A_V) C_{gd})}$ (2M)

$= 4.3\ MHz$

$f_{H_o} = \dfrac{1}{2\pi (R_D \| R_L)(C_{W_o} + C_{ds} + \left(\frac{A_V - 1}{A_V}\right) C_{gd})}$ (2M)

$= 8.79\ MHz$.

$\therefore f_H = 4.3\ MHz$ (½M)

High frequency model (1½M)

07

Page No. 7

Q. No.		Marks
6. (a)	Graphs (4 M) Explanation with equation (6M)	
(b)	Circuit diagram (2M) DC analysis (3M) AC analysis (5M)	
(c)	Graph (1M) working (4M)	