Exam Date & Time: 07-Mar-2025 (10:45 AM - 12:15 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

BTech II Semester MIDSEM Examination March 2025

FUNDAMENTALS OF ELECTRONICS [ECE 1072-PHY]

SCHEME OF VALUATION

(6) Assuming 'M1' in saturation.

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS}-V_{TH})^2$$

$$= \frac{1}{2}\times 200\times10^{-6}\times\frac{2}{0.18}(1-0.5)^2 = 277.77\,\mu A$$

$$V_{DS} = V_{DD} - I_D R_D = 1.8 - 277.77\times10^{-6}\times 2\times10^{3} = 1.24V$$

$$V_{GS} - V_{TH} = 1 - 0.5 = 0.5V$$

Since $V_{DS} > V_{GS} - V_{TH}$, 'M1' is in saturation → 1 MARK

Drain current derivation → 2 MARKS

$V_{DS} - I_D$ characteristics → 1 MARK

7 $I_o = 1\,pA$ at $20^\circ C$

$I_D = ?$ $150^\circ C$, $V_D = 0.5V$

$r_d = ?$ $150^\circ C$

$$I_o' = I_o\, 2^{\frac{150-20}{10}}$$

$$I_o' = 1p \cdot 2^{13}$$

$$\boxed{I_o' = 8.192\,nA} \quad — \tfrac{1}{2}M$$

$$V_T = \frac{T}{11600} = \frac{150+273}{11600} = \frac{423}{11600} = 36.465\,mV \quad — \tfrac{1}{2}M$$

$$I_D = I_o'\left[e^{\frac{V_D}{\eta V_T}} - 1\right]$$

(*) Assume diode is Ge, $\eta = 1$

$$I_D = 8.192n\left[e^{\frac{0.5 \times 11600}{423}} - 1\right]$$

$$\boxed{I_D = 7.383\,mA} \quad — 1M$$

$$r_d = \frac{\eta V_T}{I_o' + I_D} = \frac{1 \times 36.465m}{8.192n + 7.383m} = 4.939\,\Omega \quad — 1M$$

(*) Assume diode is Si, $\eta = 2$

$$I_D = 8.192n\left[e^{\frac{0.5 \times 11600}{2 \times 423}} - 1\right]$$

$$\boxed{I_D = 7.768\,\mu A} \quad — 1M$$

$$r_d = \frac{2 \times 423}{(8.192n + 7.768\mu) \times 11600} = 9.378\,K\Omega \quad — 1M$$

NOTE: Based on the decimal points taken, diode current and resistance can vary. Please consider the diode current and resistance values with ±(10 to 15)% tolerance while evaluating the answer scripts.

(8) $I_{Lmax} = -I_{Zmin} + I_T = -0.2\times10^{-3} + \frac{12-10}{10}$

$I_{Lmax} = 200\times10^{-3} - 0.2\times10^{-3} = 199.8\times10^{-3}$

$R_{Lmin} = \frac{V_Z}{I_{Lmax}} = \frac{10}{199.8\times10^{-3}} = \underline{\underline{50.05\Omega}}$ — 1.5 MARKS

P/V_Z

$I_{Lmin} = I_T - I_{Zmax} = 200\times10^{-3} - 1\times10^{-1} = 100\times10^{-3}$

$R_{Lmax} = \frac{10}{100\times10^{-3}} = \underline{\underline{100\Omega}}$. — 1.5 MARKS

9. primary $V_{rms} = 210V \Rightarrow V_{Peak} = 210\sqrt{2}$

$\boxed{V_{peak} = 296.98V}$

Secondary $V_m = V_{peak}/10$

$\boxed{V_m = 29.698V}$

(a) $V_{dc} = \frac{V_m}{\pi} = \frac{29.698}{\pi} = 9.453V$ — ½M

(b) $\eta = \frac{P_{dc}}{P_{ac}} = \frac{(V_{dc})^2}{(V_{rms})^2} = 0.405$ — ½M

$V_{rms} = \frac{V_m}{2} = 14.849V$

(c) $PIV = V_m = 29.698V$ — ½M

(d) V_{dc} (with C-filter) $= \left(\frac{2fCR_L}{1+2fCR_L}\right)V_m$

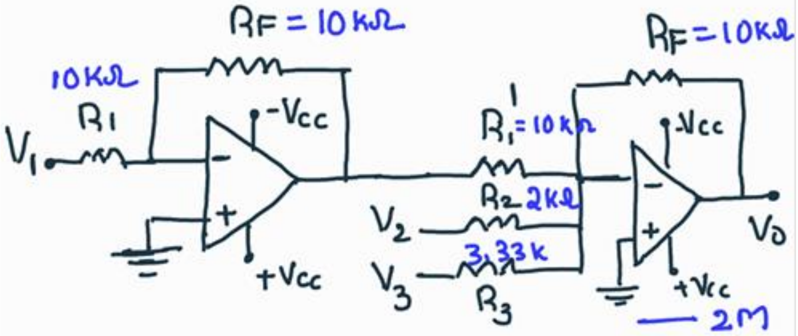
$= \left(\frac{2\times60\times1m\times1k}{1+2\times60\times1m\times1k}\right)29.69$

$\boxed{V_{dc} = 29.452V}$ — ½M

(e) $I_{rms} = \frac{V_{rms}}{R_L} = 14.849mA$ — ½M

(f) $f_o = f_i = 60Hz$ — ½M

10 $V_0 = V_1 - 5V_2 - 3V_3$, $R_F = 10\,k\Omega$



$$\frac{R_F}{R_1} = 1$$

$$\boxed{R_1 = 10\,K\Omega} \text{ — } \tfrac{1}{2}M$$

$$\frac{R_F}{R_1'} = 1 \Rightarrow R_1' = 10\,K\Omega \quad \text{— } \tfrac{1}{2}M$$

$$\frac{R_F}{R_2} = 5 \Rightarrow R_2 = 2\,K\Omega \quad \text{— } \tfrac{1}{2}M$$

$$\frac{R_F}{R_3} = 3 \Rightarrow R_3 = 3.33\,K\Omega \quad \text{— } \tfrac{1}{2}M$$

(11)

$$V_{DD} - I_D R_D = V_G - V_{TH} = \frac{V_{DD} R_2}{R_1 + R_2} - V_{TH}.$$

$$1.8 - I_D(3\times10^3) = \frac{1.8\times12\times10^3}{17\times10^3} - 0.4$$

$$I_D = \frac{1.8 - 0.87}{3\times10^3} = 0.31\,mA.$$

1 MARK

$$V_{GS} = V_G - V_S = \frac{1.8\times12\times10^3}{17\times10^3} - 0.31\times10^{-3}\times1\times10^3$$

$$V_{GS} = 0.96\,V$$

1 MARK

$$I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_{max}(V_{GS} - V_{TH})^2$$

$$0.31\times10^{-3} = \frac{1}{2}\times100\times10^{-6}\left(\frac{W}{L}\right)(0.96 - 0.4)^2$$

$$\boxed{\left(\frac{W}{L}\right)_{MAX} = 19.77}$$

1 MARK

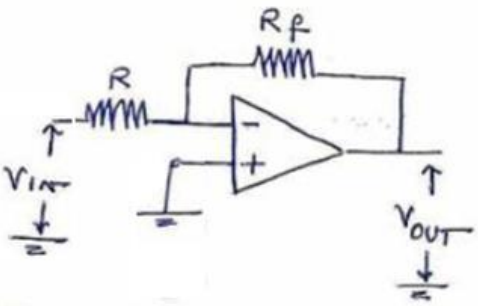
(12)

$$A_d = \frac{V_o}{V_1 - V_2} = \frac{10}{2\times10^{-3}} = 5000 \longrightarrow$$ **0.5 MARKS**

$$A_c = \frac{V_o}{\left(\frac{V_1 + V_2}{2}\right)} = \frac{5\times10^{-3}}{0.5\times10^{-3}} = 10 \longrightarrow$$ **0.5 MARKS**

$$CMRR = \left|\frac{A_d}{A_c}\right| = \frac{5000}{10} = 500 \longrightarrow$$ **1 MARK**

(13)



NON-INVERTING AMPLIFIER CIRCUIT $\longrightarrow$ **1 MARK**

$$A_v = \frac{-R_f}{R}$$

$$10 = \frac{-R_f}{R} \Rightarrow R = \frac{R_f}{10} = 1\,k\Omega$$ **1 MARK**

(14)

During both the half cycles of V_{in} diode conducts.

$$\therefore V_o = 5\sin\omega t + 5$$ **1 MARK**

$$V_{DC} = 5V$$

$$I_{DC} = \frac{5}{1\times10^{3}} = 5mA \longrightarrow$$ **1 MARK**