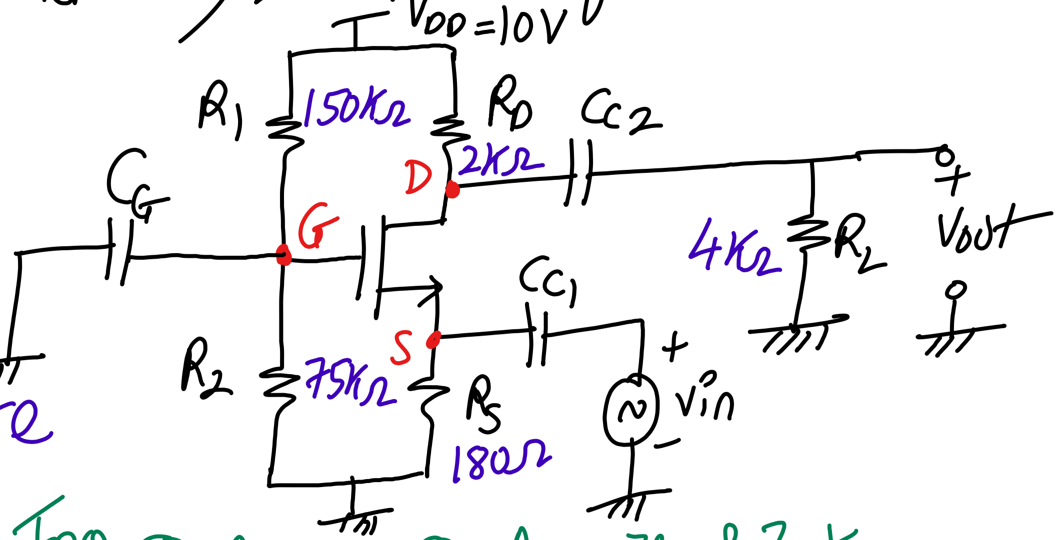
AEC lec 22 31/8/23

Numerical: Find A_v, Z_{in} & Z_{out} for ckt shown:

$k_n = 1\,mA/V^2$

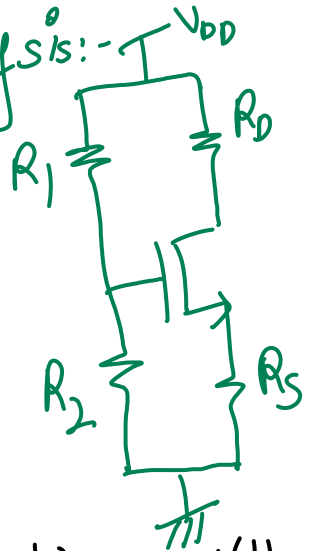
$\lambda = 0$; $V_{TN} = 1V$

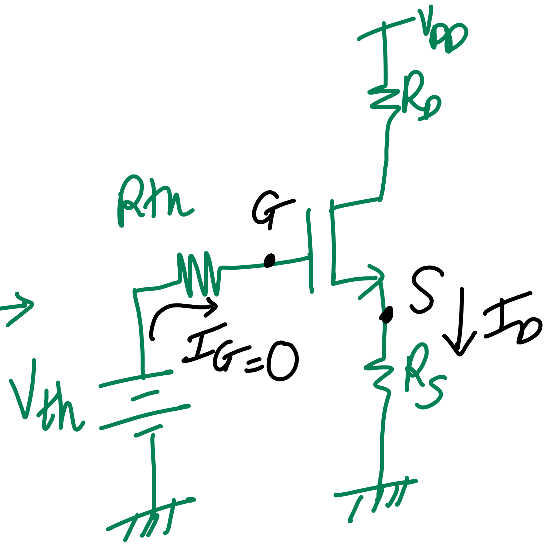


Common Gate amplifier

Solution: ① I_{DQ}, V_{GSQ} ② g_m, $r_o = \infty$ ③ A_v, Z_{in} & Z_{out}

① DC analysis:-





$$V_{th} = \frac{R_2}{R_1 + R_2} \times V_{DD}$$

$$V_{th} = \frac{75K}{150K + 75K} \times 10 \quad ; \quad V_{th} = 3.33\,V$$

$$V_{GS} = V_G - V_S$$

$$V_{GS} = V_{th} - I_D R_S$$

$$V_{GS} = 3.33 - I_D(180) \quad —①$$

Assuming given device is operating in saturation region,

$$I_{DQ} = k_n(V_{GS} - V_{TN})^2 = 1 \times 10^{-3}(V_{GS} - 1)^2 \quad —②$$

Put eq^n ② in ①,

$$V_{GS} = 3.33 - 0.18(V_{GS}^2 - 2V_{GS} + 1)$$

$$V_{GS} = 3.33 - 0.18V_{GS}^2 + 0.36V_{GS} - 0.18$$

$$\rightarrow 0.18V_{GS}^2 + 0.64V_{GS} - 3.153 = 0$$

⋮

$V_{GS} = 2.77V$ ($V_{GS} > V_{TN}$) ✓ $V_{GS} = -6.32V$ ✗ Reject

$$I_{DQ} = k_n(V_{GS} - V_{TN})^2 = 1\times10^{-3}(2.77-1)^2$$

$$\boxed{I_{DQ} = 3.132mA}$$

b) $g_m = 2k_n(V_{GS} - V_{TN}) = 2\times10^{-3}(2.77-1)$

$$\boxed{g_m = 3.54\ \frac{mA}{V}}$$

$$r_o = \frac{1}{\lambda I_D} \rightarrow \lambda = 0 \rightarrow r_o = \infty\Omega$$

c) Small-slg equivalent ckt

$R_D \| R_L = 2K \| 4K = 1.3333K$

$$A_v = g_m(R_D \| R_L) = 3.54\times10^{-3} \times 1.3333K = 4.72$$

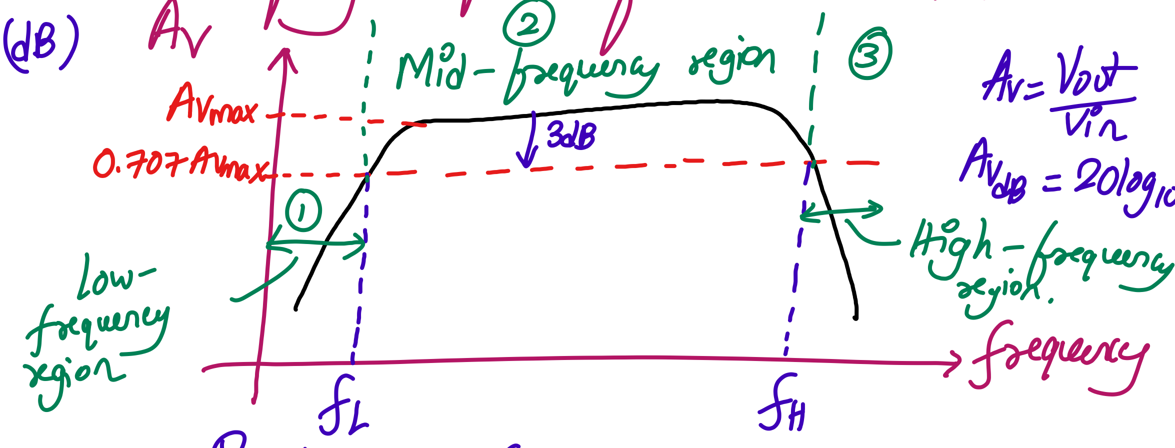
$$Z_{in} = R_S \| \frac{1}{g_m} = 180 \| \left(\frac{1}{3.54\times10^{-3}}\right) = 180 \| 282.48$$

$$\boxed{Z_{in} = 109.94}$$

$$\boxed{Z_{out} = R_D \| R_L = 1.333K\Omega}$$

——×——×—— (Module 2)

Module 3: Frequency response of MOSFET amplifier



$$A_v = \frac{V_{out}}{V_{in}}$$

$$A_{v_{dB}} = 20\log_{10}\left(\frac{V_{out}}{V_{in}}\right)$$

$$\text{Bandwidth} = f_H - f_L$$

93, 95, 24, 25, 82, 45, 17, 22
97, 85, 78, 80, 44, 75, 4, 64,
50, 48, 41, 40, 2, 46, 42