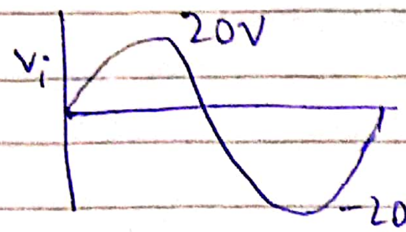
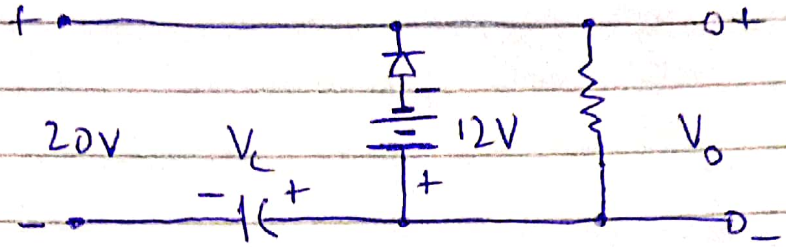
Name: SHAH RAZA Reg No: 18PWCSE1658

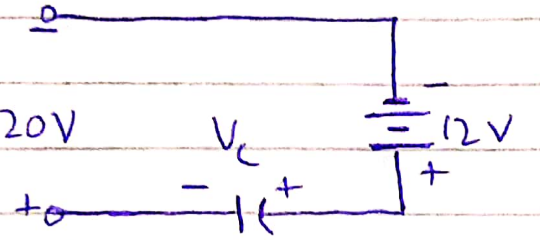
(Q1)

(a)





For V_c the diode should be in on-state



$-12V + V_c + 20V = 0$

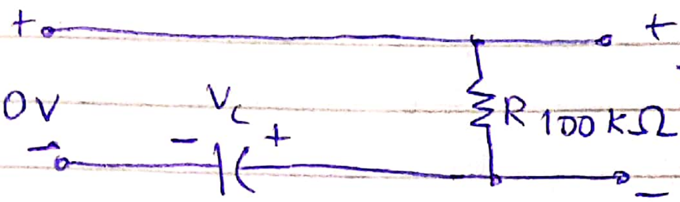
$V_c = -20V + 12V$

$\boxed{V_c = -8V}$ at on state $V_o = -12V$

V_o in the off state

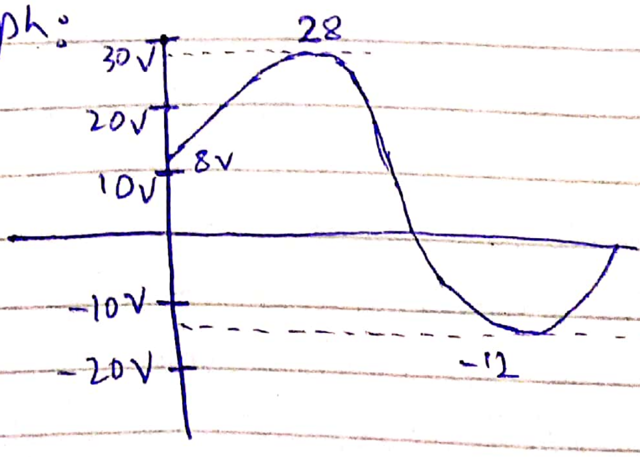
$V_o - 8V - 20V = 0$

$V_o = 28V$



$$V_o = \begin{cases} -12V, & V_i = -20V \\ 20V, & V_i = +20V \end{cases}$$

(b) Output Graph:



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(Q2)

(a).

$$I_E = \frac{V_{EE} - V_{BE}}{R_E}$$

$$= \frac{8 - 0.7}{2200}$$

$$\boxed{I_E = 3.32\ mA}$$

(b)

$$V_C = V_{CC} - I_C R_C$$

$$\approx V_{CC} - I_E R_C$$

$$= 10 - (3.32 \times 10^{-3})(1800)$$

$$\boxed{V_C = 4.02V}$$

(c)

$$V_{CE} = V_{CC} + V_{EE} - I_C(R_C + R_E)$$

$$= 10 + 8 - (3.32 \times 10^{-3})(2200 + 1800)$$

$$\boxed{V_{CE} = 4.72\ V}$$

(Q3)

$V_{EE} = 6V$ $\quad R_E = 6.8 \times 10^3$

$\alpha = 0.998$ $\quad R_c = 4.7 \times 10^3$

$V_{CC} = -10V$

(a)

$$r_e = \frac{26mV}{I_E}$$

$$I_E = \frac{6-0.7}{6.8\times10^3}$$

$$= 7.79 \times 10^{-4}$$

$$\boxed{r_e = 33.35\ \Omega}$$

(b)

$$Z_i = R_e \parallel r_e$$

$$Z_i = \frac{R_e \times r_e}{R_e + r_e}$$

$$= \frac{6.8\times10^3 \times 33.5}{6.8\times10^3 + 33.5}$$

$$\boxed{Z_i = 33.187}$$

$$Z_o = R_c$$

$$\boxed{Z_o = 4.7\times10^3\ \Omega}$$

(c)

$$A_V = \frac{V_o}{V_i} = \alpha \frac{R_c}{r_e}$$

$$\cong \frac{R_c}{r_e}$$

$$A_V = 0.998 \times \frac{4.7\times10^3}{33.35}$$

$$\boxed{A_V = 142}$$

|Q4|

(a) $I_{DSS} = 12\ mA$, $V_p = -4V$

Using short hand method, when $V_{GS} = 0$,

$$I_D = I_{DSS} = 12\ mA$$

When $V_{GS} = V_p = -4V$,

$$I_D = 0\ mA$$

When $V_{GS} = 0.3 V_p = -1.2V$,

$$I_D = I_{DSS}/2$$

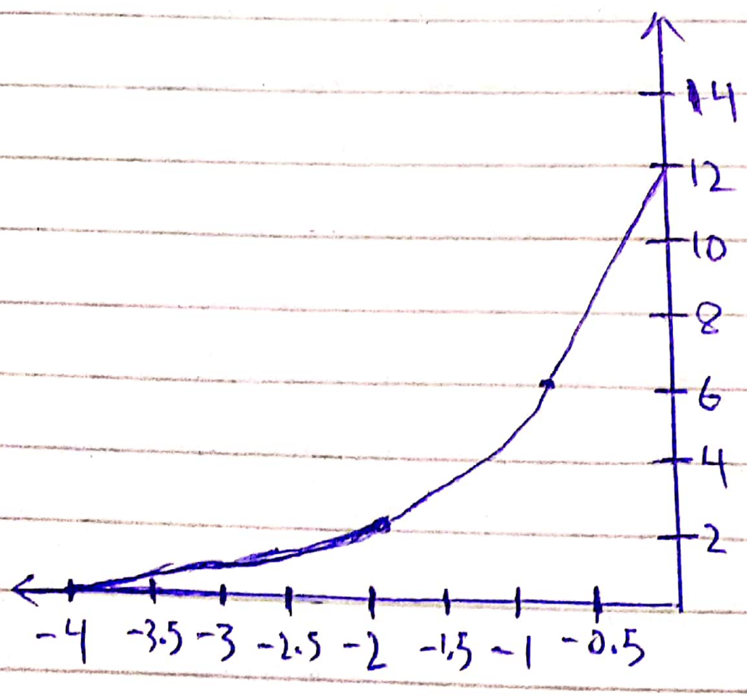
$$= \frac{12\ mA}{2}$$

$$= 6\ mA$$

When $V_{GS} = 0.5 V_p = -2V$

$$I_D = 12\ mA/4$$

$$I_D = 3\ mA$$



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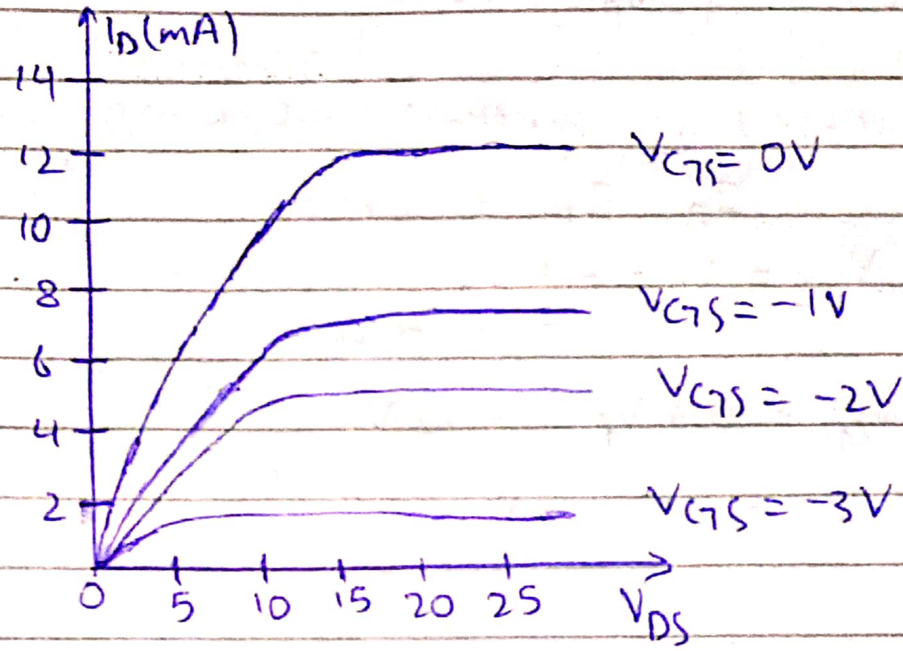
(b)



(Q5)

$V_{GS} = 5V$

$I_{Don} = 4mA$

$V_{DSon} = 0.1V$

$V_{DSon} = V_D - V_S$

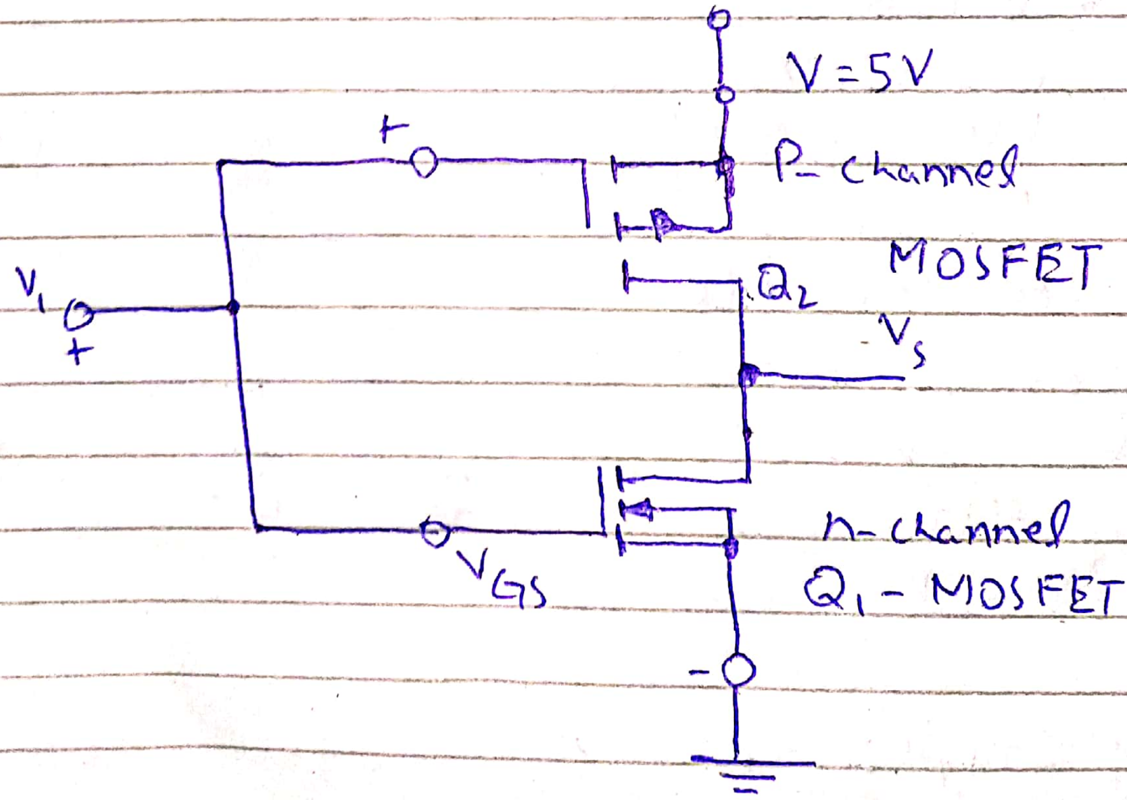
$V_S = 5V$ so,

$V_{DSON} + V_S = V_D$

$V_D = 5 + 0.1$

$V_D = 5.1V$

Schematic Diagram:



(Q6)

(a) We know that from the given figure

$$V_G = \frac{110 \times 10^3}{110 \times 10^3 + 910 \times 10^3} \times 20$$

$$\boxed{V_G = 2.157\,V}$$

(b)

Using the shorthand method to evaluate data points of the transfer curve

$V_{GS}(V)$	$I_D(mA)$
0	$I_{DSS} = 10$
$0.3V_p = -1.05$	$\frac{I_{DSS}}{2} = 5$
$0.5V_p = -1.75$	$\frac{I_{DSS}}{4} = 2.5$
$V_p = -3.5$	0

From the network equation,

$$V_{GS} = V_G - I_D R_S$$
$$= 2.157 - 1100 I_D$$

For $I_D = 0\,mA$

$$V_{GS} = 2.157 - 0(1100)$$
$$= 2.157\,V$$

For $I_D = 4\,mA$

$$V_{GS} = 2.157 - (0.004)(1100)$$
$$= -2.243\,V$$

After sketching the transfer curve with the network equation on the same graph and noticing the intersection.

$$\boxed{I_{DQ} = 3.3\ mA}$$

$$\boxed{V_{GSQ} = -1.5\ V}$$

(c) we know that

$$V_D = V_{DD} - I_D R_D$$
$$= 20 - (0.0033)(2200)$$
$$\boxed{V_D = 12.74\ V}$$

Source voltage can be evaluated through the voltage pull up from ground across R_S,

$$V_S = I_D R_S$$
$$= (0.0033)(1100)$$
$$\boxed{V_S = 3.63\ V}$$

(d) we know that

$$V_{DS} = V_D - V_S$$
$$= 12.74 - 3.63$$
$$\boxed{V_{DS} = 9.11\ V}$$