Problem #1

Let $V_{out1} = V_{out}$ due to the 12V supply only ($I_D=0$)
$V_{out2} = V_{out}$ due to the 0.6mA current source.

*When calculating $V_{out1}$, current source is open.*

\[
V_{out1} = \frac{12V}{(10k+20k)} \times 20k = 8V
\]

*When calculating $V_{out2}$, voltage source is shorted,*

\[
V_{out2} = -\frac{1}{3} \times 0.6mA \times 20k = -4V
\]

\[V_{out} = V_{out1} + V_{out2} = 8 - 4 = 4V\]
Problem #2:

(a) \[
\begin{array}{c}
V_S = 15V \\
\end{array}
\]
\[
\begin{array}{c}
R_1 = 10k \\
V_o = \frac{R_2}{R_1 + R_2} \\
R_2 = 5k \\
\end{array}
\]

* In order to find $V_{os}$, find $V_o$ without any load at the output. i.e.
\[
V_o = \frac{R_2}{R_1 + R_2} \times 15V = 5V
\]

* In order to find Thevenin output impedance ($R_o$), short all independent voltage supplies & open all independent current sources & find the output impedance looking into the output port. i.e.
\[
R_o = \frac{R_1}{R_1 + R_2} = \frac{5k \times 10k}{5k + 10k} = 3.3k
\]

Thevenin's Equivalent:
\[ V_{out_1} = \frac{5k}{5k+10k} \times 15V = 5V \]

\[ V_{out_2} = 0 \]

\[ V_{os} = V_{out_1} + V_{out_2} = 5V + 0 = 5V \]
\[ R_0 = \frac{10k \times 5k}{10k + 5k} = 3.33 \, k\Omega \]

The Thévenin's Equivalent is:

\[ 15V \quad V_o \]

\[ 3.33 k\Omega \]
Problem #3

In order to find $I_{sc}$, we short-circuit the output. Since there are two sources, we will use superposition.

$I_{sc1}$:

$$I_{sc1} = \frac{-12V}{10k} = -1.2\,mA$$

$I_{sc2}$:

$$I_{sc2} = 0.6\,mA$$

$$I_{sc} = I_{sc1} + I_{sc2} = -1.2\,mA + 0.6\,mA = -0.6\,mA$$
\[ R_0 = \frac{20k \times 10k}{20k + 10k} = 6.66 \, k\Omega \]

Norton Equivalent:

\[ -0.6 \, mA \quad \equiv \quad 6.66 \, k\Omega \]

Problem #4

D.C. equivalent circuit:

\[ V_{DD} \]

\[ R_1 \quad R_2 \quad R_c \quad R_e \quad I_{dc} \quad R_L \]
High Frequency equivalent circuit:

\[ V_{GS} \]
\[ R_S \]
\[ R_1 \]
\[ R_2 \]
\[ V_{DD} \]
\[ \text{Problem #5} \]

\[ V_{1} \]
\[ 1\text{mA} \]
\[ 1k \]
\[ 5V \]

\[ \text{KVL:} \]
\[-5 + 1V + V_1 + 1V = 0 \]

\[ \Rightarrow V_1 = 5 - 2 = 3V \]

\[ V_1 = 3V \]
Problem #6

\[ A(s) = \frac{10(s + 200\pi)}{s + 2000\pi} \]

\[ = \frac{1 + \frac{s}{200\pi}}{1 + \frac{s}{2000\pi}} \]

On substituting,

\[ s = j\omega = j2\pi f \]

\[ A(f) = \frac{1 + j\frac{f}{100}}{1 + j\frac{f}{1000}} \]

\underline{Magnitude}

For \( f \ll 100 \),

\[ 20 \log_{10} |A(f)| \approx 20 \cdot \log_{10} (1) = 0 \text{ dB} \]

For \( f \gg 1000 \),

\[ 20 \log_{10} |A(f)| \approx 20 \log_{10} (10) = 20 \text{ dB} \]

\underline{Phase:}

(a) For the numerator

\[ \angle A(f) = 45^\circ \text{ @ } f = 100 \text{ w/ } 90^\circ/\text{decade slope} \]

(b) For the denominator:

\[ \angle A(f) = -45^\circ \text{ @ } f = 1000 \text{ w/ } -90^\circ/\text{decade slope} \]
$20 \log |A(f)|$

$20 \text{dB}$

$90^\circ$

$45^\circ$

$-45^\circ$

$-90^\circ$

Asymptote.

Actual

$\text{Numerator}$

$\text{Denominator}$