problems : 59, 60, 73 & 61-64

59) a) if (A) = 20mA then $V_D = 20 - 20mA \cdot 2k\Omega = -20$
can't get (−) from (+)

proper: $V_D = \frac{1}{2} V_{DD} \Rightarrow$ 10 V across 2K
$\hookrightarrow I = \frac{10V}{2K} = 5mA$

b) $V_G = 0$ $V_S = 5mA \cdot 100\Omega = .5V \rightarrow V_{GS} = -.5$

c) ~~(for high freq)~~ ~~Rfeedback~~ Gain = $g R_D = (.01)(2000) = -20$ (inverts)

d) $R_G = 100k$

e) (for high freq) $R_D = 2k$

66) select $V_{DD} = 12V$ Q @ $V_{GS} = -.2$ & $V_{DS} = 6V$ & $I_d = 4.7mA$

$R_D = \frac{12-6}{4.7mA} = 1.3k\Omega$ select R_G "big" say 1M

$I_D R_S = V_S = .2 \Rightarrow R_S = \frac{.2V}{4.7mA} = 43\Omega$

$\frac{1}{\omega C_S} = \frac{1}{10} R_S \Rightarrow C_S = \frac{10}{\omega R_S} = \frac{10}{2\pi \cdot 100 \cdot 43} = 370\mu F$
(select freq min = 100 Hz)

$\frac{1}{\omega C_{out}} = R_D \Rightarrow C_{out} = \frac{1}{\omega R_D} = \frac{1}{2\pi \cdot 100 \cdot 1300} = 1.2\mu F$

$Z_{out} = R_D$; $Z_{in} = R_G$

$g = \frac{\Delta I_D}{\Delta V_G} = \frac{3.7mA}{.2V} = 18.5 \; m\Omega^{-1}$

gain = $A_v = g R_D = -18.5m\Omega^{-1} \cdot 1.3k\Omega = -24$

73) Q @ $I_D = 3mA$, $V_{GS} = -1.5V$, $V_{DS} = 6V$ $V_{DD} = 12V$

power = $3mA \cdot 6V = 18mW$

R_D (from y intercept of load line) = $2k\Omega$

$R_S = \frac{1.5V}{3mA} = 500\Omega$ $g = \frac{\Delta I_D}{\Delta V_G} = \frac{2.6mA}{1V} = 2.6 m\Omega^{-1}$

gain = $A_v = g R_D = -(2.6m\Omega^{-1})(2000) = -5.2$

$R_G \sim 1M\Omega$; $I_{DSS} = 8.5mA$ V_T (estimate) = $-3.2V$
$\hookrightarrow$ WAPP $\rightarrow -3.8V$

73 move)

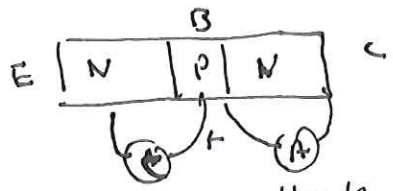
$$C_S = \frac{10}{\omega R_S} = \frac{10}{2\pi \cdot 100 \cdot 500} = 32\,\mu F$$

$$C_{out} = \frac{1}{\omega R_D} = \frac{1}{2\pi \cdot 100 \cdot 2000} = .8\,\mu F$$

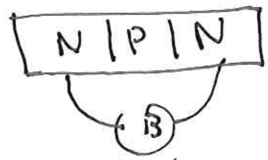
Z_{out} (high freq) $= R_D = 2k$

$Z_{in} = R_G = 1M\Omega$

61)



Low High (back biased diode)



High (one of PN junctions must be back biased)

62)

$$I_C = \frac{\Delta V}{R_C} = \frac{10-5}{4000} = 1.25\,mA$$

$$I_B = \frac{\Delta V}{R_B} = \frac{10-.6}{100{,}000} = 94\,\mu A$$

$\Big\} = h = 13.3$

Power $= V_{CE} \cdot I_C = 5 \cdot 1.25 = 6.25\,mW$

63) $(V_1) = .6$ for any B

$B = 80$: $I_B = \frac{15-.6}{200K} = 72\,\mu A$; $I_C = 80 \cdot I_B$; $V_2 = 15 - 2000 \cdot I_C$

$I_C = 5.76\,mA$ (A)

$V_2 = 15 - 11.5 = 3.48\,V$ (V_2)

$B = 160$: $I_B =$ same ; " = " 2x above $= 11.5\,mA$ BUT ; $= 15 - 2 \times (11.5) < 0$ ← Not Possible

So: This transistor is "saturated" with $V_{CE} \sim .2V$ (ie essentially zero)

with $(A) = \frac{15-.2}{2000} = 7.4\,mA$ (A max)

64: (left): $V_{out} = 2.4V$ for any β

(middle) $3V = I_E \cdot R_E + .6 + I_B \cdot R_B$

$= ((\beta+1) R_E + R_B) I_B + .6$

$$\frac{2.4}{((\beta+1) R_E + R_B)} = I_B$$

$$V_{out} = R_E I_E = R_E (\beta+1) I_B = \frac{R_E\ 2.4\ (\beta+1)}{((\beta+1) R_E + R_B)}$$

$\beta = 50$: $\frac{3k \cdot 2.4 \cdot 51}{(51 \cdot 3k + 100k)} = 1.45V$

$\beta = 100$ $\frac{3k \cdot 2.4 \cdot 101}{(101 \cdot 3k + 100k)} = 1.80V$

(right) $I_B = \frac{(10 - .6)}{R_B}$; $I_c = \beta I_B$

$$V_{out} = 10 - R_c I_c = 10 - \frac{(10 - .6)}{R_B} \beta R_c$$

$\beta = 50$ $= 10 - \underbrace{\frac{9.4}{200k} \cdot 50 \cdot 3k}_{7.05} = 2.95V$

$\beta = 100$ $= 10 - 2 \times 7.05 < 0$ ← Not possible

This transistor is "saturated" with $V_{CE} \sim .2V$