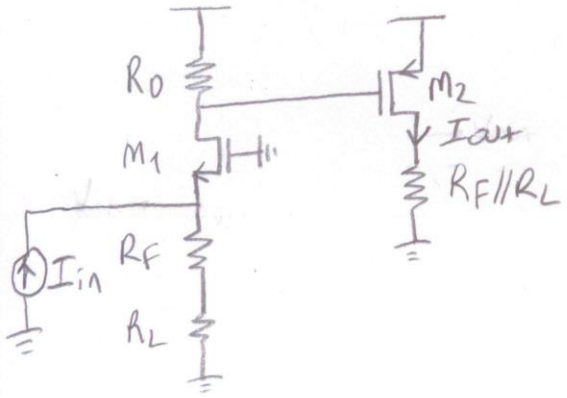
EHB 335E - HOMEWORK IV - SOLUTIONS - ALICAN GAGLAR

(1) If $V_{in}\uparrow$, since values of the currents on every branch are constant, $V_{S_1}\uparrow$

$\Rightarrow V_{D2}\uparrow,\ V_{out}\uparrow,\ V_{D2}\downarrow,\ V_{out}\downarrow$ $\Rightarrow$ So, it is a negative feedback.

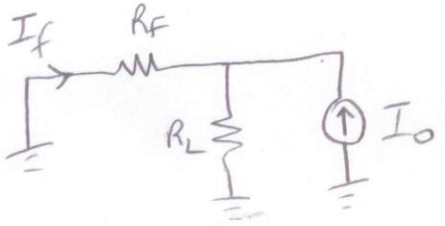
(2) It is a current amplifier (Shunt-Series)



$$R_{out} = R_F \,//\, R_L$$

$$R_{in} = 1/g_{m1} \,//\, (R_F + R_L)$$

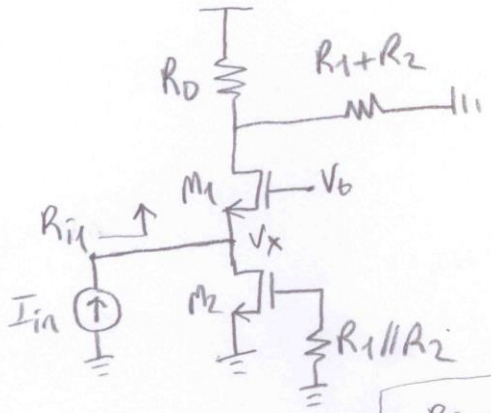
$$A = \frac{I_{out}}{I_{in}} = \frac{-R_F + R_L}{1/g_{m1} + R_F + R_L} \cdot R_D \cdot g_{m2}$$



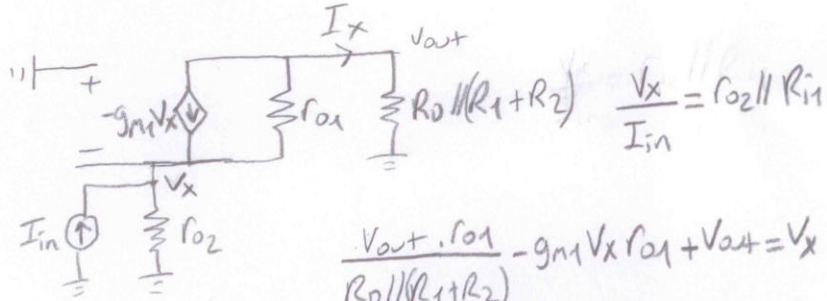
$$\frac{I_f}{I_o} = \beta = \frac{-R_L}{R_f + R_L} \Rightarrow A_f = \frac{A}{1 + A\beta}$$

$$R_{of} = R_{out}(1 + A\beta) \qquad R_{if} = \frac{R_{in}}{1 + A\beta}$$

(3) It is a transresistance amplifier (Shunt-Shunt)



$\Rightarrow$



$$\frac{V_x}{I_{in}} = r_{o2} \,//\, R_{i1}$$

$$\frac{V_{out} \cdot r_{o1}}{R_D // (R_1 + R_2)} - g_{m1} V_x r_{o1} + V_{out} = V_x$$

$$\frac{V_{out}}{V_x} = \frac{(1 + g_{m1} r_{o1})(R_D // (R_1 + R_2))}{r_{o1} + R_D // (R_1 + R_2)}$$

$$R_{i1} = \frac{r_{o1} + R_D // (R_1 + R_2)}{1 + g_{m1} r_{o1}}$$

$$A = \frac{V_x}{I_{in}} \cdot \frac{V_{out}}{V_x} = \frac{R_D // (R_1 + R_2) \cdot r_{o2}}{r_{o2} + R_{i1}}$$

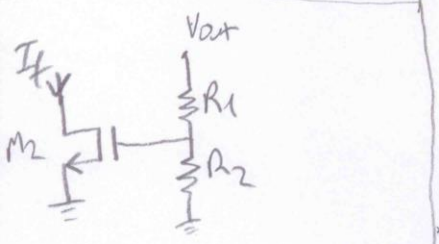
$$A_f = \frac{A}{1 + A\beta}$$

$$R_{in} = R_{i1} \,//\, r_{o2}$$

$$R_{out} = R_D // (R_1 + R_2) // (g_{m1} r_{o1} r_{o2} + r_{o2} + r_{o1})$$

$$R_{if} = \frac{R_{in}}{1 + A\beta}$$

$$R_{of} = \frac{R_{out}}{1 + A\beta}$$



$$\frac{I_f}{V_{out}} = \beta = \frac{R_2}{R_1 + R_2} \cdot g_{m2}$$

4) a)

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        --- Operating Point ---

V(n004):        1.1             voltage
V(n001):        1.8             voltage
V(n003):        1.22707         voltage
V(n005):        0.561053        voltage
V(n002):        1.65591         voltage
Id(M2):         0.000286464     device_current
Ig(M2):         0               device_current
Ib(M2):         -1.80813e-012   device_current
Is(M2):         -0.000286464    device_current
Id(M1):         0.000835643     device_current
Ig(M1):         -0              device_current
Ib(M1):         -1.65592e-012   device_current
Is(M1):         -0.000835643    device_current
I(R2):          0.00112211      device_current
I(R1):          0.000286464     device_current
I(V2):          -0.00112211     device_current
I(V1):          0               device_current
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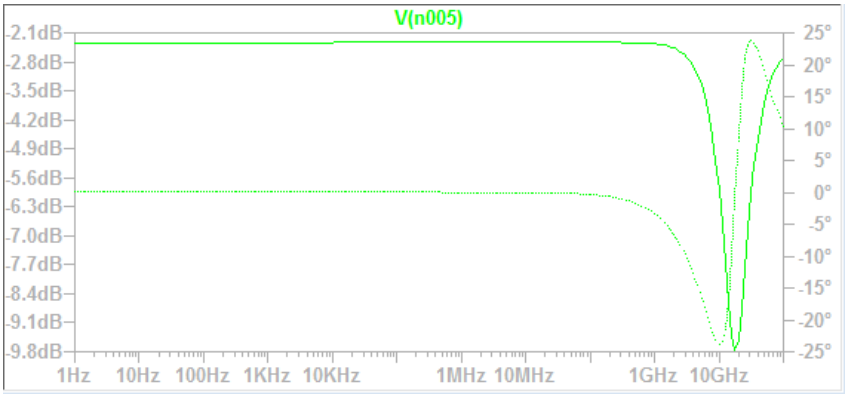
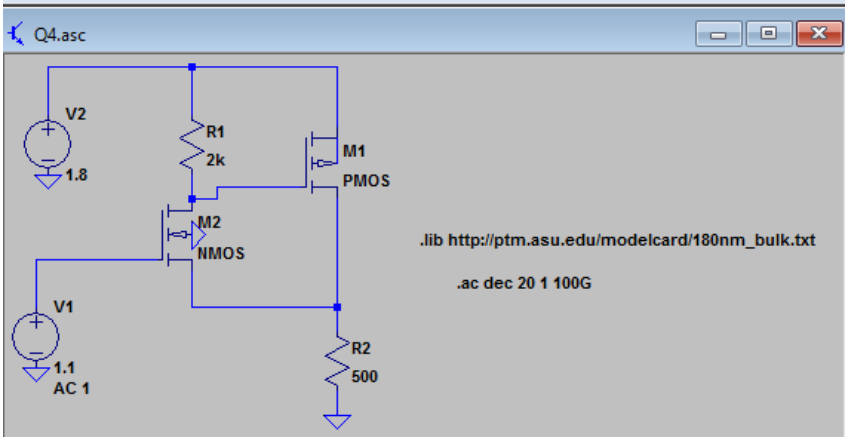
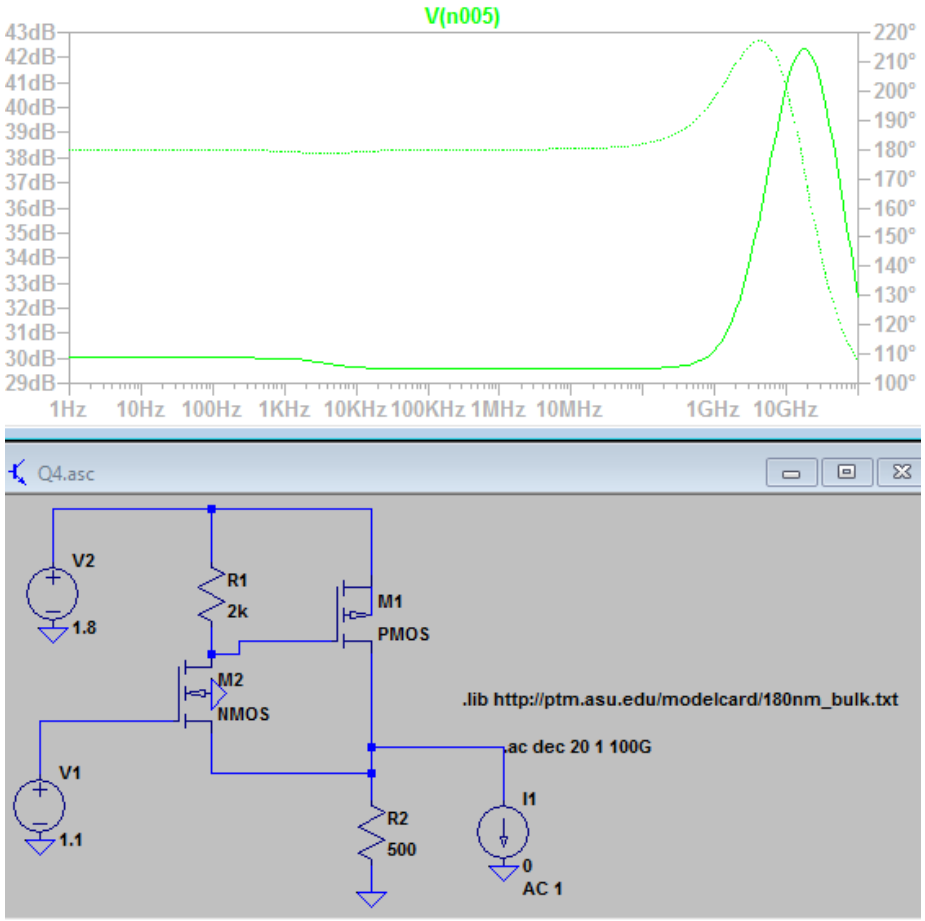
b)

The closed loop gain:





The output impedance:



The input impedance is infinite.