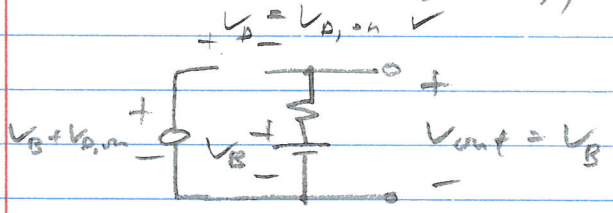
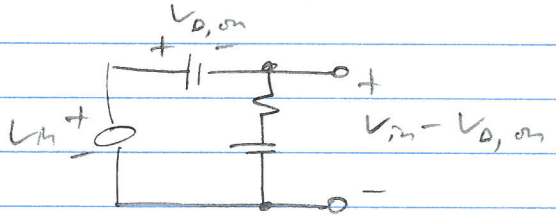
ECEn 340 Practice Midterm 1 Solutions

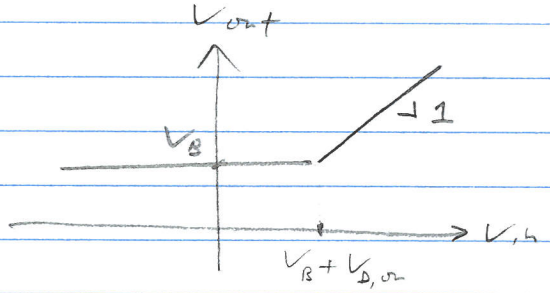
1. Assume diode is just off when $V_{in} = V_B + V_{D,on}$



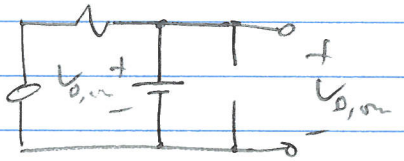
If $V_{in} < V_B + V_{D,on}$, diode is off, $V_{out} = V_B$

If $V_{in} > V_B + V_{D,on}$

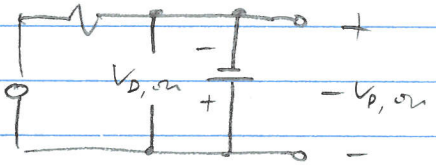




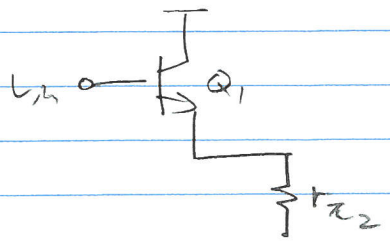
2. If $V_{o,sat} > V_{D,on}$



If $V_{o,sat} < V_{D,on}$

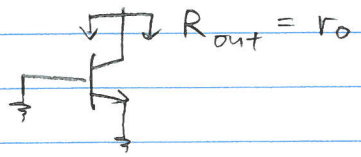


3

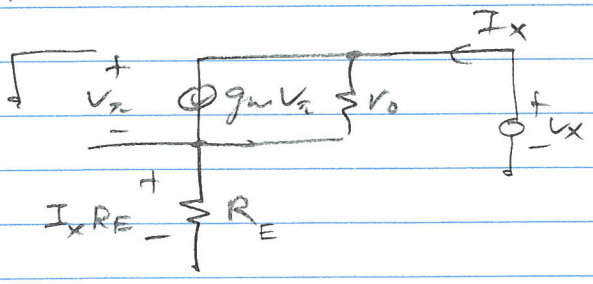


$$R_{in} = r_{\pi_1} + \beta r_{\pi_2}$$

4. S.S.



5- S.S.



$$V_\pi = -I_x R_E$$

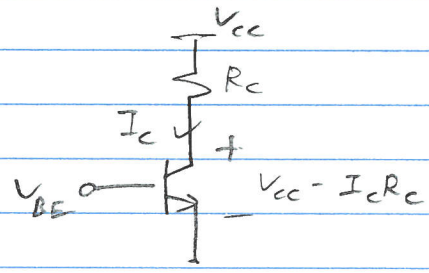
$$I_x = g_m V_\pi + \frac{V_x - I_x R_E}{r_o}$$

$$= -g_m I_x R_E + \frac{V_x}{r_o} - \frac{I_x R_E}{r_o}$$

$$I_x \left(1 + g_m R_E + \frac{R_E}{r_o}\right) = \frac{V_x}{r_o}$$

$$\frac{V_x}{I_x} = r_o + R_E + g_m R_E r_o$$

6.



At the edge of active mode when

$$V_{BE} = V_{CE} = V_{CC} - I_C R_C = V_{CC} - I_S e^{V_{BE}/V_T} R_C$$

$$I_S = \frac{V_{CC} - V_{BE}}{R_C} e^{-V_{BE}/V_T}$$

7.

$$I_C = I_S e^{V_{BE}/V_T} \left(1 + \frac{V_{CE}}{V_A}\right)$$

$$V_{CE} = 2.5 - I_C \times 2k$$

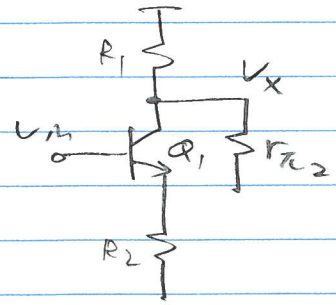
$$I_C = \underbrace{I_S e^{V_{BE}/V_T}}_{231\mu} \left(1 + \frac{2.5 - I_C \times 2k}{5}\right)$$

$$= 231\mu + 115\mu - 92.4m I_C$$

$$I_C (1 + 92.4m) = 346\mu$$

$$I_C = 0.317 \text{ mA}$$

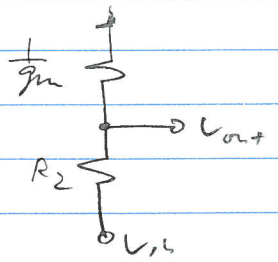
8 S.S.



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

$$= \frac{-g_{m_1}(R_1 \| r_{\pi_2})}{1 + g_{m_1} R_2} \times -g_{m_2} R_3$$

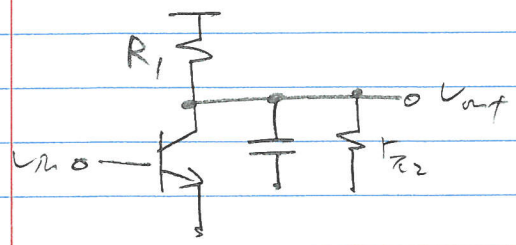
9. S.S.



$$V_{out} = V_{in} \frac{\frac{1}{g_m}}{\frac{1}{g_m} + R_2}$$

$$\frac{V_{out}}{V_{in}} = \frac{1}{1 + g_m R_2}$$

10. S.S.



$$\frac{V_{out}}{V_{in}} = -g_m \left(R_1 \| r_{\pi_2} \| \frac{1}{sC} \right)$$

$$= \frac{-g_m R_1 \| r_{\pi_2}}{1 + s (R_1 \| r_{\pi_2}) C}$$

$$\omega_{-3dB} = \frac{1}{(R_1 \| r_{\pi_2}) C}$$