NAME: SOLUTION SET

April 30th, 2013

MAXIMUM POINTS: 100

EECE 322: Electronics-II (Spring 2013, University of New Mexico)
MAKE-UP EXAMINATION

RULES:

- Write your name on the top left corner
- Time Allotted = 75 Minutes
- Closed Book and Closed Notes
- You are allowed one single sided 8.5 x 11 page of formulae
- You may use a calculator
- Write your answers on the question paper. You may use additional sheets if needed.

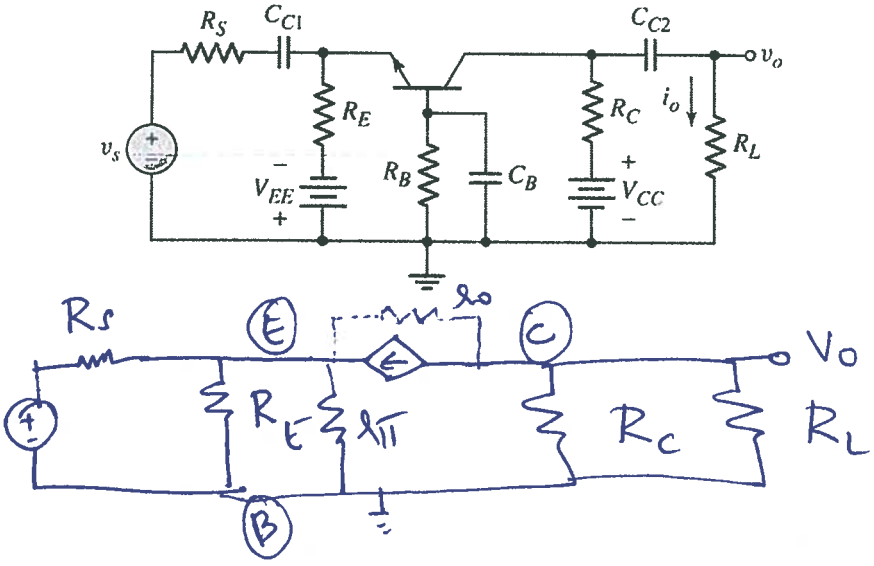
HINTS:

- Please read the questions carefully and only provide only the information that is requested. This will save you time.
- If you are stuck in a particular question, move on to the next and come back to the question later. Solving the easy problems will give you confidence to solve the more challenging questions.

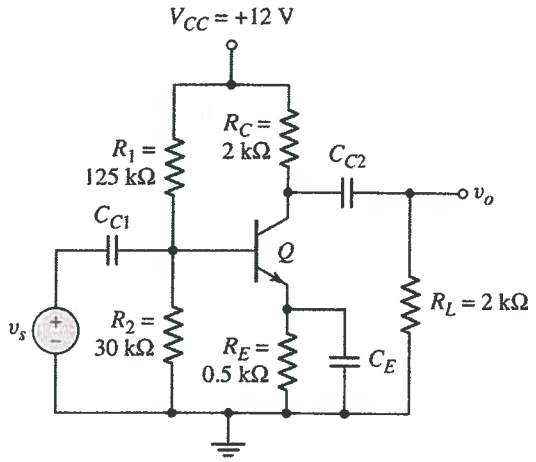
Section A: Conceptual Questions (60 Points)

1. Draw the AC equivalent circuit for the mid-band frequency response range.

8 Points



2 Consider the circuit below. Determine the power dissipated in R_C, R_L and the transistor when v_s=0. Assume β=80, $V_{BE}(on)$=0.7V and V_A=infinity. From the DC analysis, it is determined that the I_{CQ}=2mA and V_{CEQ}=6.99V. *9 Points*



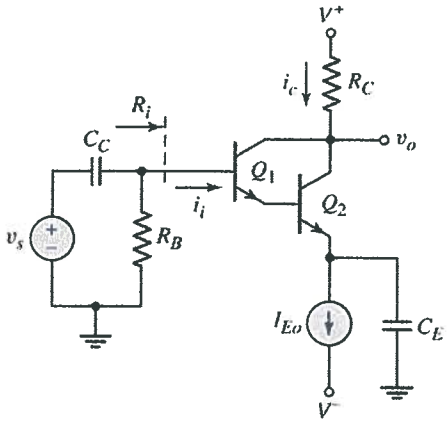
$$P_{R_C} = I_{CQ}^2 R_C = 8mW$$

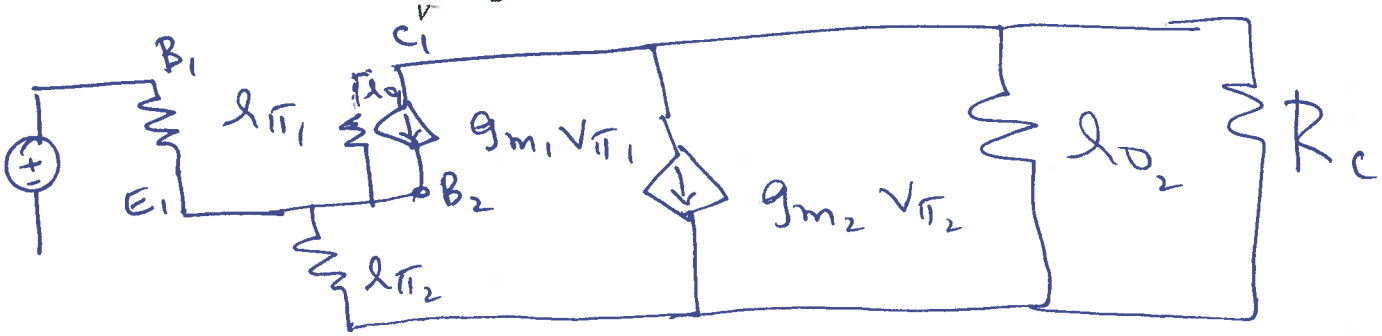
$$P_{R_L} = 0$$

$$P_Q = I_{CQ} V_{CEQ} + I_{BQ} V_{BEQ} = 14.0mW$$

3 Draw the AC equivalent circuit for the following circuit. Ignore the coupling and bypass capacitors.

8 Points





4. When analyzing a transistor circuit in the high frequency range, the following assumptions can be made

5 Points

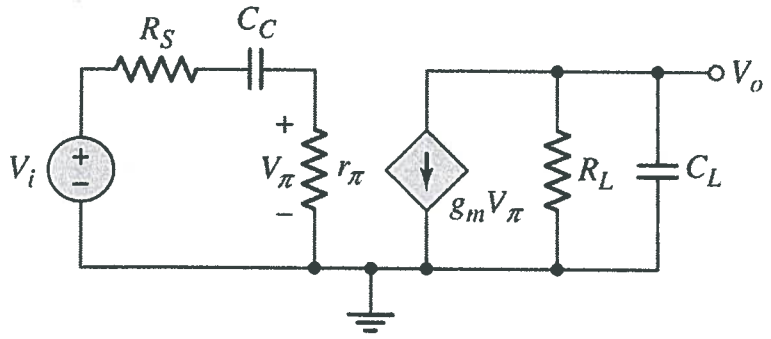
(A) Ignore the effects of the coupling and bypass capacitors and include the effects of the load capacitor

(B) Ignore the effects of the coupling and load capacitors and include the effects of the bypass capacitor

(C) Ignore the effects of the load capacitors and include the effects of the coupling and bypass capacitor

(D) Ignore the effects of the load and bypass capacitors and include the effects of the coupling capacitor

5. Consider the circuit below. Determine the upper 3dB frequency. The parameters are R_s=100Ω, R_L=10KΩ,r_π=2.4KΩ, g_m=50mA/V,C_c=5 μF and C_L=4pF. *8 Points*

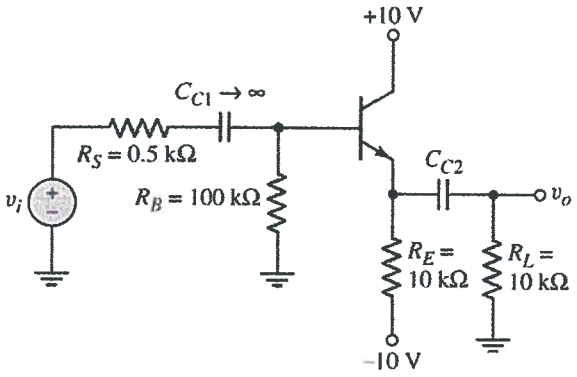


$\tau_p = R_L C_L = 0.044s$

$f_H = \frac{1}{2\pi\tau_p} = 3.98\,MHz$

6. Determine the lower 3dB frequency for the following circuit. Assume that the effect of C_{C1} can be ignored. Assume that the $\beta=100, V_{BE}(on)=0.7V$, $V_A=120V$, $C_{C2}=1\mu F$. The small signal AC parameters are $r_\pi=3.1K\Omega$, $g_m=32.2mA/V$ and $r_0=143K\Omega$.

8 Points



$$R_o = R_E \| r_o \| \frac{r_\pi + R_S \| R_B}{(1+\beta)}$$

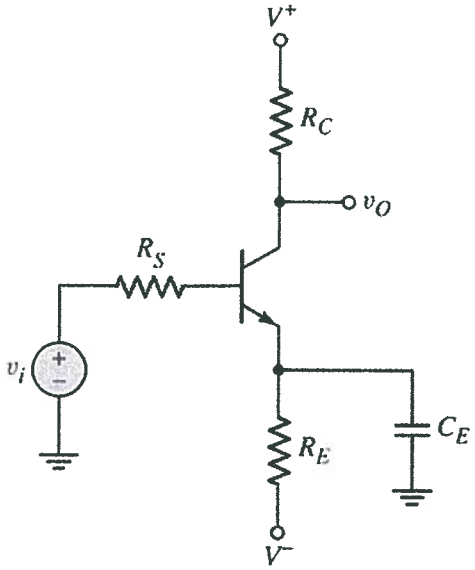
$$= 35.5\,\Omega$$

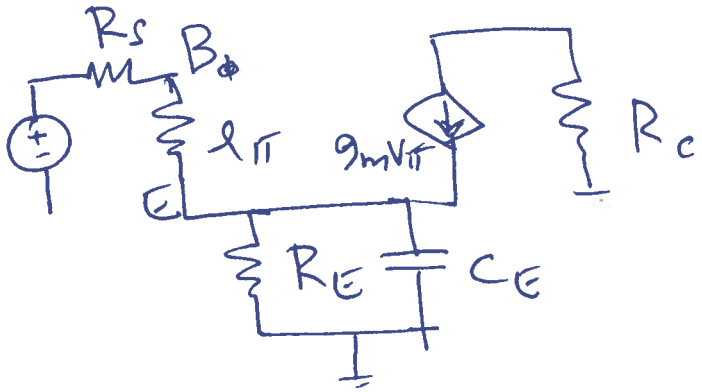
$$\tau_s = [R_o + R_L]\, C_{C_2} = \approx 10ms$$

$$f_L = \frac{1}{2\pi\tau_s} = 15.9\,Hz$$

7. Draw the AC equivalent circuit for the following circuit. Make sure you include the emitter bypass capacitor in the circuit.

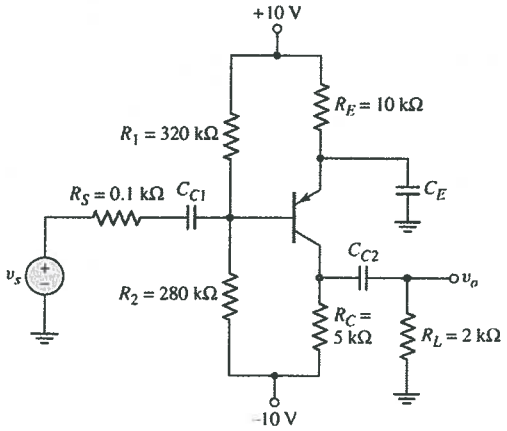
8 Points

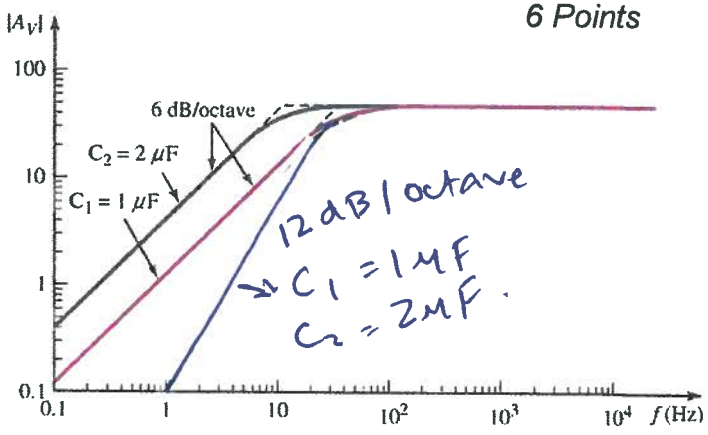




8. Consider the circuit shown below. The Bode plots for the circuit including only the input coupling capacitor (C_1=1μF) is shown in pink. Similarly, the Bode plot for the circuit including only the output coupling capacitor (C_2=2μF) is shown in black. Draw the Bode plot for the circuit if both the coupling capacitors are included. Indicate the slope of the curve in dB/octave.

6 Points

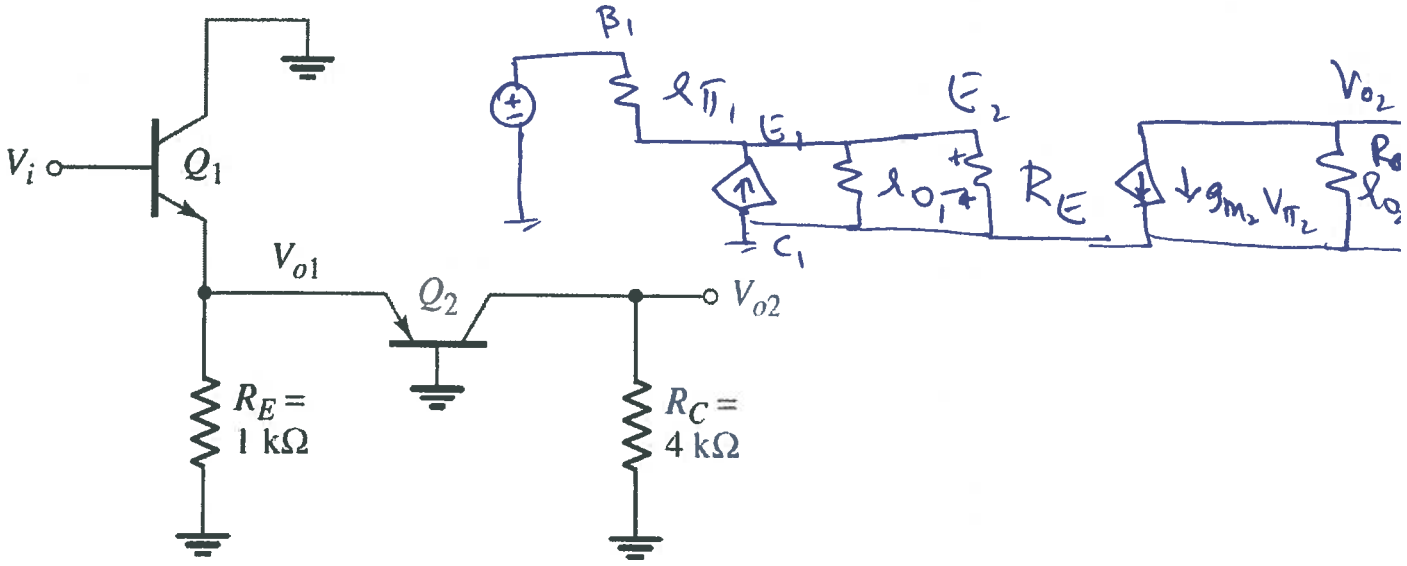




Section B: Problems (40 Points)

20 Points

B.1. Consider the ac equivalent circuit in Figure P6.73. The transistor parameters are $\beta_1 = 120$, $\beta_2 = 80$, $V_{A1} = V_{A2} = \infty$, and $I_{CQ1} = I_{CQ2} = 1$ mA. (a) Find the small-signal voltage gain $A_{v1} = V_{o1}/V_i$. (b) Determine the small-signal voltage gain $A_{v2} = V_{o2}/V_{o1}$. (c) Find the overall small-signal voltage gain $A_v = V_{o2}/V_i$.



(a) $g_{m_1} = g_{m_2} = 38.46\,mA/V$.

$r_{\pi_1} = 3.12\,k\Omega$ $\quad r_{\pi_2} = 2.08\,k\Omega$.

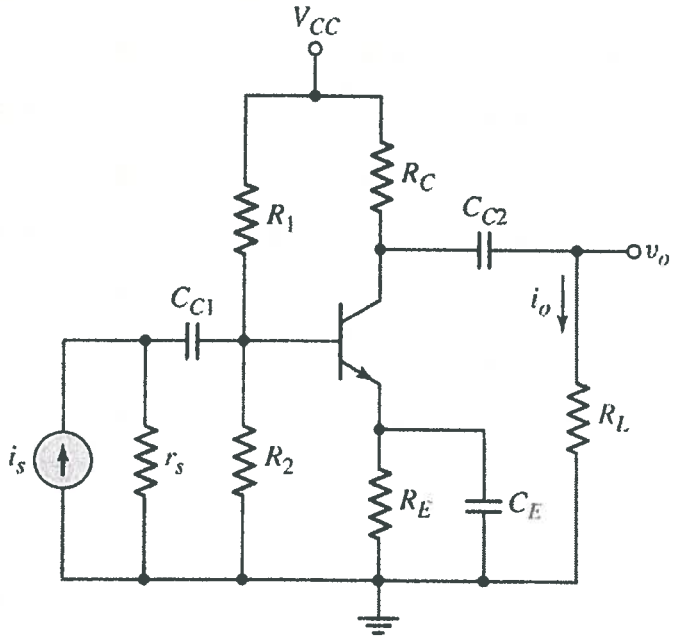
$$A_{V_1} = \frac{V_{o1}}{V_i} = \frac{1+\beta_1\left[R_E \,\|\, (r_{\pi_2} \,\|\, 1+\beta_2)\right]}{r_{\pi_1} + (1+\beta_1)\left(R_E \,\|\, \dfrac{r_{\pi_2}}{1+\beta_2}\right)} = 0.493$$

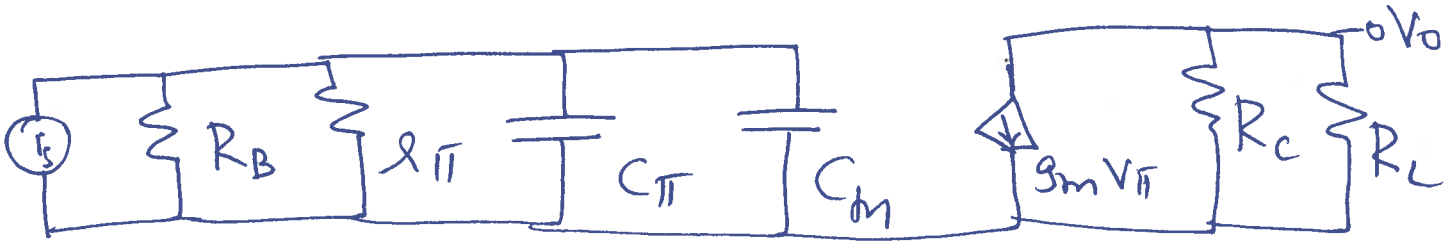
(b) $$A_{V_2} = \frac{V_{o_2}}{V_{o_1}} = g_{m_2} R_C = 153.8$$

(c) $$A_V = \frac{V_{o_2}}{V_i} = A_{V_1} A_{V_2} = 75.8.$$

B.2. Determine the 3dB cut off frequency of the current gain for the circuit shown below in the following two cases (a) including the Miller capacitance and (b) ignoring the Miller capacitance (C_M=0). The circuit parameters are R_C=R_L=4KΩ, r_π=2.6KΩ, R_B=r_S||R_1||R_2=200KΩ,C_π=0.8pF,C_m=0.05pF and g_m=38.5mA/V.

20 Points





$$I_o = -g_m V_\pi \left(\frac{R_C}{R_C + R_L}\right)$$

$$V_\pi = I_s \left[R_B \| r_\pi \| 1/j\omega C_\pi \| 1/j\omega C_M\right]$$

$$A_i = \frac{I_o}{I_s} = -g_m \left(\frac{R_C}{R_C + R_L}\right)\left[\frac{R_B \| r_\pi}{1 + j\omega (R_B \| r_\pi)(C_\pi + C_M)}\right]$$

$$f_{3dB} = \frac{1}{2\pi (R_B \| r_\pi)(C_\pi + C_M)} = 13.2 \text{ MHz}$$

With $C_M = 0$ $\quad f_{B\,3dB} = \frac{1}{2\pi (R_B \| r_\pi)(C_\pi)} = 77.5 \text{ MHz}$