國立臺灣科技大學
九十二學年度碩士班招生考試試題
系所組別：電機工程系碩士班乙二組、電機工程系碩士班丙二組
科　目：電子學

總分100分

1. Consider the following MOSFET common-source stage:

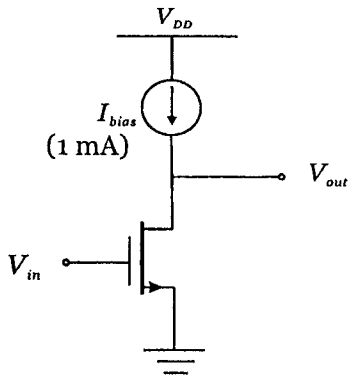

Fig. P1.1

with V_{DD} = 5 V, I_{bias} = 1 mA. For the MOSFET, assume the threshold voltage, V_{TN}, is 0.7 V, the process transconductance parameter, k'_n, is 100 μA/V^2, the channel-length modulation, λ_n, is 0.05 V^{-1}, and the body-effect coefficient is neglected.

(a) (5 points) Find the dc value of the input voltage such that the ac voltage gain is – 100.

(b) (5 points) Find the value of $(W/L)_n$ of this NMOS transistor.

(c) (10 points) If the circuit is reconfigured as shown in Fig. P1.2 and assume that the current source is actually implemented by a PMOS circuit where the PMOS has V_{TP} = – 0.7 V, k'_p = 30 μA/V^2, $(W/L)_p$ = 10, λ_p = 0.03 V^{-1}. Find the new ac voltage gain and voltage V_{GP}, respectively.

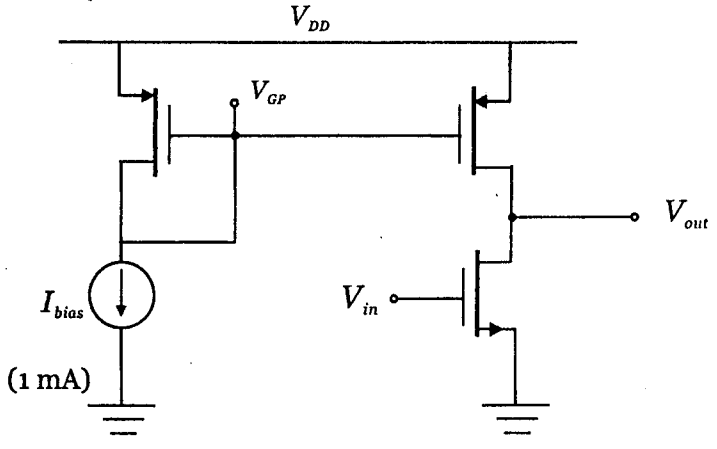

Fig. P1.2

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2. The following figure, Fig. P2 , is considered.

(a) (10 points) Determine the Q-point values I_{CQ} and V_{CEQ} of this transistor circuit.

(b) (10 points) Sketch the ac equivalent circuit under the assumption that the output capacitor represents a short circuit for ac frequencies of interest and find an expression for the ac current gain $A_I = \frac{I_{out}}{I_{in}}$.

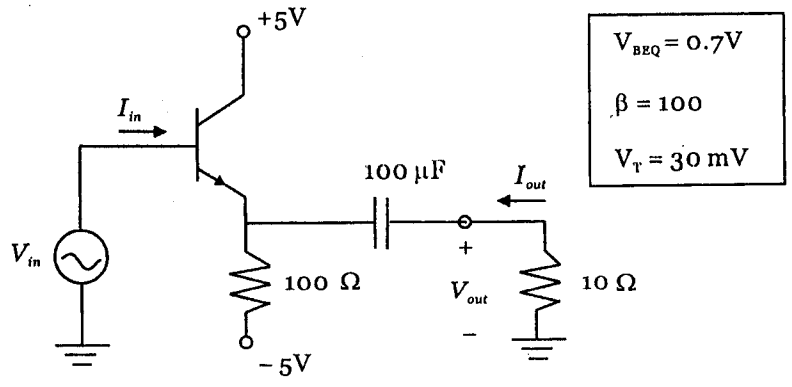

Fig. P2

3. (10 points) Assuming the diodes in the circuits of Fig. P3 are ideal, find the values of the labeled voltage V_X and current **I**.

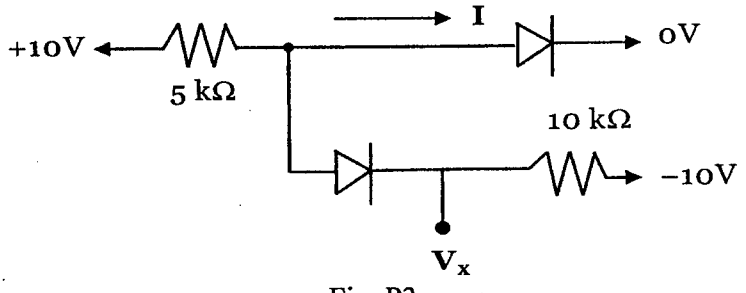

Fig. P3

4. (18 points) Consider the circuit shown in Fig.P4. Let $R_S = 100K\Omega$, $R_E = 820\Omega$, $r_\pi = 1.1K\Omega$, Q_2 be biased at $I_E = 5mA$, and $\beta_1 = \beta_2 = 100$ for Q_1 and Q_2. Determine R_{in}, R_{out}, $A_V = \frac{V_O}{V_S}$ and $A_I = \frac{I_{E_2}}{I_S}$. Calculate to 3 significant digits.

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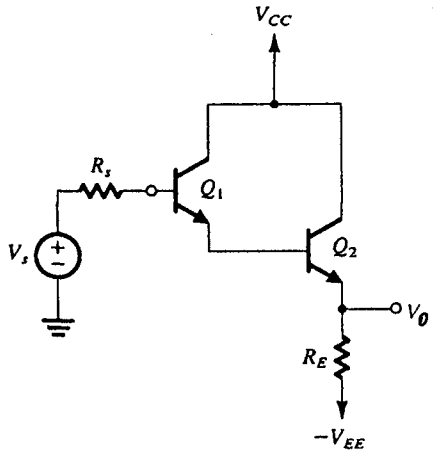

Fig. P4

5. (16 points) For the circuit shown in Fig.P5, describe the theory of operation of the circuit by drawing a diagram in which the voltage transfer curve, the v_I *vs.* t and the v_O *vs.* t curves are put together and the input signal is a sinusoid. Determine the power conversion efficiency η and the maximum efficiency η_{max}.

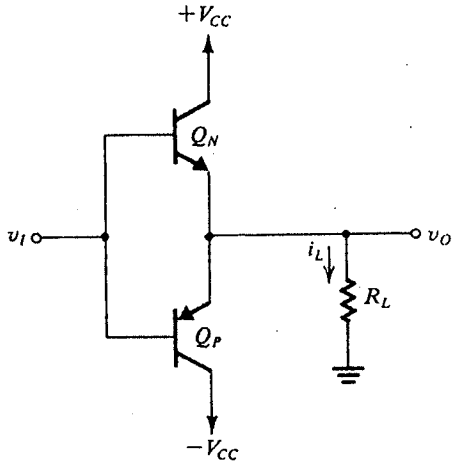

Fig. P5

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6. (16 point) Derive the equation for calculating the output voltage V_o given the input voltage V_i for the circuit shown in Fig.P6. Draw the Bode diagram for the voltage transfer characteristic and mark the important values on the diagram.

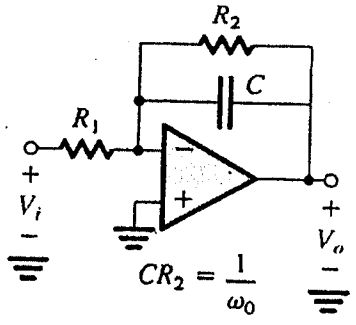

Fig.P6