99學年度 動力機械工程學系乙組(電控組) 碩士班入學考試

科目 電路學及電子學 科目代碼 0903 共 3 頁，第 1 頁　　*請在【答案卷卡】作答

1. Write down FIVE of the basic theorems in analysis of electric circuits by using simple sentences with ONE drawing for illustration. (10 %)

2. Taiwan Power Company supplies AC utility power to residential homes in Taiwan via single-phase three-wires system operated at 115/230 V at 60 Hz. Please write down the mathematical expressions for the two line voltages and calculate the power of an oven with 52.9 Ω resistance wire connected to the 220 V socket. (5 %)

3. In the design of electric circuits, you are only allowed to use resistors, capacitors, and inductors to finish your design. Please answer the following given design problems.

a) Given a resistor in 10 kΩ, use either a capacitor with 1μF or an inductor with 1 μH to design a first-order low-pass filter. Please draw the finished schematic drawing and calculate the bandwidth of the filters. (5 %)

b) In part a), assuming you have used the resistor and capacitor to complete the design, what would be the frequency response if you add the given inductor in parallel to the capacitor? Write down the analytical expression to show the responses. (5 %)

4. In the design of probe for oscilloscopes, a 10X probe must use a voltage divider to achieve the 10:1 ratio of signal attenuation to expand the voltage range of probe. However, due to parasitic capacitance C_1 at circuit inside the scope, a compensating capacitor with variable adjustment is adopted in the probe as shown in Figure 4.

a) Please show the condition that can makes the V_{out}/V_{in} become totally independent of signal frequency by finding an analytical expression. (5 %)

b) If R_1=1 MΩ and C_1= 90 pF are known inside the scope, calculate the values of R_2 and C_2 to fulfill the 10X design requirement based on the results from part a). (5 %)

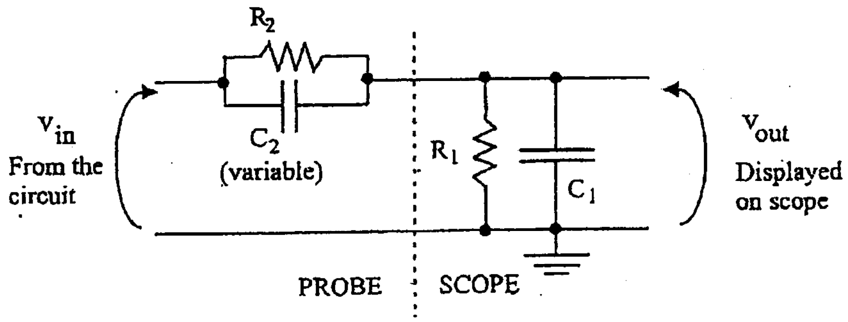
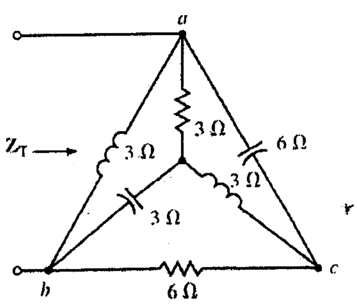


Figure 4

5. Please determine the Z_T of the network shown in Figure 5 by using Y-Δ conversions. (10 %)

Figure 5



6. Consider the noninverting amplifier circuit shown in Figure 6. The input v_I is a low-frequency sine-signal with amplitude V_P and average equal to zero. A load resistance R_L is connected from the output to ground. Let the op amp be ideal except that its output voltage saturates at ±12 V and its output current is limited to the range ±16 mA.

(a) For $R_L = 1\ \text{k}\Omega$ and $V_P = 1$ V, find the output voltage. (5%)

(b) For $R_L = 1\ \text{k}\Omega$ and $V_P = 1.5$ V, find the output voltage v_O and draw its waveform vs. time. (5%)

(c) For $V_P = 1$ V, what is the lowest value of R_L for which an undistorted sine-wave output is obtained? (5%)

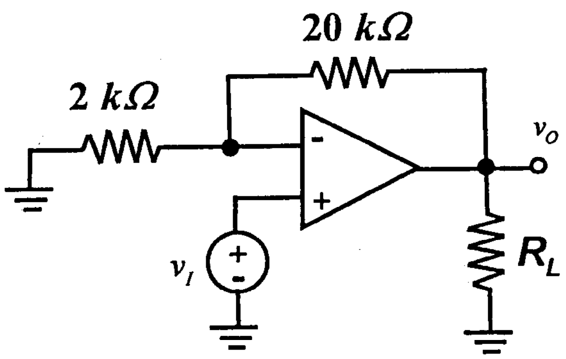


Figure 6

7. The circuit of Figure 7 is a BJT amplifier with a feedback resistor R_F.

(a) Given $\beta = 100$, $R_F = 100\ \text{k}\Omega$, $R_E = 80\ \Omega$, $R_L = 10\ \text{k}\Omega$, and I = 1 mA, find the dc collector current I_C and the dc voltage at collector V_C. Assume that $V_{BE} = 0.7$ V. (6%)

(b) Use the T model to draw the small-signal equivalent circuit and find the voltage gain v_O/v_i. (9%)

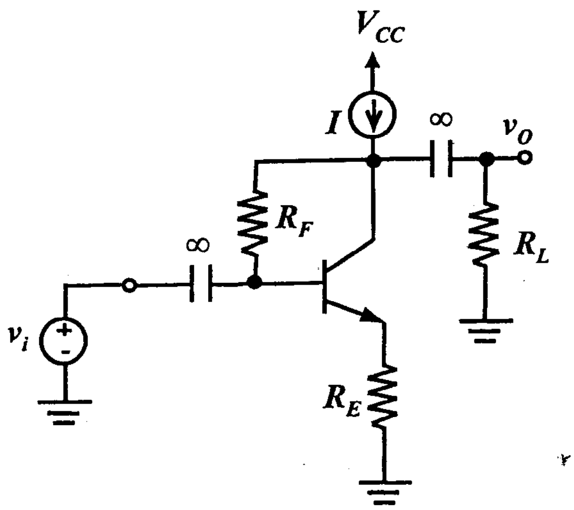


Figure 7

8. Figure 8 shows the high-frequency equivalent circuit of a MOSFET amplifier with a resistance R_S connected in the source lead.

(a) Derive an expression of the 3-dB frequency f_H for the voltage gain v_O/v_I using the open-circuit time-constant method. (12%)

(b) Use the result of part (a) to comment the effect of R_S to the 3-dB frequency f_H. (3%)

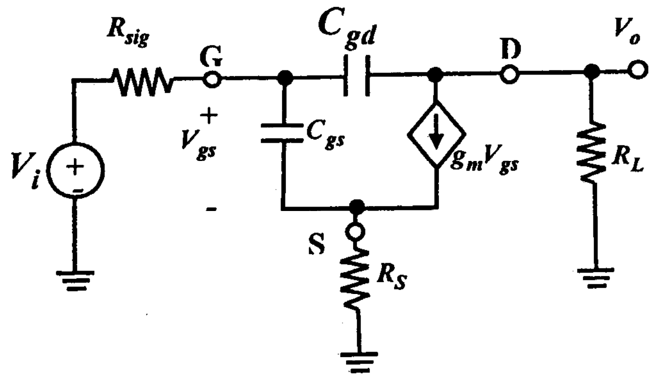


Figure 8

9. Consider the differential amplifier as shown in Figure 9. Assume that $\lambda = 0$, $V_t = 0.7$ V, and $\frac{1}{2}k_n'\left(\frac{W}{L}\right) = 0.2$ mA/V^2 for all transistor. Let $V^+ = +5$V, $V^- = -5$ V, and $I_Q = 0.8$ mA. If $v_1 = v_2 = 0$, $R_1 = 20\ \text{k}\Omega$, and $R_D = 10\ \text{k}\Omega$, determine I_1, I_Q, I_{D1}, V_{DS1}, and V_{DS4}. (10%)

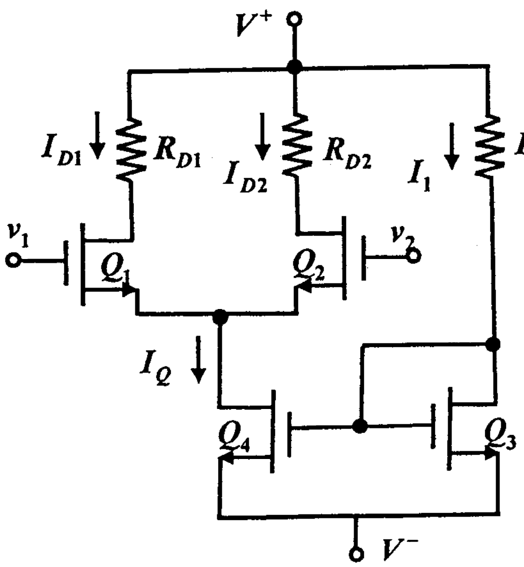


Figure 9