八十五學年度國立台灣工業技術學院研究所碩士班招生考試

所別：電機工程技術研究所　　組別：控制組　　科目：電子學

1. Modulation techniques have been widely used in many applications such as AM/FM radio and measurements that require frequency shifting. Usually, a demodulator is required at the receiver end to recover the original signal. The simplest circuit to achieve AM demodulation involves merely a diode, a resistor and a capacitor.
   (a)(5 points) Draw the circuit.
   (b)(5 points) Plot the waveforms at the important nodes.
   (c)(6 points) Describe in words (as detail as you can, but no more than 100 words, either in English or in Chinese) how such a circuit works.

2. The frequency spectra of many control systems are in the low end and this allows filtering of some types of unwanted signals easy. Typically, such a filter can be constructed using an operational amplifier together with some resistors and capacitors.
   (a)(8 points) Design a one-pole filter for such a purpose and plot the circuit. Justify your design by deriving the transfer function.
   (Step by step derivation for the transfer function is required. Solutions failed to do so will not be given any point.)
   (b)(8 points) Plot the frequency response and specify the important values on the diagram.

3. "Counting" is a basic operation in every day life, and this is also true in engineering application. Digital devices that implement such an operation involve binary counters and decade counters. While many commercially available devices have been manufactured for the latter, a circuit consisting of the former and some gates can be used in place of the latter if there is a shortage of the latter.
   (a)(9 points) Design and plot such a circuit.
   (b)(9 points) If it is required to monitor the operation of the circuit and there are only some LEDs and resistors at hand, what would you devise to do the job? Plot the circuit. Assume that the LED is ON if the output of the corresponding bit is LOW. Specify in your circuit the values of the resistors and the supply voltage that you use

(命題用紙)

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4. The n-channel MOSFET in Fig. P4 has $V_t = 1V$, $K=0.5mA/V^2$, and $\lambda=0$.

Analyze the circuit (Fig. P4) and determine:

(a) the drain current I_D (5%)

(b) the drain voltage V_D (5%)

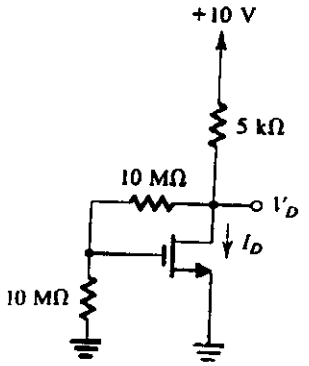

Fig. P4

5. Consider the complementary BJT class-B output stage (Fig. P5), and neglect the effects of V_{BE} and V_{CEsat}. For ±10V power supplies and a 100 Ω load resistance,

(a) what is the maximum sine-wave output power available ? (5%)

(b) What supply power corresponds? (5%)

(c) What is the power-conversion efficiency? (5%)

(d) For output signals of half this amplitude, find the power-conversion efficiency. (5%)

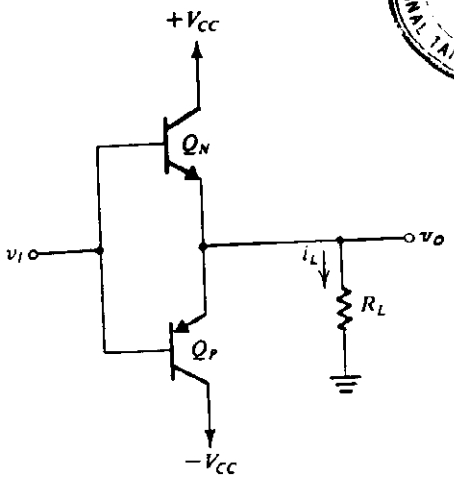

Fig. P5

(命題用紙)

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6. The equivalent circuit of an amplifier is shown in Fig. P6. The input signal source is coupled to the amplifier input via coupling capacitor C_c. Capacitor C_L represents a parasitic capacitance appearing across the load resistance R_L.

(a) Derive an expression for the amplifier voltage gain A(s)= $V_o(s) / V_i(s)$ (5%)

(b) Noting that C_c is responsible for the frequency dependence of the gain at low frequencies and that C_L causes the gain to fall off at high frequencies, find A_m, $F_L(s)$, and $F_H(s)$ (5%).

(c) For R_s = 10 kΩ, R_i = 100kΩ, and R_L =10kΩ, find the required value of G_m to obtain a midband gain of 20 dB (5%).

(d) Find the minimum value of C_c so that f_L is at most 10 Hz (5%)

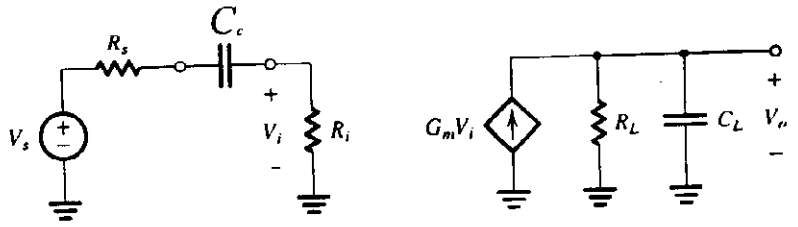

Fig. P6