國立中山大學101學年度碩士暨碩士專班招生考試試題

科目：電子學【海下海物所碩士班選考】　　題號：4163

1. (18%) For the circuit in Fig. 1, find the values of i_I, v_I, i_1, i_2, v_o, i_L, and i_o. Also find the voltage gain v_o/v_I, and the current gain i_L/i_I.

2. (20%) The 6.8-V zener diode in the circuit of Fig. 2 is specified to have $V_Z = 6.8$ V at $I_Z = 5$ mA, $r_z = 20\ \Omega$, and $I_{ZK} = 0.2$ mA. The supply voltage V^+ is nominally 10 V but can vary by ±1 V. (a) Find V_O with no load and with V^+ at its nominal value. (b) Find the change in V_O resulting from the ±1-V change in V^+. (c) Find the change in V_O resulting from connecting a load resistance R_L that draws a current $I_L = 1$ mA. (d) Find the change in V_O when $R_L = 2$ kΩ. (e) Find the value of V_O when $R_L = 0.5$ kΩ.

3. (16%) Figure 3 shows a discrete common-source MOSFET amplifier utilizing the drain-to-gate feedback biasing arrangement. Determine the small-signal voltage gain v_o/v_i, and the input resistance R_{in}. The transistor has $V_t = 1.5$ V, $k'_n(W/L) = 0.25$ mA/V^2, and $V_A = 50$ V. Assume the coupling capacitors to be sufficiently large so as to act as short circuits at the signal frequencies of interest.

4. (15%) A piezoelectric crystal, such as quartz, exhibits electromechanical-resonance characteristics that are very stable and high Q factors. The circuit symbol of a crystal is shown in Fig. 4(a) and its equivalent circuit model is given in Fig. 4(b). A 2-MHz quartz crystal is specified to have L = 0.52 H, $C_s = 0.012$ pF, $C_p = 4$ pF, and $r = 120\ \Omega$. Find the series resonance frequency f_s, parallel resonance frequency f_p, and the Q factor.

5. (15%) For the class B output stage of Fig. 5, let $V_{CC} = 6$ V and $R_L = 4\ \Omega$. If the output is a sinusoid with 4.5-V peak amplitude, find (a) the output power; (b) the average power drawn from each supply; (c) the power efficiency obtained at this output voltage; (d) the peak currents supplied by v_I, assuming that $\beta_N = \beta_P = 50$; (e) the maximum power that each transistor must be capable of dissipating safely.

6. (16%) For a *pn* junction with $N_A = 10^{17}$/cm^3 and $N_D = 10^{16}$/cm^3, find, at T = 300 K, the built-in voltage, the width of the depletion region, and the distance it extends in the *p* side and in the *n* side of the junction. Use $n_i = 1.5\text{x}10^{10}$/cm^3.

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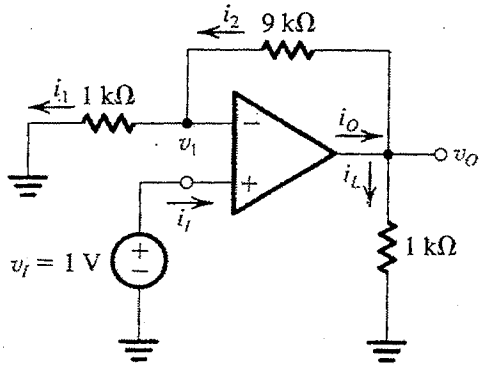

Fig. 1

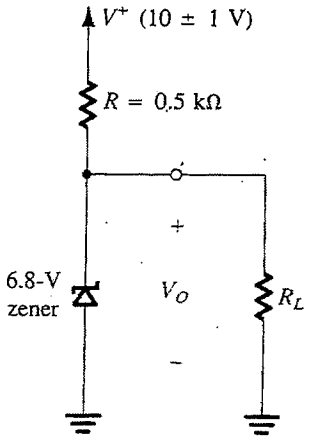

Fig. 2

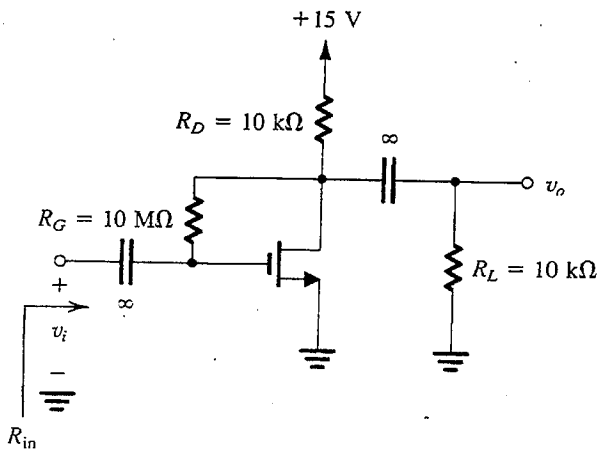

Fig. 3

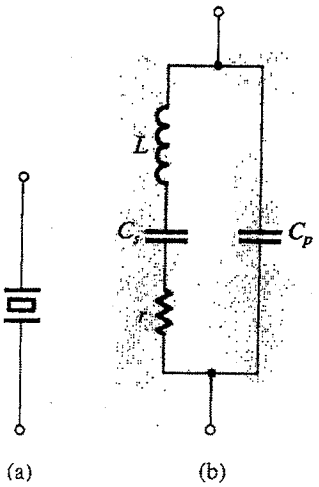

Fig. 4

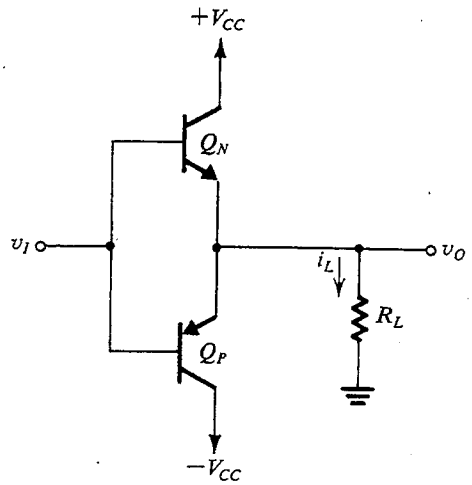

Fig. 5