所別：光電科學與工程學系碩士班 不分組(一般生)　科目：電子學　共 2 頁 第 1 頁
光電科學與工程學系碩士班 不分組(在職生)
本科考試可使用計算器，廠牌、功能不拘　＊請在試卷答案卷（卡）內作答

1. Assume the transistor in the circuit in Fig.1 has parameters of $V_{BE(on)} = 0.7$ V, current gain $\beta = 120$, thermal voltage $V_T = 0.026$ V, and Early voltage $V_A = 100$ V. The resistors are set as $R_1 = 1$ KΩ and $R_2 = 1$ KΩ.
   (a) Determine the Q-point (working point) of transistor (V_{CEQ}, I_{CQ}). (5%)
   (b) Define the load line equation, sketch the load line and plot the Q-point for transistor. (5%)
   (c) Determine the mid-band small-signal trans-resistance $R_{in} = v_O/i_S$. (5%)

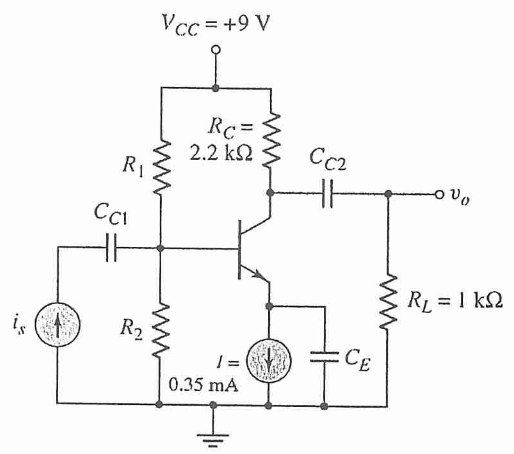

Fig. 1

2. A current-to-voltage converter with a phototransistor that converts light intensity into an output current i_C is shown in Fig. 2(a). The transistor has a finite capacitor C_{CE} and must be biased as shown in Fig. 2(a). The current-to-voltage converter realized using an op-amp has a finite open-loop differential gain A_{od}. The transistor output versus input characteristics are shown in Fig. 2(b).
   (a) Determine the input resistance R_{in} of current-to-voltage converter. (5%)
   (b) Define the load line equation and sketch the load line for transistor. (5%)
   (c) Determine the small-signal trans-impedance $Z_{in} = v_O/i_C$ of current-to-voltage converter under considering the frequency response. (10%)
   (d) Determine the higher corner (-3 dB) frequency f_H of Z_{in}. (5%)

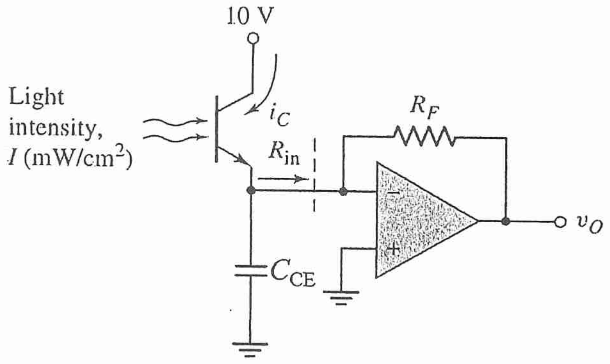

Fig. 2(a)

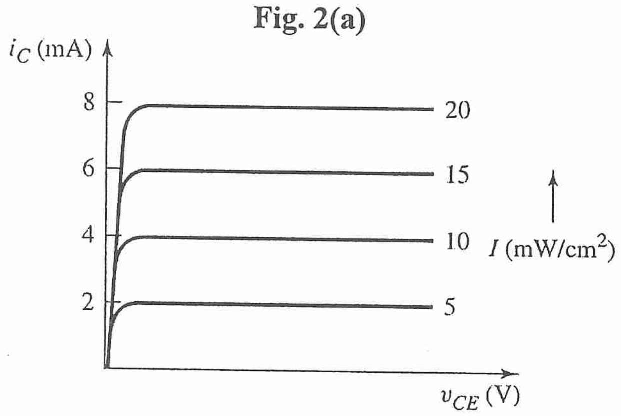

Fig. 2(b)

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3. The circuit in Fig. 3(a) is used to drive an LED with a voltage source. Assume the op-amp is ideal. The resistors are set as R_1 = 1 KΩ, R_F = 1 KΩ, and R_2 = 1 KΩ. The LED has piecewise linear parameter of turn on (cut-in) voltage V_r = 3 V and forward diode resistance r_f = 0 Ω. If the triangular wave, shown in Fig. 3(b), is applied.
(a) Plot i_D versus v_I for the circuit. (5%)
(b) Plot v_O versus time for the circuit. (5%)

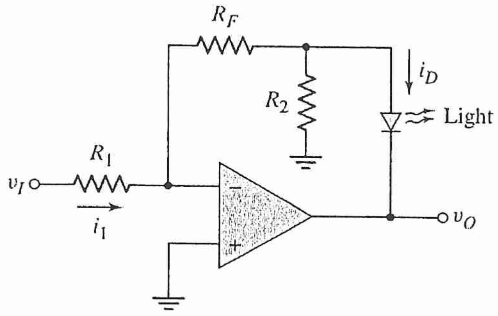

Fig. 3(a)

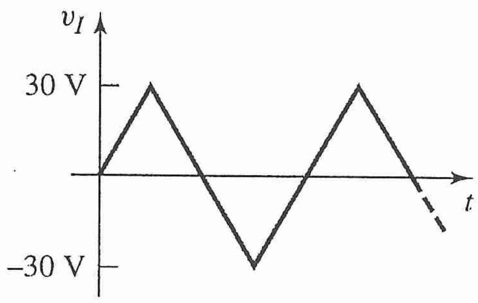

Fig. 3(b)

4. Consider the circuit shown in Fig. 4 where R = 19 kΩ. V is 10 V which is superimposed a 60 Hz sinusoid of 1-V peak amplitude. The diode has a 0.5-V voltage drop at 0.5-mA current. The constant n in diode equation is 2 for silicon. Calculate the amplitude of the sine-wave across the diode. (15%)

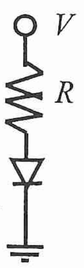

Fig. 4

5. An enhancement-type NMOS transistor with threshold voltage V_t = 2 V has its source terminal grounded and a 3-V dc source connected to the gate. The drain is connected to a dc voltage of 3 V. The process trans-conductance parameter, $\mu_n C_{ox}$, is 40 μA/V^2. The width and the length of the channel region are W = 100 μm and L = 2 μm, respectively. Neglect the dependence of i_D on V_{GS} in saturation. Find the drain current. (20%)

6. Calculate the unity-gain frequency f_T for the n-channel MOSFET whose the capacitance between gate-source and gate-drain, C_{gs} and C_{gd}, are 30 fF and 2 fF, respectively. Assume that the trans-conductance g_m is 0.2 mA/V. (15%)

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