國立中央大學 107 學年度碩士班考試入學試題

所別： 光電科學與工程學系 碩士班 不分組(一般生)　　共 2 頁 第 1 頁

科目： 電子學

本科考試可使用計算器，廠牌、功能不拘　　＊請在答案卷(卡)內作答

7% 1. Please explain the concept of holes as much as you can.

2. An abrupt planar semiconductor p^+-n junction at $T = 300$ K is uniformly doped with an acceptor concentration $N_a = 2\times10^{17}\,\text{cm}^{-3}$ and an unknown donor concentration of N_d. The dielectric constant of the intrinsic material is $\epsilon_s = 11.7$ ($\epsilon_0 \sim 8.854\times10^{-12}$ F/m) and the cross-sectional area of the p^+-n junction is $10^{-5}\,\text{cm}^2$. An inductance of 3.306mH is connected in parallel with the p^+-n diode. At a reverse-biased voltage $V_R = 1\text{V}$, the resonant frequency of the LC circuit (assume the resistance is negligibly small) is $f = 8.85\text{MHz}$ and 99 percent of the total space charge width is in the n region. Answer the following questions:

5% (a) What is the capacitance per unit area of this p^+-n junction?

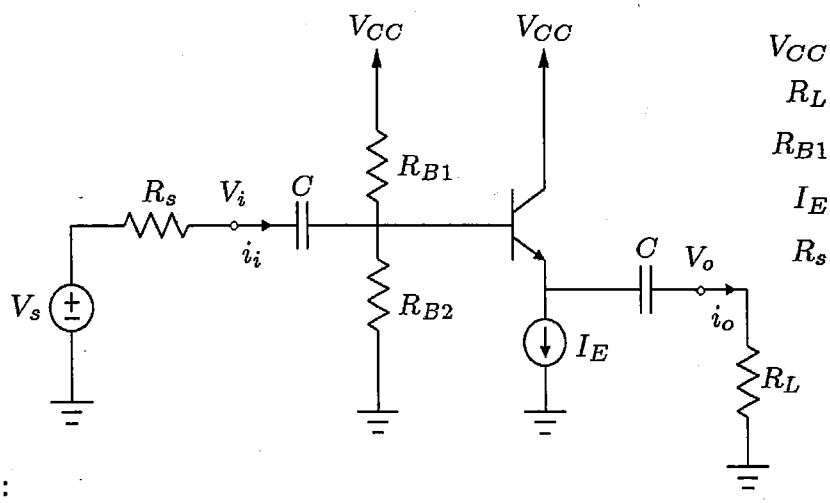
8% (b) Determine N_d

10% (c) Given the expression for the junction width W

$$W = \left\{\frac{2\epsilon_s(V_{bi}+V_R)}{q}\left[\frac{N_a+N_d}{N_aN_d}\right]\right\}^{1/2},$$

where $q = 1.60\times10^{-19}$ C. Determine the built-in voltage V_{bi} at $V_R = 1\text{V}$.

3 The BJT amplifier shown in Fig. 1 uses a BJT having $\beta = 110$. All capacitors are assumed to be sufficiently large.



$V_{CC} = 15$ V
$R_L = 2$ kΩ
$R_{B1} = R_{B2} = 15$ kΩ
$I_E = 2$ mA
$R_s = 500$ Ω

參考用

Fig. 1:

5% (a) Determine the DC voltage at the emitter V_E.

5% (b) Draw the small-signal model of this amplifier with all parameter values calculated and labeled properly.

10% (c) Find out the small-signal current gain i_o / i_i.

注意:背面有試題

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4. For the circuit in Fig. 2,

10% (a) derive the transfer function $T \equiv \upsilon_O / \upsilon_I$;

10% (b) sketch the transfer characteristic of the circuit (υ_O versus υ_I).

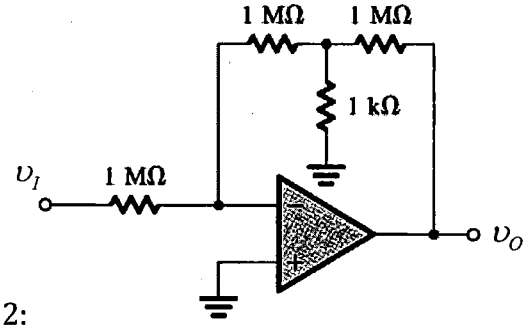

Fig. 2:

5. Consider the phase-shift oscillator in Figure 3,

10% (a) find the oscillation frequency of υ_O;

5% (b) determine the condition for oscillation.

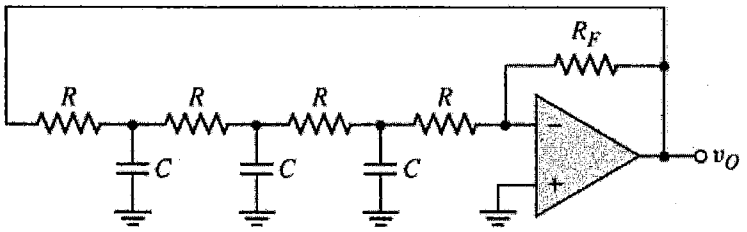

Fig. 3:

6. Fig. 4 shows the circuit for a constant current driver. The normal driving condition for LED is set at 750mA. For Q_1, $\beta = 100$, $V_{BE} = 0.75\text{V}$, $V_{CE,sat} = 0.2\text{V}$ and $V_{CE,breakdown} = 50\text{V}$.

5% (a) Derive the relation between the reference voltage V_1 and the current though LED.

5% (b) What are the proper values for the resistor R_1 and the reference voltage V_1?

5% (c) As under 750mA driving, the forward voltage of the LED is 2.5V. As the constant current driver sustains in normal operation, what is the maximal number of the LEDs in series between **VCC** and Q_1?

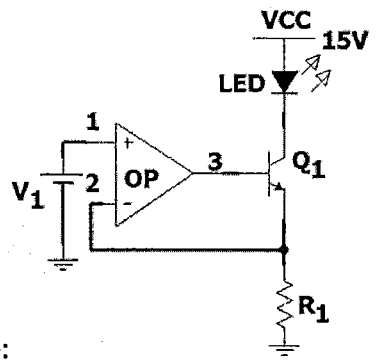

Fig. 4:

注意:背面有試題

參考用