國立中央大學 109 學年度碩士班考試入學試題

所別： 光電類　　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

本試題共四大題計算題，無計算過程不予計分。答案請標示單位。

1. For the common source circuit shown in Figure 1, a n-MOSFET is utilized with the drain-to gate resistance. The device has $V_t = 1.5V$, $V_A = \infty$, $\mu_n C_{ox}(W/L) = 0.25$ mA/V^2. We assume the coupling capacitance is large enough to act as a short circuit for the applied AC signal.

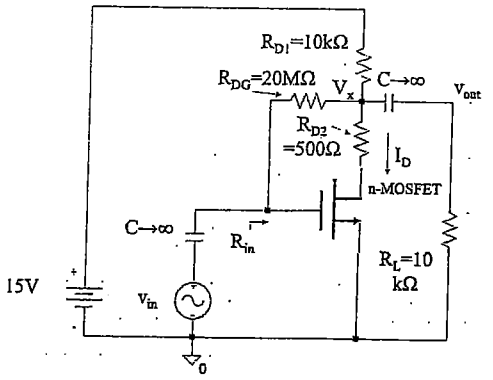

Figure 1

10% (a) DC analysis: Please find the current I_D and voltage V_x.

5% (b) Please determine the small signal-voltage gain (V_{out}/V_{in}).

5% (c) Please determine input impedance R_{in}.

5% (d) If R_{D2} is a variable resistance, what is the allowed maximum R_{D2} to keep the MOSFET in saturation region.

2. Refer the circuit shown in Figure 2, a BJT differential pair is driven by a current mirror and connected with a variable resistance R_{c1} (5~10 kΩ). All BJTs are assumed to be the same with β=100 and r_o= ∞ (no early effect). Please evaluate the following at room temperature (V_T=25mV):

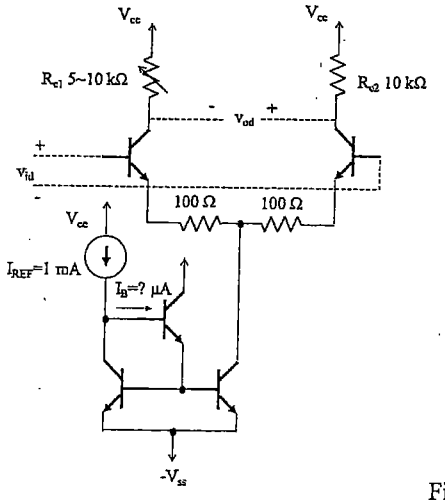

Figure 2

5% (a) For the current mirror, please help to find the base current I_B for base current compensation.

10% (b) If R_{c1} is adjusted to 10kΩ pairing with R_{c2}, please find the differential voltage gain (v_{od}/v_{id})

5% (c) What is the input differential resistance R_{id}?

5% (d) If Rc1 is accidentally adjusted to 9 kΩ, please find the resulting input offset Vos.

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3. According to the active filter shown in Fig. 3, please answer the following questions.

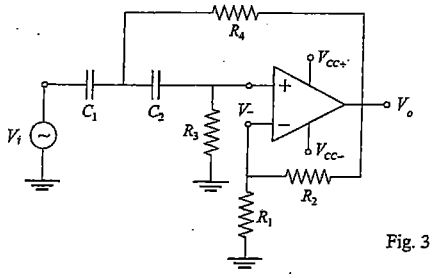

Fig. 3

1) Please give the transfer function of this filter, including the gain (G) and the filter (V_-/V_i): (8%)

$$\mathbf{H}(s)=\frac{V_o}{V_i}=\frac{GV_-}{V_i}=\boxed{\text{(a)}}\times\frac{\boxed{\text{(b)}}\,s^2+\boxed{\text{(c)}}\,s+\boxed{\text{(d)}}}{\boxed{\text{(e)}}\,s^2+\boxed{\text{(f)}}\,s+\boxed{\text{(g)}}}$$

2) This active filter is (a) low-pass, (b) high-pass, (c) band-pass filter. (3%)

3) This filter is a _____-order filter. (3%)

4) If $C_1 = C_2 = 0.1$ μF and $R_3 = R_4 = 1$ kΩ, what is the corner frequency of this filter? (4%)

5) For a sinusoidal input signal with frequency of 1 kHz and amplitude of 1 V, if $R_1 = 19$ kΩ and $R_2 = 1$ kΩ, what is the amplitude of the output signal V_o. (4%)

6) Following question 5), what are the V_{cc+} and V_{cc-} required to get the output signal without saturation. (2%)

4. According to the differential amplifier shown in Fig. 4, please answer the following questions.

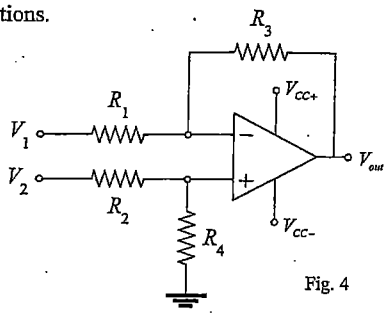

Fig. 4

1) Please describe the relation between V_1, V_2 and V_{out}. (6%)

$$V_{out}=V_1\times\frac{\boxed{(a)}}{\boxed{(b)}}+V_2\times\frac{\boxed{(c)}}{\boxed{(d)}}$$

2) To synthesize an output signal $V_{out} = 2\cos(200t) - 5\cos(1000t)$ V from two input signals $\cos(1000t)$ V and $\cos(200t)$ V, if $R_1 = 1$ kΩ, please find the values of R_2, R_3 and R_4, and assign the signals for V_1 and V_2. (10%)

R_2 = _____; R_3 = _____; R_4 = _____; V_1 = _____; V_2 = _____.

3) Please design a circuit which can transform the input signal $1+1\cos(100t)$ V into an output signal $V_{out} = 5\cos(100t)$ V. Set $R_1 = 1$ kΩ, please find the values of R_2, R_3 and R_4, and assign the signals for V_1 and V_2. (10%)

R_2 = _____; R_3 = _____; R_4 = _____; V_1 = _____; V_2 = _____.

參考用

注意：背面有試題