國立成功大學

113學年度碩士班招生考試試題

編　號：178、187、193

系　所：電機工程學系
電腦與通信工程研究所
電機資訊學院-微電、奈米聯招

科　目：電子學

日　期：0201

節　次：第 1 節

備　註：可使用計算機

編號： 178、187、193　　國立成功大學 113 學年度碩士班招生考試試題

系　　所：電機工程學系、電腦與通信工程研究所、電機資訊學院-微電、奈米聯招

考試科目：電子學　　考試日期：0201，節次：1

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Fig. 1 uses an ideal op amp to design a differentiation circuit for which the time constant is 10^{-3} s using a 10-nF capacitor. (16%)
   (a) What is the value of resistor (R)? (4%)
   (b) What are the gains and phase shifts found for this circuit at one-tenth and 10 times the unity-gain frequency? (4%)
   (c) A series input resistor is added to limit the gain magnitude at high frequencies to 100 V/V. What is the associated 3-dB frequency? (4%)
   (d) What gain and phase shift result at 10 times the unity-gain frequency? (4%)

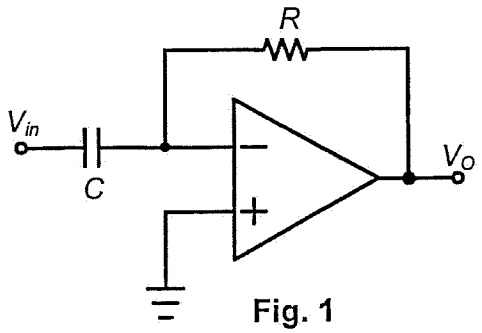

Fig. 1

2. In the common-gate amplifier circuit of Fig. 2, Q_2 and Q_3 are matched. $K'_n(W/L)_n = K'_p(W/L)_p = 4$ mA/V^2, and all transistors have threshold voltage $|V_t| = 0.8$ V and Early voltage $|V_A| = 20$ V. The signal v_{sig} is a small sinusoidal signal with no dc component. (20%)
   (a) Neglecting the effect of V_A, find the required value of V_{BIAS}. (4%)
   (b) Find the values of g_{m1} and r_o for all transistors. (4%)
   (c) Find the input resistance (R_{in}). (4%)
   (d) Find the output resistance (R_{out}). (4%)
   (e) Calculate the voltage gains v_o/v_i and v_o/v_{sig}. (4%)

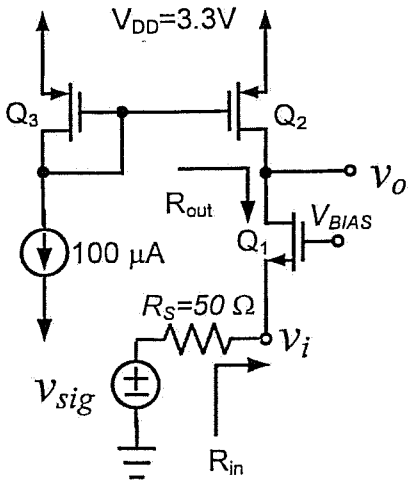

Fig. 2

3. The feedback current amplifier in Fig. 3 utilizes two identical NMOS transistors sized so that at I_D=0.2 mA they operate at $V_{OV}=(V_{GS}-V_t)$=0.2 V. Both devices have threshold voltage V_t=0.5 V and Early voltage V_A=10 V. (14%)
   (a) Find the voltage gain $A_f = I_o/I_s$.(4%)
   (b) Find the input resistance (R_{in}) and output resistance (R_{out}). (10%)

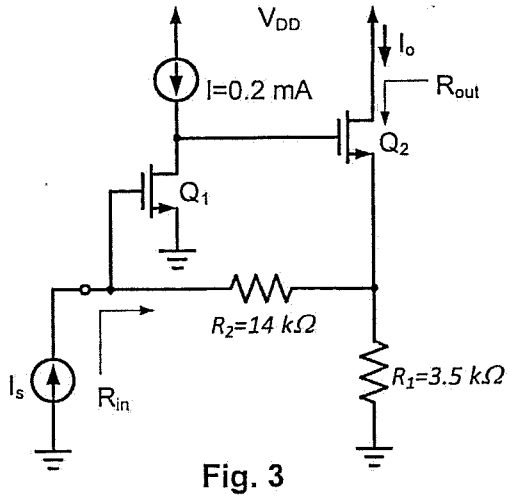

Fig. 3

4. The op amp in the circuit of Fig. 4 has an open-loop gain of 10^6 and a single-pole rolloff with ω_{3dB} = 100 rad/s. Please find the close-loop transfer function, including its zero and poles. (10%)

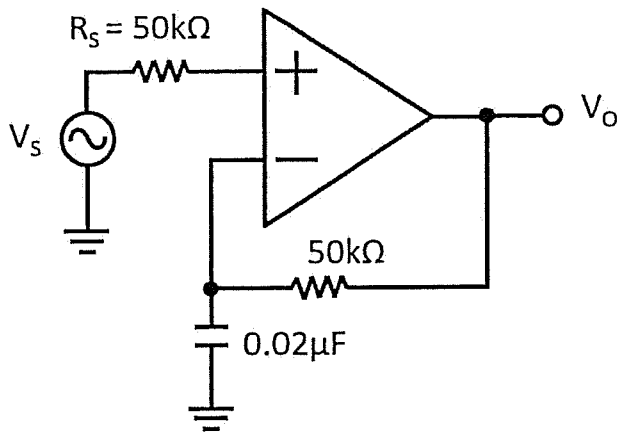

Fig. 4

5. Figs. 5(a) and (b) show two types of oscillators, and the configuration in Fig. 5(b) is the most commonly used configuration nowadays. Please answer the following questions. (20%)
   (a) Describe the Barkhausen criterion. (4%)
   (b) Draw the small signal model and derive the loop gain of Fig. 5(a). (6%)
   (c) According to the results in (b), prove that the oscillation frequency $\omega_0 = \frac{1}{\sqrt{L\frac{C_1C_2}{C_1+C_2}}}$.(4%)

(d) What is the role of inverter with feedback resistor R_F in Fig. 5(b). (6%)

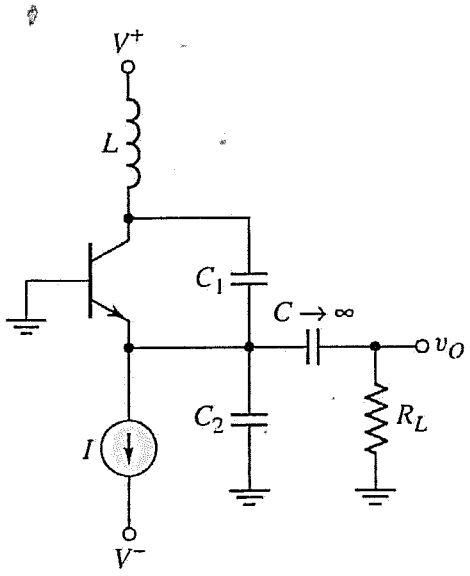

Fig. 5(a)

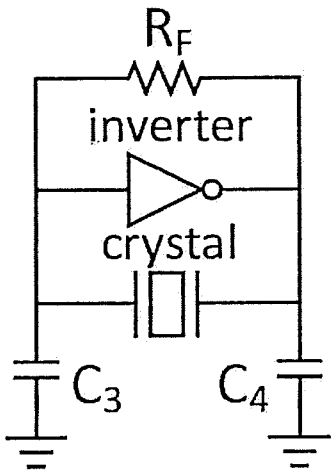

Fig. 5(b)

6. The BJTs in the circuits of Fig. 6 have β_P=20, β_N=200, $|V_{BE}|$=0.6V and $|V_A|$=100V. (20%)

(a) Please find the value of I_C in Fig. 6(a). (7%)

(b) Please find the value of V_C in Fig. 6(b). (7%)

(c) Please find the value of R_{in} in Fig. 6(b). (6%)

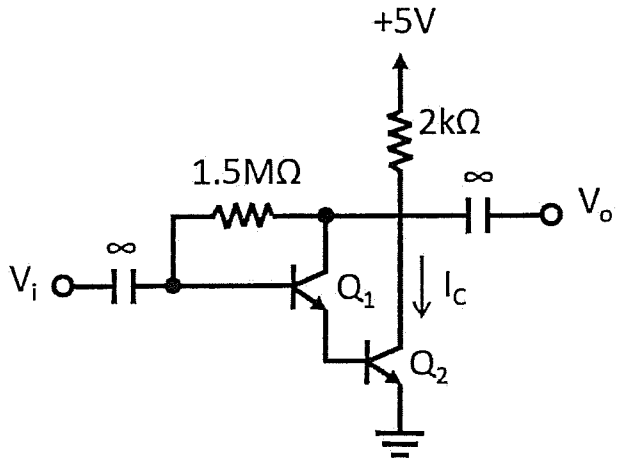

Fig. 6(a)

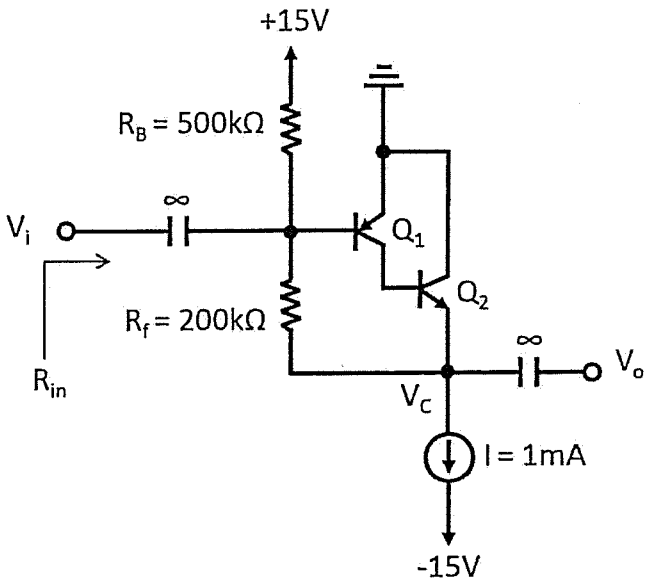

Fig. 6(b)