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1. 選擇題 (6 分)

1-1 Which of the following statements is wrong for an ideal voltage amplifier? (A) an infinitely high input resistance, (B) an infinitely high output resistance, and (C) an infinitely high open-circuit voltage gain. (3 分)

1-2 Which of the following statements is wrong? (A) the forward-biased current of a *pn* diode increases as operating temperature increases, (B) the emitter-base capacitance (Cπ) is usually larger than the collector-base capacitance (Cμ) in a BJT amplifier, and (C) an emitter follower has an infinitely high output resistance. (3 分)

2. 計算題 (19 分)

2-1 The NMOS transistor in the source-follower circuit of Fig. 1(a) has g_m = 5 mA/V and a very large r_O. Find the open-circuit voltage gain (v_{o1}/v_i) and the output resistance (R_{o1}). (6 分)

2-2 The NMOS transistor in the common-gate amplifier of Fig. 1(b) has g_m = 5 mA/V and a very large r_O. Find the input resistance (R_{i2}) and the voltage gain (v_o/v_{i2}). (6 分)

2-3 If the output of the source follower in Fig. 1(a) is connected to the input of the common-gate amplifier in Fig. 1(b), find the overall voltage gain v_o/v_i. (7 分)

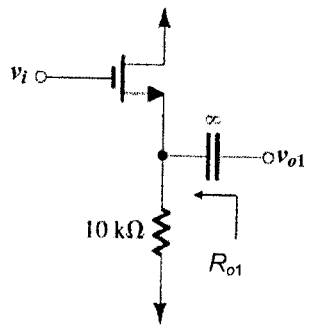


Fig. 1(a)

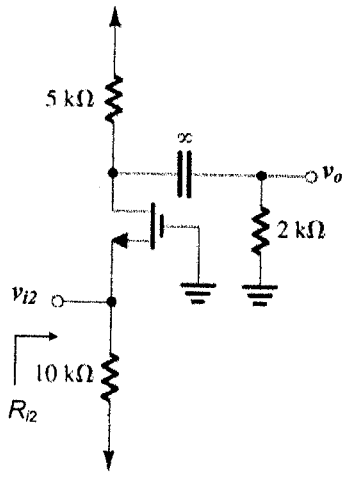


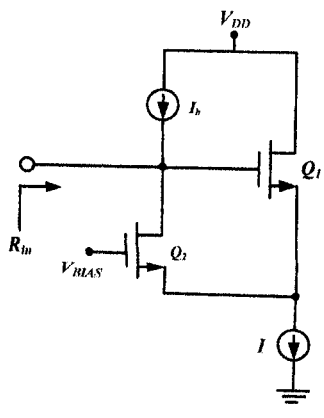
Fig. 1(b)

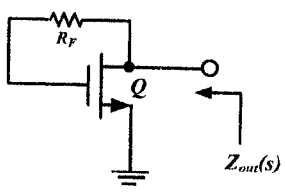
3. 計算題 (22 分)

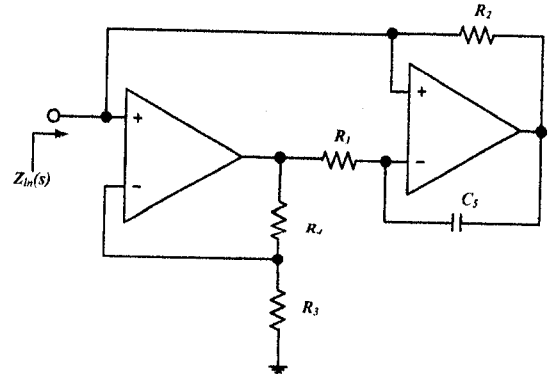
3-1 The circuit of Fig. 2(a) is a source follower with positive feedback. The transconductances of Q_1 and Q_2 are g_{m1} and g_{m2}, respectively. The capacitances C_{gs} and C_{gd} can be neglected. Also neglect output resistance r_o and body effect. Calculate the input resistance R_{in}. (6 分)

3-2 The circuit of Fig. 2(b) is a common-source configuration with a resistive feedback, which can be used as an active inductor. Calculate the *s*-domain output resistance $Z_{out}(s)$ in terms of R_F, g_m, C_{gs}, and C_{gd}. (6 分)

3-3 The circuit of Fig. 2(c) is a gyrator which can be used as an active inductor. Assume that ideal op amps are applied in the circuit. Calculate the *s*-domain input impedance $Z_{in}(s)$. (10 分)







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4. 計算題 (18 分)

A feedback circuit is shown in Fig. 3, which consists of a common-gate amplifier formed by Q_1 and R_D. The capacitive divider C_1, C_2 senses the output voltage, applying the result to the gate of common-source transistor Q_f. The bias circuit for Q_f is not shown. The design parameters are illustrated as follows: g_{m1} = 5 mA/V, g_{mf} = 1 mA/V, R_D = 10 kΩ, C_1 = 0.9 pF, and C_2 = 0.1 pF. Assume that C_1 and C_2 are sufficiently small that their loading effect on the basic amplifier can be neglected. Also neglect output resistance r_o and body effect.

4-1 Derive the expressions of the transimpedance gain V_o / I_s. (12 分)

4-2 Find the output resistance R_{out}. (6 分)

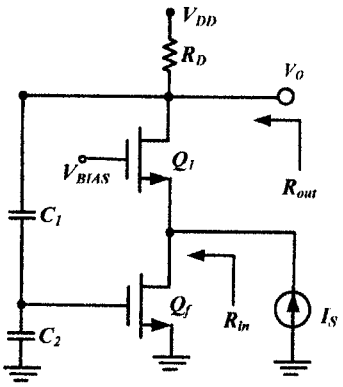

Fig. 3

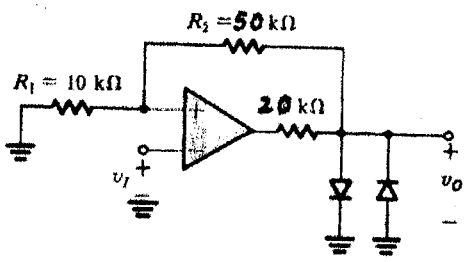

Fig. 4

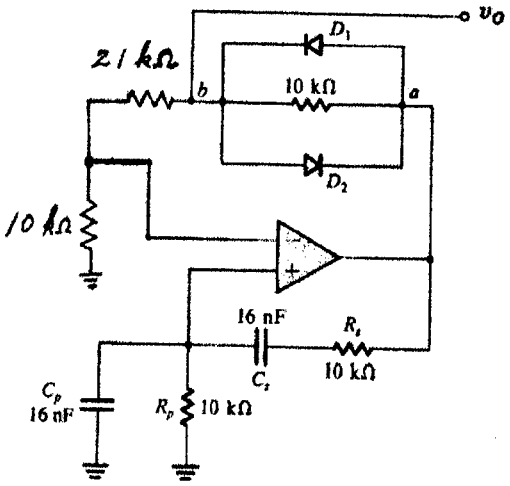

Fig. 5

5. 計算題 (6 分)

A sinusoidal oscillator is formed of an amplifier with a constant gain of 10 and a second-order bandpass filter. If this oscillator circuit produces sustained oscillations at 2 kHz, find

5-1 the pole frequency, (3 分)

5-2 the center-frequency gain of the filter. (3 分)

6. 計算題 (9 分)

For the circuit in Fig. 4, the diodes are assumed to have a constant 0.6 V drop when conducting, and the op amplifier saturates at ±10 V.

6-1 Sketch and label the transfer characteristic. (3 分)

6-2 What is the maximum diode current? (3 分)

6-3 If R_1 is eliminated and R_2 is short-circuited, sketch and label the transfer characteristic. (3 分).

7. 計算題 (20 分)

For the high-voltage Wien-bridge oscillator with a nonlinear control network for amplitude, as shown in Fig. 5, find

7-1 the frequency of oscillation, (8 分)

7-2 the peak-to-peak amplitude of the v_O, by modeling each diode as a 0.7 V battery in series with a 100 Ω resistance when conducting. (12 分)