※ 注意：全部題目均請作答於試卷內之「非選擇題作答區」，請標明題號依序作答。

(A) Short Answers (if necessary, please use schematic for your answer) (42%)

1. Please briefly explain the "Early Effect" of MOSFET and BJT. (6%)
2. Please briefly describe the current flow in an npn transistor and its minority-carrier concentration profile in the active mode. (6%)
3. Frequency compensation design is important in feedback. Please describe the basic idea of frequency compensation and explain how Miller compensation works. (6%)
4. The concept of switched-capacitor circuit has been widely employed in IC implementation. Please explain the basic operation of an inverting integrator implemented by a switched-capacitor circuit. (6%)
5. Please explain propagation delays based on a CMOS inverter. Please also named three methods to reduce the propagation delay. (6%)
6. Please briefly describe operations of a set/rest flip-flop. (6%)
7. Please draw a CMOS static random-access memory (SRAM) cell and explain its read operation. (6%)

(B) Circuit Analysis and Design (58%)

1. (8%) As shown in Fig. 1, it is an operational amplifier circuit. Assume the operational amplifier is ideal. Please find the transfer function V_o/V_s.

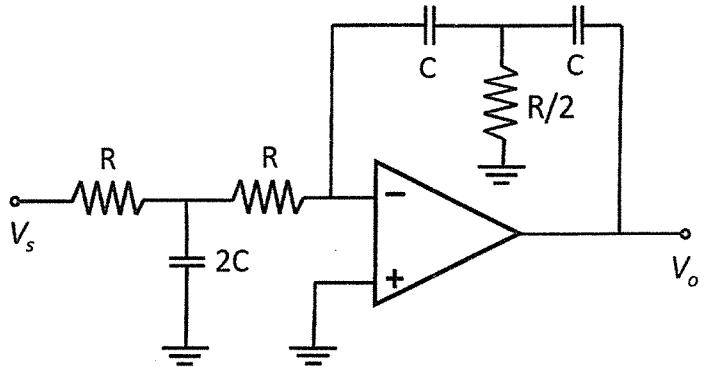

Figure 1.

2. (12%) Consider the PMOS common-gate circuit in Fig 2. The transistor parameters are: V_{TP} = -1V, K_p=0.5 mA/V^2, and λ=0. (a) Determine R_S and R_D such that I_D=0.5mA and V_{SD}=6V; (b) Determine the input impedance R_i and the output impedance R_o; (c) Determine the load current i_o and the output voltage v_o, if i_i = 5sin ωt μA.

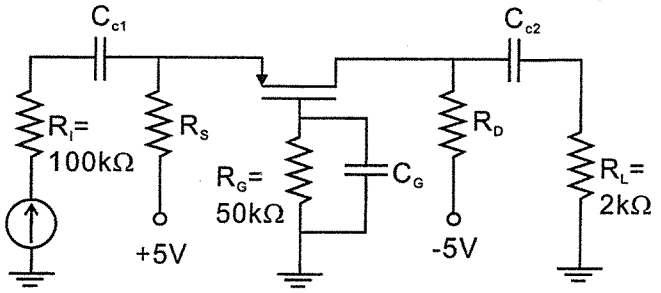

Figure 2

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3. (20%) There is a MOSFET amplifier as shown in Fig. 3. Assume the two MOSFET is exactly the same. If C_s is sufficient large, please find (a) the schematic of its small signal model; (b) the mid-band voltage gain (V_o/V_s); (c) the 3dB frequency of the MOSFET amplifier. If C_s can affect the mid-band signal, please find (d) the mid-band voltage gain (V_o/V_s).

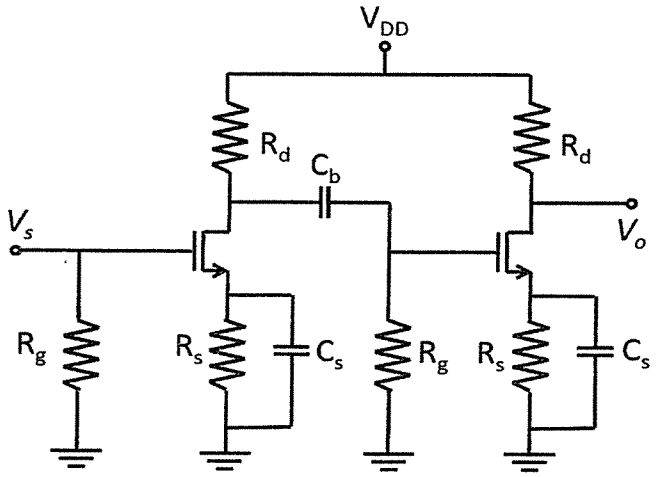

Figure 3.

4. (18%) Assume the MOSFETs shown in Fig. 4 are the same. The feedback inverting voltage gain $\mu = 30$. The chancel resistance (r_d) = 10 kΩ. Assume R_d = 50 kΩ, R_s = 0.3 kΩ, R = 10 kΩ, and R_g = 1MΩ. Neglect the reactance of all capacitors. Please find the feedback voltage gain, feedback input resistance, and feedback output resistance.

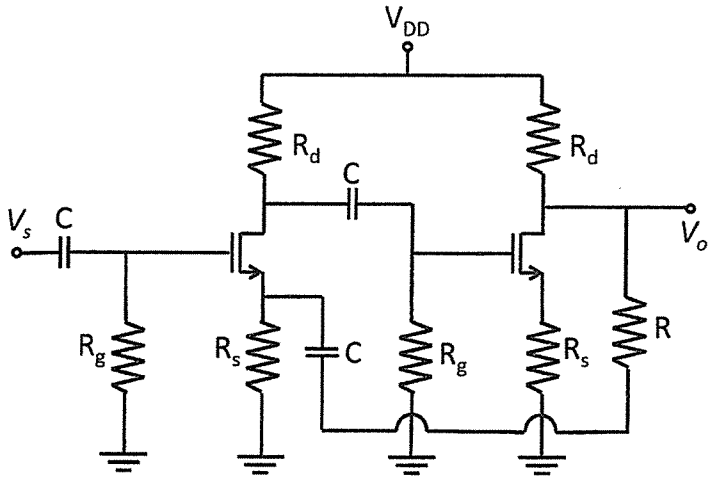

Figure 4.

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