*請依題號順序作答

A. (25%) Please answer the following questions in few sentences and/or drawings

1. Please explain the principle of superposition briefly. (5%)
2. Please list 5 physical limitations of operational amplifiers and explain them briefly. (10%)
3. Please list a noise coupling mechanism and explain it briefly. (5%)
4. Please explain the gain-bandwidth product in filter design. (5%)

B. (75%) Calculations

1. Wheatstone bridge circuit shown in Fig. 1 has been applied in many applications. Please find the value of the voltage $V_{ab} = V_a - V_b$. in terms of resistors and V_S. (10%)

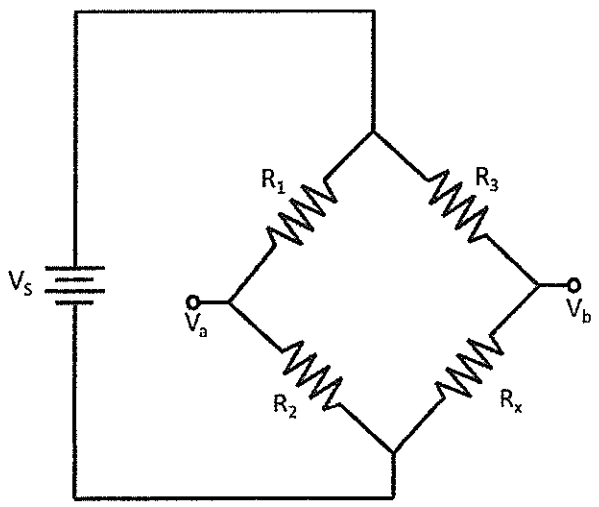

Figure 1.

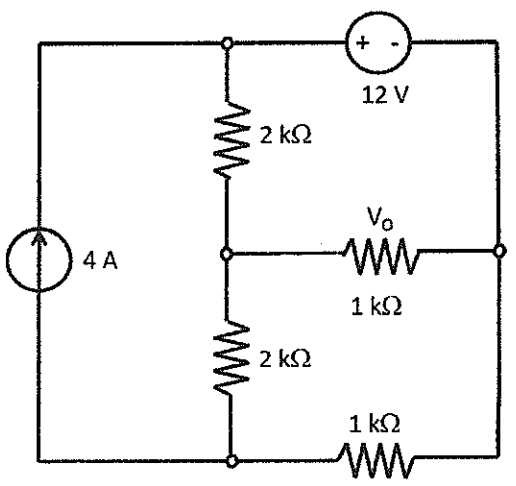

Figure 2.

2. Please find V_O in the circuit shown in Fig. 2 (10%)

3. Assume the op-amp is ideal for this problem. As shown in Fig. 3, determine an expression for, and numerical value of the output voltage. (15%)
   $v_{S1} = 2.9\times10^{-3}\cos(\omega t)$ V; $v_{S2} = 3.1\times10^{-3}\cos(\omega t)$ V;
   $R_1 = 1\text{k}\Omega$; $R_2 = 3.3\text{k}\Omega$; $R_3 = 10\text{k}\Omega$; $R_4 = 18\text{k}\Omega$;

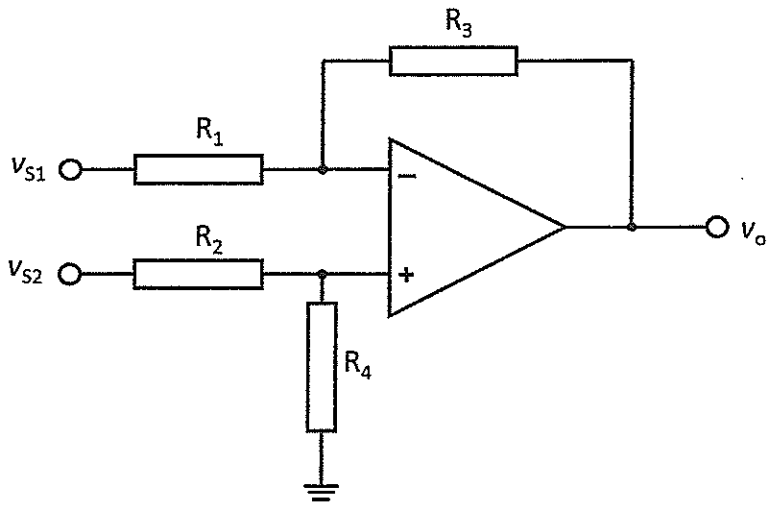

Figure 3

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4. In the circuit shown in Fig. 4, assume that DC steady-state condition exist for t < 0. Determine at t = 0+, just after the switch is opened, the current through and voltage across the inductor and the capacitor and the current through R_{S2}. (20%)

$V_{S1} = 15\text{ V}; V_{S2} = 9\text{ V}; R_{S1} = 130\Omega; R_{S2} = 290\Omega; R_1 = 1.1\text{k}\Omega; R_2 = 700\Omega; C = 0.35\mu\text{F}$

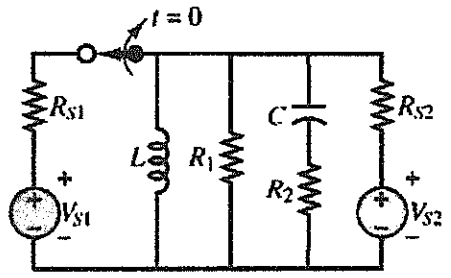

Figure 4.

5. The circuit in Fig. 5 is a common-emitter amplifier, where C_{C1} and C_{C2} are coupling capacitors. (20%)
   (1) For a MOSFET with a threshold voltage of V_t, derive the maximum voltage gain for given V_{DD} and V_{GG}. (6%)
   (2) Given that V_{DD} = 5 V, V_{GG} = 2 V, k_n = 2 mA/V^2 and V_t = 1 V, find the maximum voltage gain of the amplifier and the value of R_D in this case. (6%)
   (3) A sinusoidal output with an amplitude of 1 V is needed for the amplifier. Using the same V_{DD}, V_{GG}, k_n and V_t in (2), find the maximum voltage gain and the value of R_D. (8%)

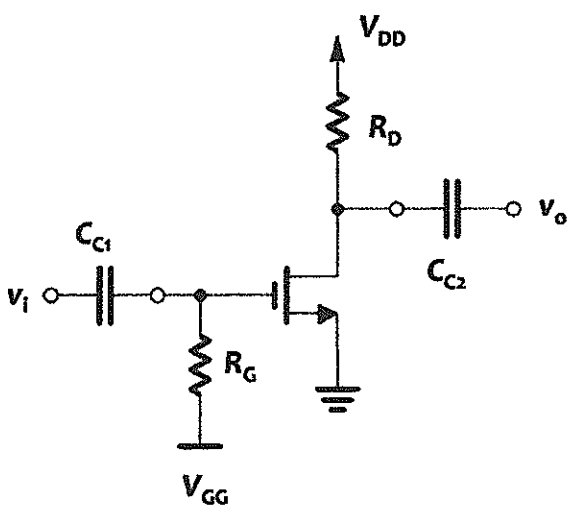

Figure 5.

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