1. (20%) Suppose we have a sensor, with a Thévenin resistance that varies from zero to 10 kΩ, connected to the input of an amplifier. We want the output voltage of the amplifier to vary by less than 2 percent with changes in the Thévenin resistance of the sensor. What parameter of the amplifier is important in this situation? What range of values is allowed for the parameter?
2. (20%) Suppose we have a two-stage cascaded amplifier with an ideal transconductance amplifier as the first stage and an ideal transresistance amplifier as the second stage. What type of the amplifier results and what is its gain in terms of the gains of the two stages? Is it a good selection for an input source with a large Thévenin resistance? Justify your answer.
3. (15%) The NMOS transistor in the circuit of Fig. 3 has $g_m = 5$ mA/V and a large r_o. Find the open-circuit voltage gain and the output resistance. In what situation can the influence of r_o be ignored?
4. (21%) The circuit symbol of an operational amplifier (OP) is shown in Fig. 4A:
   (a) If the OP is ideal, describe the following characteristics, voltage gain, input impedance, output impedance, common-mode rejection ratio (CMMR).
   (b) Using the symbol shown in Fig. 4A, draw the circuits for an inverter and a voltage follower, respectively.
   (c) Please name the circuit shown in Fig. 4B, and derive the output voltage as a function of V_{in}, R, and C.

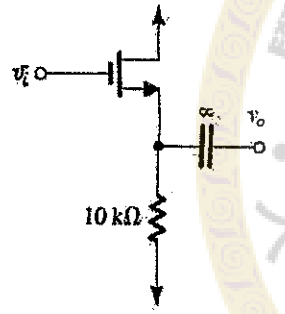

Fig. 3

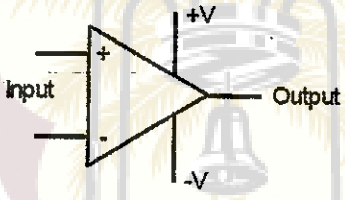

Fig. 4A

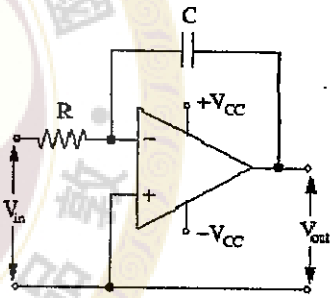

Fig. 4B

5. (24%) Consider each of the circuits in Fig. 5A, 5B, 5C, 5D, 5E, and 5F. Assume that the diodes (D, D_1, and D_2) are ideal. The input V_i is a sine wave. For each circuit, please draw the curves of V_i and V_o with respect to time for one full cycle. Note that all bias voltages, V, V_{B1}, and V_{B2}, are less than the amplitude of V_i.

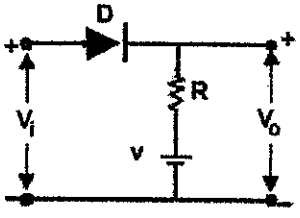

Fig. 5A

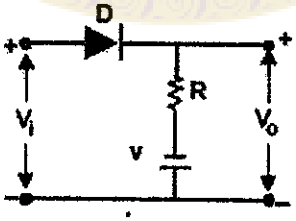

Fig. 5B

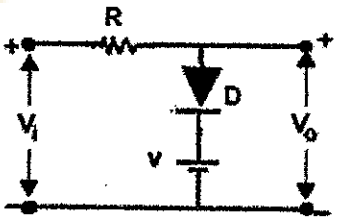

Fig. 5C

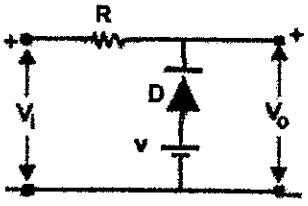

Fig. 5D

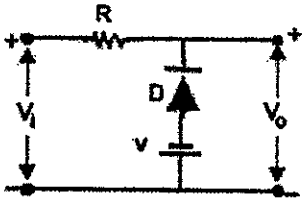

Fig. 5E

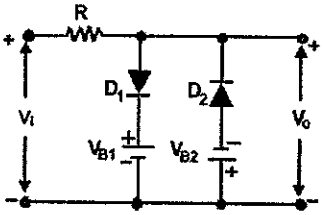

Fig. 5F

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