

1. In Fig. 1, please derive an expression for the voltage gain V_o/V_s as a function of frequency, and find expressions for the dc gain and the 3-dB frequency. (12%)

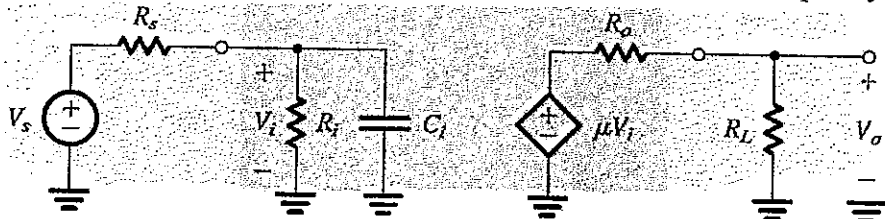


Fig. 1

2. In Fig. 2, let the op amp be ideal:
- Please find I_1, I_2, I_3, I_L , and V_x . (10%)
 - If V_o is not to be lower than -13 V, please find the maximum allowed value for R_L . (4%)
 - If R_L is varied in the range 100Ω to 1 k Ω , what is the corresponding change in I_L and in V_o ? (8%)

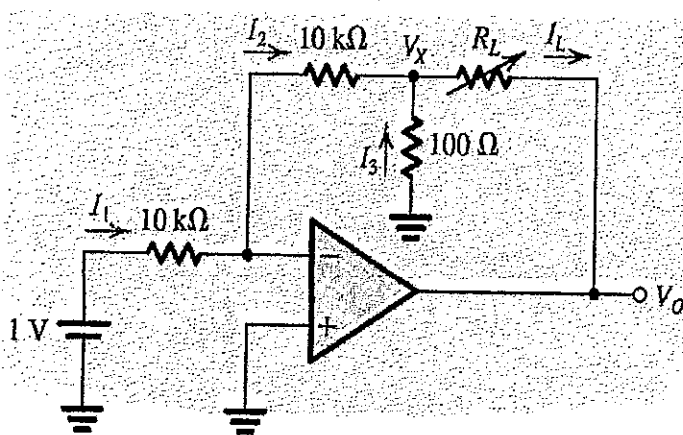


Fig. 2

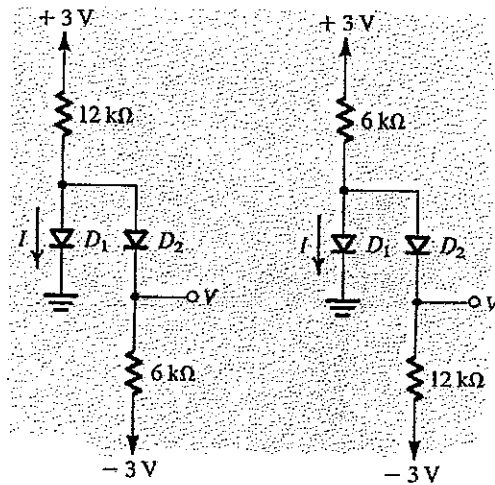


Fig. 3

- Assuming that the diodes in the circuits of Fig. 3 are ideal, please find the values of the labeled currents and voltages (8%).
- The NMOS transistor in the CS amplifier shown in Fig. 4 has $V_t = 0.7$ V and $V_A = 50$ V. Please neglect the Early effect and find the overall voltage gain when the MOSFET is operating in saturation with $I_D = 0.5$ mA and $V_{OV} = 0.3$ V. (12%)

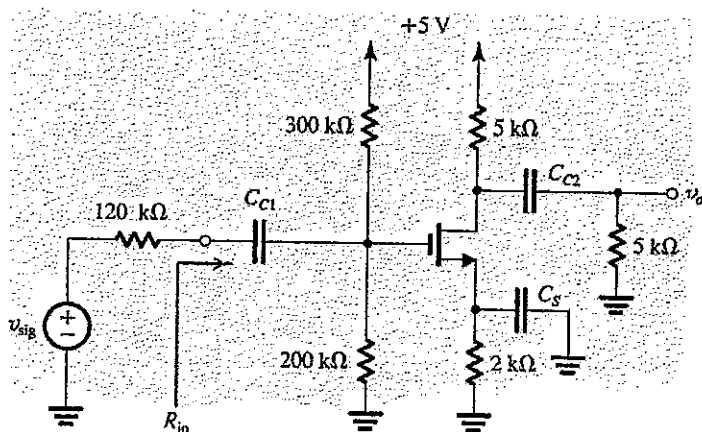


Fig. 4

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5. The amplifier of Fig. 5 consists of two identical common-emitter amplifiers connected in cascade. Observe that the input resistance of the second stage, R_{in2} , constitutes the load resistance of the first stage.
- (a) Please determine the dc collector current and dc collector voltage of each transistor for $V_{CC} = 15\text{ V}$, $\beta = 100$, $R_1 = 100\text{ k}\Omega$, $R_2 = 47\text{ k}\Omega$, $R_E = 3.9\text{ k}\Omega$, and $R_C = 6.8\text{ k}\Omega$. (12%)
- (b) Please find R_{in1} , R_{in2} , and the overall voltage gain for $R_{sig} = 5\text{ k}\Omega$ and $R_L = 2\text{ k}\Omega$. (9%)

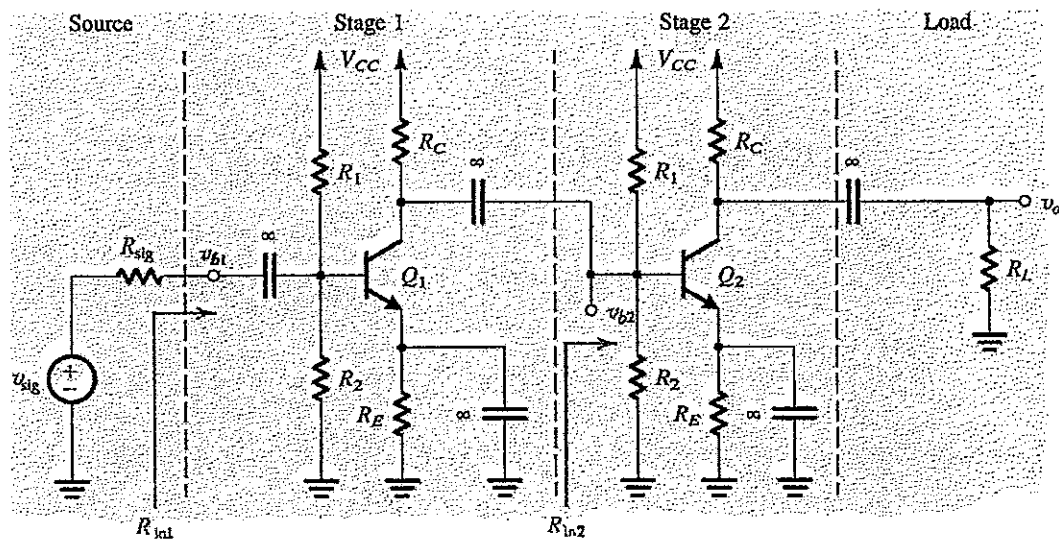


Fig. 5

6. The capacitor of Fig. 6 is uncharged. The switch is moved to position 1 for 10 ms, then to position 2, where it remains.
- (a) Please determine v_C and i_C during charge. (6%)
- (b) Please determine v_C and i_C during discharge. (6%)
- (c) Please sketch the charge and discharge waveforms. (5%)
7. Please solve for the currents through R_1 and R_4 in the circuit of Fig. 7. (8%)

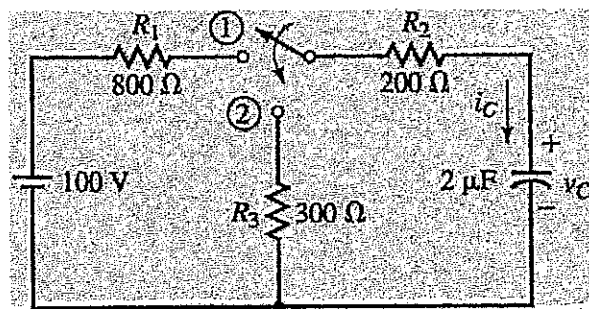


Fig. 6

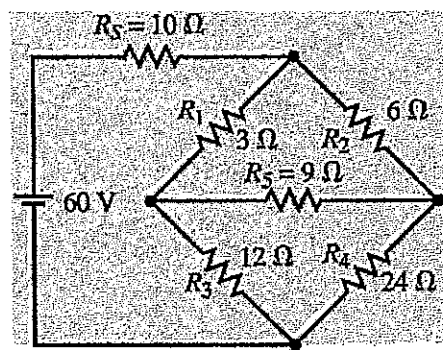


Fig. 7