1. For the circuit in Figure 1, the parameters are V_{TN} = 1.5V and Kn = 0.5 mA/V^2 for transistors M_1 and M_2.

(5%) (a) Determine that I_D, V_{GS1}, V_{DS1}, V_{GS2}, and V_{DS2} for transistors M_1 and M_2, respectively.

(5%) (b) Sketch the load line for transistor M_2.

(5%) (c) Sketch the current-voltage characteristics of transistor M_1.

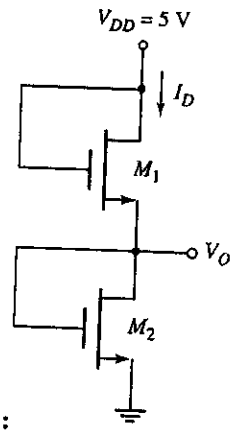

Fig. 1:

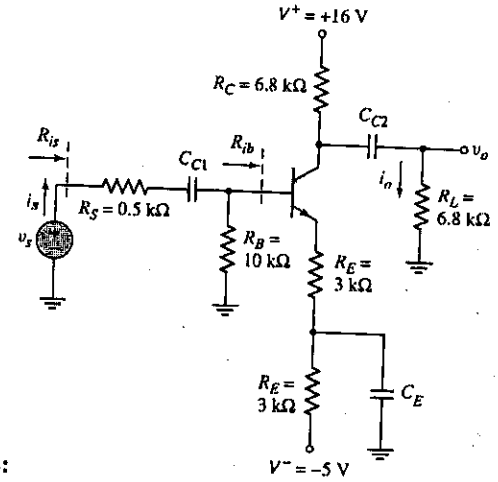

Fig. 2:

2. Consider the circuit shown in Fig. 2. The parameters are β = 150 and $V_A = \infty$.

(5%) (a) Determine the small-signal voltage gain $A_v = v_o/v_s$.

(5%) (b) Determine the small-signal current gain $A_i = i_o/i_s$.

(5%) (c) Find the input resistance R_{ib}.

(5%) (d) Find the input resistance R_{is}.

3. A multistage amplifier is shown in Figure 3. The transistor parameters for M_1 are V_{TN} = 0.5 V, Kn = 2 mA/V^2, and λ = 0, and for M_2, M_3, and M_4 are V_{TP} = -0.5 V, Kp = 1 mA/V^2, and λ = 0. Let V_{DD} = 10 V, V^+ = 10 V, and V^- = -10 V, I_{Bias} = 0.1 mA. The resistor parameters are R_S = 10 kΩ, R_D = 5 kΩ, R_G = 500 kΩ, and R_L = 5 kΩ. The capacitor parameters are C_{gs} = 10 pF, C_{gd} = 2 pF for all transistors, C_G and C_S approaching infinite in the small signal circuit, and C_C = 5 μF for all coupling capacitors.

(5%) (a) Determine the lower 3 dB frequency.

(5%) (b) Determine the upper 3 dB frequency.

(5%) (c) Determine the midband voltage gain.

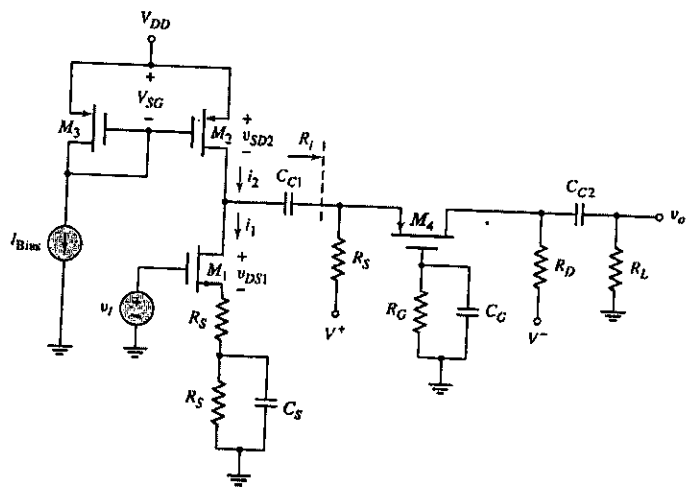

Fig. 3:

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4. A signal generating circuit is shown in Figure 4. The high saturated output voltage of the comparator is V_H and the low one is V_L.

(2%) (a) Find the relation between the voltage V_x and the output voltage V_o.

(3%) (b) Find the relation between the voltage V_c and the output voltage V_o.

(5%) (c) Draw the time diagram for the voltages V_c and V_o, respectively.

(5%) (d) Determine the frequency and the duty cycle of the output voltage V_o.

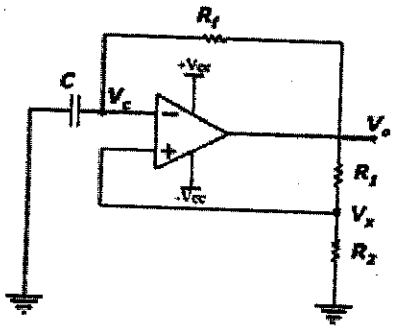

Fig. 4:

5. The figure 5 shows the circuit for a constant current driver. The normal driving condition for LED is set at 700mA. For Q_1, β=100, V_{BE}=0.75V, $V_{CE,sat}$=0.2V and $V_{CE,breakdown}$=50V.

(5%) (a) Why can it be a constant current driver? Derive the relation between the driving voltage V_1 and the output current to drive LED.

(5%) (b) What are the proper values for the resistor R_1 and the reference voltage V_1?

(5%) (c) As under 700mA driving, the forward voltage of the LED is 3.0V. What is the **maximal number** of the LEDs in series such that the constant current driver can still normally operate?

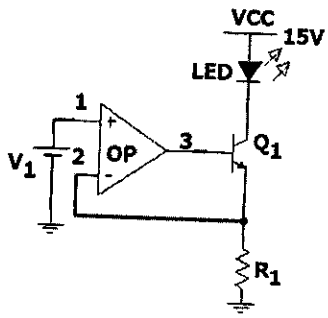

Fig. 5:

6. A second-order filter circuit is shown in Figure 6.

(10%) (a) Derive the transfer function, V_o/V_i.

(5%) (b) What are the requirements for the circuit being a low-pass filter?

(5%) (c) What are the requirements for the circuit being a high-pass filter?

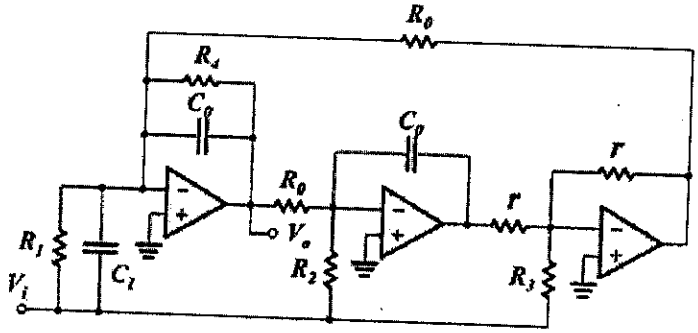

Fig. 6:

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