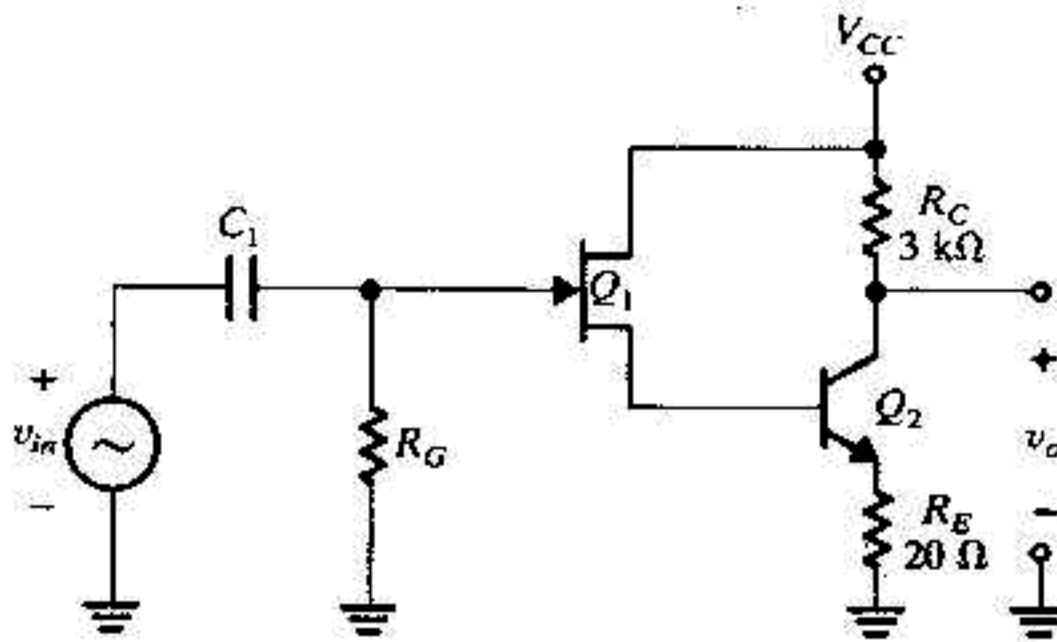
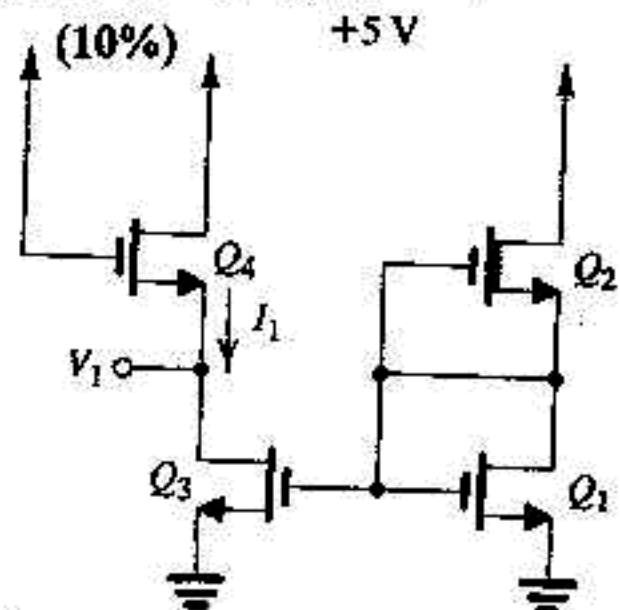


- A 6.8 V Zener diode specified at 5 mA to have $V_Z = 6.8$ V and $r_Z = 20$ Ω with $I_{ZK} = 0.2$ mA, is operated in a regulator circuit using a 200 Ω resistor and a 9 V supply.

 - Estimate the knee voltage of the Zener. (5%)
 - For no load, what is the lowest supply voltage for which the Zener remains in breakdown operation? (5%)
 - For the nominal supply voltage, what is the maximum load current for which the Zener remains in breakdown operation? (5%)
- The two-transistor amplifier shown in the following Figure combines an FET and a BJT to achieve both a high input impedance and a large voltage gain. By considering the g_m of Q_1 to be 1 mS (or 1 mA/V), and r_x and β for Q_2 to be 1 k Ω and 100, respectively, determine the voltage gain v_o/v_{in} of the amplifier. (10%)



- For the devices in the circuit of the following Figure, $|V_t| = 1$ V, $\lambda = 0$, $\gamma = 0$, $\mu_n C_{ox} = 20$ μ A/V², $L = 1$ μ m, and $W = 20$ μ m. Find the labeled current (I_1) and voltage (V_1). (10%)

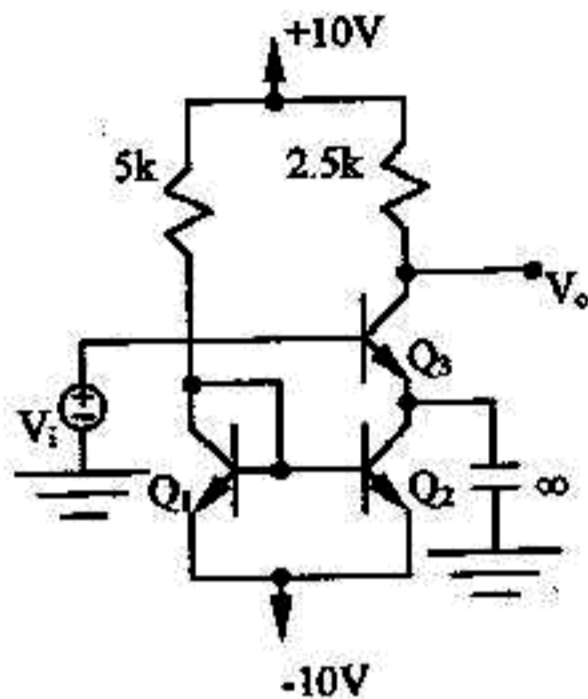


4. In the circuit, the BJTs have $\beta=100$ and $r_o=\infty$.

(1) Determine the dc voltages V_{c2} and V_{c3} .

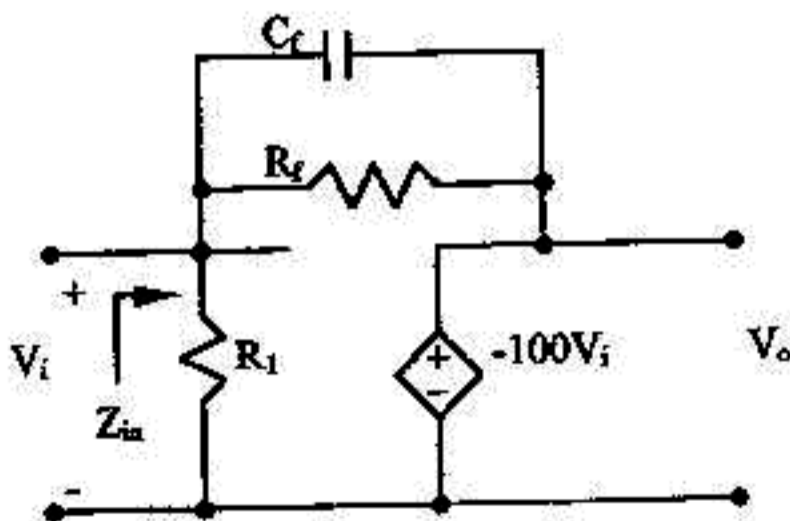
(2) Find the voltage gain V_o/V_i .

(10%)



5. An amplifier can be modeled by the equivalent circuit as shown. Find the input impedance Z_{in} and the pole of V_o/V_i .

(10%)



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6. (15%) For op amp 741, answer the following questions.

(a) 5% Draw the simple model of 741 for small signal with $f \gg f_0 = 4 \text{ Hz}$.

(c) 10% Draw the 741 output waveform (V-t plot) for one period, if the output of the 741 is $V_o = 10 \sin(2\pi \cdot t)$ with slew rate $= \pm \pi/3 \text{ V}/\mu\text{s}$, and output limits are from $-5\sqrt{3} \text{ V}$ to $+5\sqrt{3} \text{ V}$.

7. (a) Write the 2nd order band-pass filter function $T(S)=?$ 5%

(b) For the same band-pass filter function $T(S)$, if $|T(\omega_a)| = |T(\omega_b)|$ and $\omega_a \neq \omega_b$, find $\omega_a \cdot \omega_b = ?$. 10%
(15%)

8. An operational amplifier having infinite input resistance, zero output resistance and open-loop gain $A(s) = A_o / (1 + s/\omega_o)$ is connected in the circuit as shown.

(1) Find the circuit loop gain.

(2) If $R_1 = R_2$ and $C_1 = C_2$, find the high frequency corner ω_H of V_o/V_i .

(15%)

