

1. (25%) (a) (10%) Assume the diode is ideal, please plot the waveform of the output voltage  $V_o(t)$  for Fig. 1.

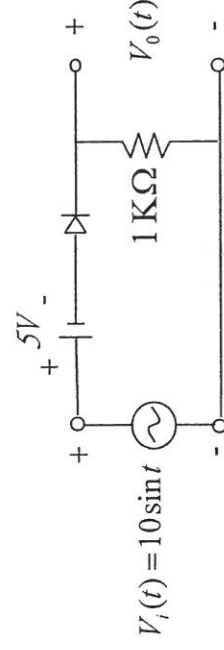


Fig. 1

- (b) (15 %) Sketch the output waveform and the voltage transfer characteristic for the circuit of Fig. 2. Assume ideal diode characteristics,  $v_s(t) = 10 \sin(2000\pi t)$ .

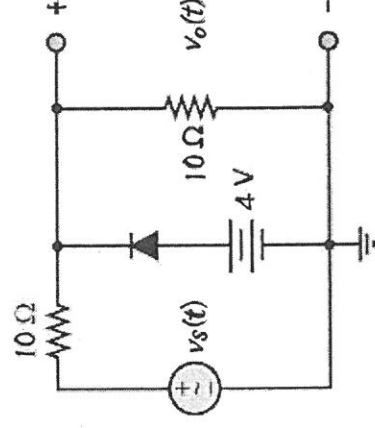


Fig. 2

2. (25%) Find the transfer function between  $v_{out}/v_{in}$ .

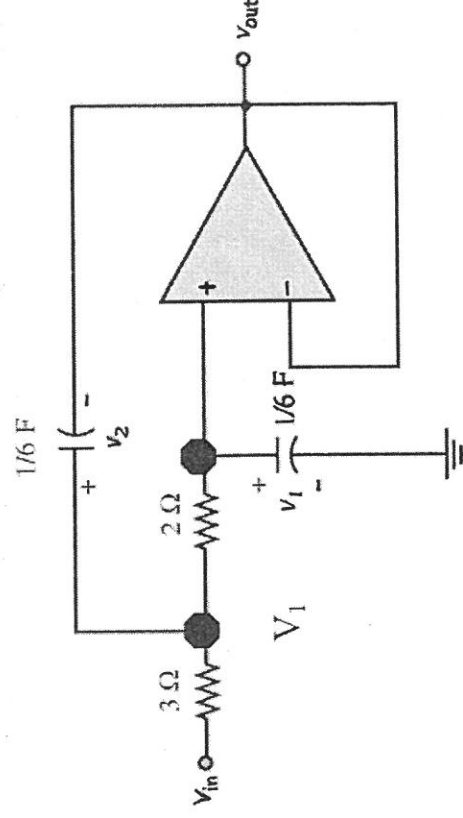


Fig. 3

- (a) (15%) Find the transfer function between  $v_{out}/v_{in}$ .  
(b) (10%) Find the undamped natural frequency and damping ratio of the transfer function

3. (25%) Fig. 4 shows a simple BJT circuit that drives a toy motor. The motor has a maximum (stall) current of 340mA. The minimum current to start motor rotation is 20mA. The variable resistance  $R_B$  is for controlling the motor torque. Choose the range of  $R_B$  corresponding to the stall and start currents stated above. Both BJTs have the same BE junction offset voltage  $V_\gamma = 0.6V$  and current gain  $\beta = 40$ .

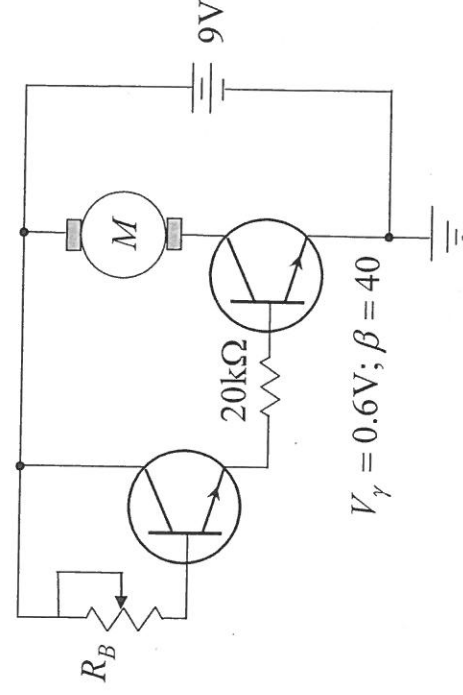


Fig. 4

4. (25%) Consider the schematic circuit in Fig. 5 as the charger of NiCd batteries. The terminal voltage of a NiCd battery is 9V when fully discharged and 10.5V when fully charged. Choose a MOSFET in terms of its threshold voltage  $V_T$ , conductance parameter  $K$ , and power rating, as well as the resistances ( $R_1, R_2$ ), so that (1) the charging current is within 50mA; and (2) the charging stops immediately after the battery is fully charged. Reason your answer.

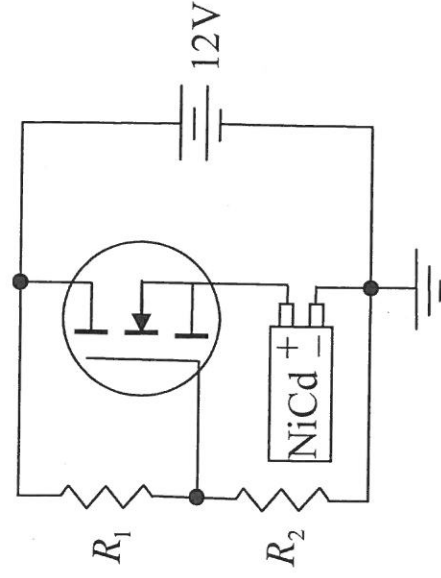


Fig. 5