1. (20%) Figure 1 shows the CS amplifier. The threshold voltage of transistor is –0.5 V. (a) Select a value for Rs to bias the transistor at I_D = 0.4 mA and $|V_{OV}|$ = 0.4 V. Assume v_{sig} to have a zero DC component. (b) Select value for R_D that results in v_o/v_{sig} = –8 V/V. (c) Find the largest sinusoid v_{sig} peak that the amplifier can handle while remaining in the saturation region. (d) If to obtain reasonably linear operation, v_{sig} peak is limited to 40 mV, what value can R_D be increased to while maintaining saturation-region operation? (5%*4)
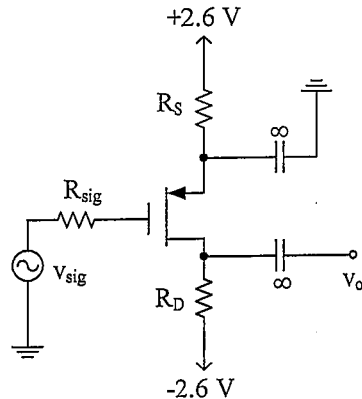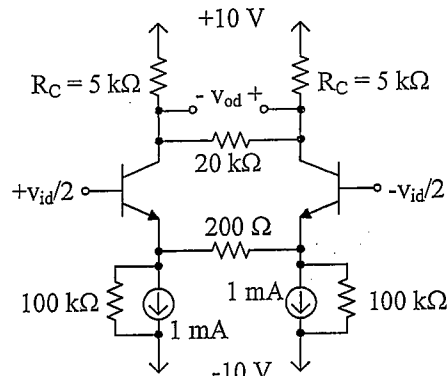

Figure 1   Figure 2

2. (20%) Figure 2 shows the differential amplifier. Please find (a) the differential gain, (b) the differential input resistance, (c) the common-mode gain assuming the resistance R_C have 2% tolerance, and (d) the common-mode input resistance. For these transistors, β = 100, thermal voltage is 25.9 mV and Early voltage V_A = 100 V. (5%*4)

3. (25%) Figure 3 shows a three-stage amplifier. (a) Find the DC bias collector current in each of the three transistors and DC bias output voltage V_o. Assume $|V_{BE}|$ = 0.7 V, β = 100, thermal voltage is 25.9 mV and neglect the Early effect for all BJTs. (b) Find the input resistance R_{in}, output resistance R_{out}, and voltage gain v_o/v_i. (10%, 5%*3)

4. (20%) For the CC-CB amplifier of Figure 4, let I = 1 mA, β = 100, C_π = 8 pF, C_μ = 3 pF, R_{sig} = 15 kΩ, R_L = 20 kΩ, and thermal voltage is 25.9 mV. Find (a) the low-frequency overall voltage gain A_M, (b) the frequencies of the poles for the high frequency response, and (c) the 3-dB frequency f_H. All BJTs have the same β, C_π and C_μ. (5%, 10%, 5%)
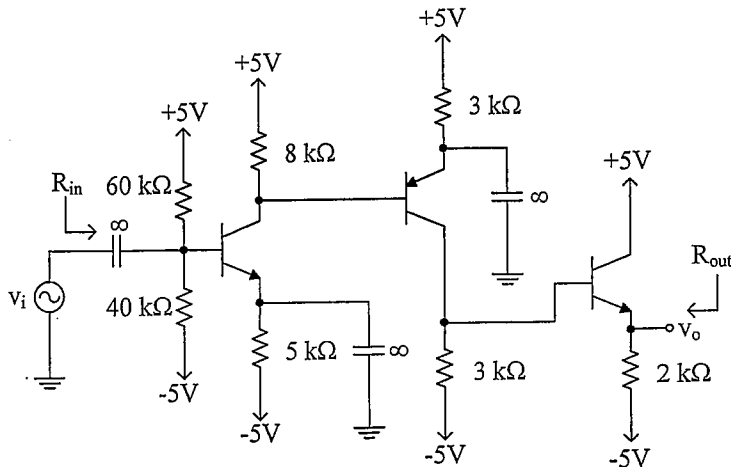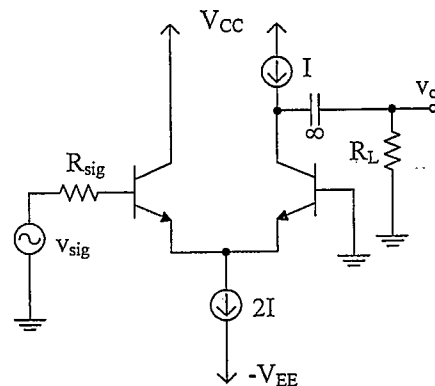

Figure 3   Figure 4

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5. (15%) Please only use the diode and capacitor components to draw the circuits of peak rectifier, DC restorer and voltage doubler to come out the stable output voltage: (a) $-V_a$, (b) $-V_a + V_a \sin(\omega t)$, (c) $-2V_a$, with a stable sinusoid input voltage $V_a \sin(\omega t)$ as shown in Figure 5. (5%*3)

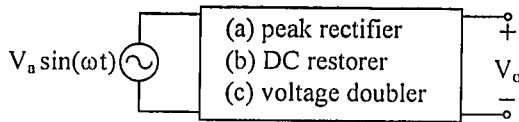$V_a \sin(\omega t)$

| (a) peak rectifier |
| (b) DC restorer |
| (c) voltage doubler |

$+$

V_o

$-$

Figure 5