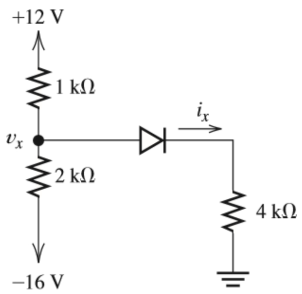
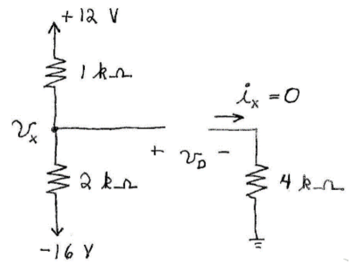
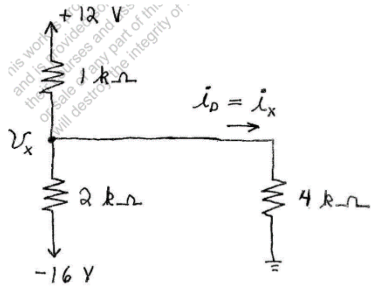
UC《电工电子学》2020-夏

Quiz 3

1. The diode shown in Figure 1 is ideal. Determine the state of the diode and the values of v_x and i_x.







Solution: If we assume that the diode is off (an open circuit), the circuit shown in middle figure.

Writing a KCL equation with resistances in kΩ, currents in mA, and voltages in V, we have

$$\frac{v_x - 12}{1} + \frac{v_x - (-16)}{2} = 0$$

Solving, we find that v_x =2.667V. However, the voltage across the diode is

$v_D = v_x$, which must be negative for the diode to be off. Therefore, the diode must be on.

With the diode assumed to be on (i.e. a short circuit) the circuit is shown in right figure.

Writing a KCL equation with resistances in kΩ, currents in mA and voltages in V, we have

$$\frac{v_x - 12}{1} + \frac{v_x - (-16)}{2} + \frac{v_x}{4} = 0$$

Solving, we find that v_x =2.286V. Then, the current through the diode is

$$i_D = i_x = \frac{v_x}{4} = 0.571 \text{ mA}$$

Of course, a positive value for iD is consistent with the assumption that the diode is on.

2. Design a full-wave bridge rectifier power supply to deliver an average voltage of 9 V with a peak-to-peak ripple of 2 V to a load. The average load current is 100 mA. Assume that ideal diodes and 60-Hz ac voltage sources of any amplitudes needed are available. Draw the circuit diagram for your design. Specify the values of all components used.

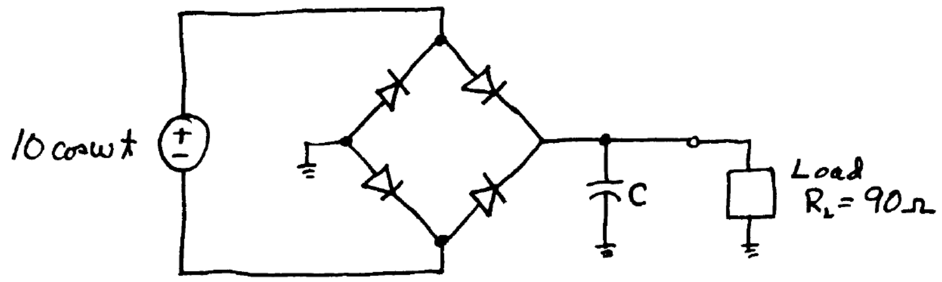
Solution:

The peak voltage must be 10 V.

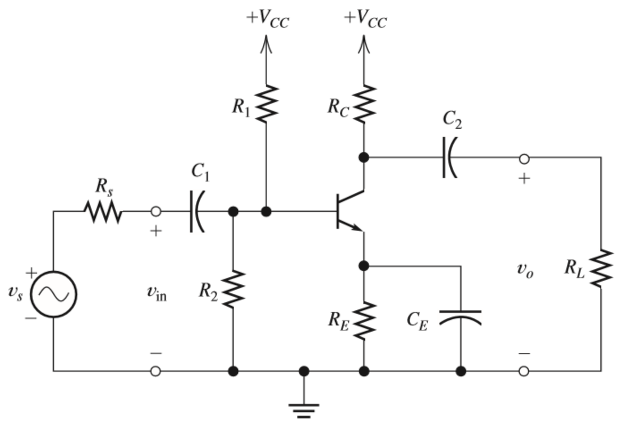
For a full-wave rectifier, the capacitance is given by Equation 9.12 in the text:

$$C = \frac{I_L T}{2V_r} = \frac{0.1(1/60)}{2(2)} = 417\ \mu F$$

The circuit diagram is:



3. The common-emitter amplifier shown in Figure 2 has R_1 = 100 kΩ, R_2 = 47 kΩ, R_C = 2.2 kΩ, R_L = 5.6 kΩ, β = 120, V_T = 26 mV, and I_{CQ} = 4 mA. Determine the value of the voltage gain $A_v = v_o/v_{in}$ and the input impedance.



Solution:

$$r_\pi = \frac{\beta V_T}{I_{CQ}} = \frac{120(26\text{ mV})}{4\text{ mA}} = 780\ \Omega$$

$$R_L' = \frac{1}{1/R_L + 1/R_C} = 1.579\text{ k}\Omega$$

$$A_v = -\frac{\beta R_L'}{r_\pi} = -243.0$$

$$R_B = \frac{1}{1/R_1 + 1/R_2} = 31.97\text{ k}\Omega$$

$$Z_{in} = \frac{1}{1/R_B + 1/r_\pi} = 761.4\ \Omega$$