Prob.1 For a circuit as shown in Figure 1, answer the followings.

(a) Find a Thevenin's equivalent circuit with respect to terminal a-b.(8 pts)

(b) If the box X represents a passive element, and its i-v characteristic is expressed as follows. Please calculate v and i. (7 pts)

$$i = \begin{cases} 0 & ; \quad v \le 2\,volts \\ \frac{1}{5}(v-2) & ; \quad v > 2\,volts \end{cases}$$

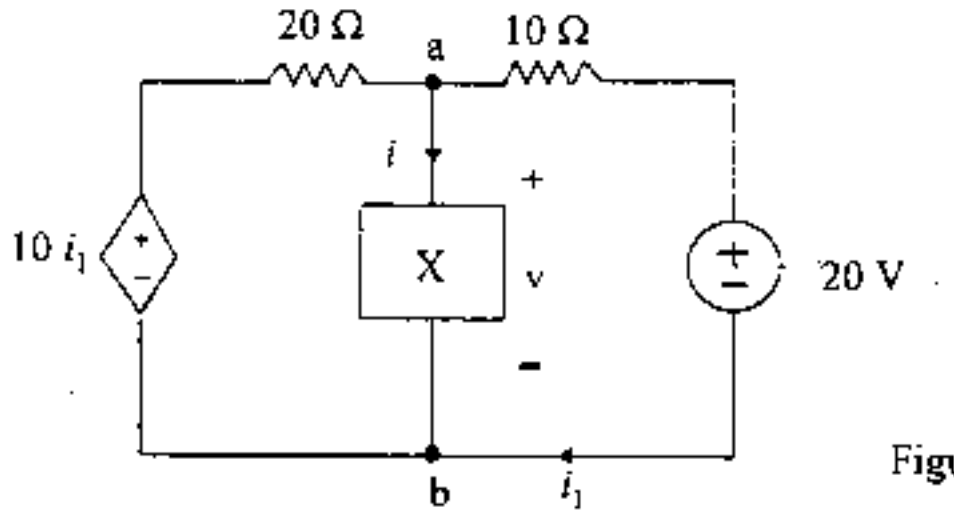


Figure 1

Prob.2 For a circuit as shown in Figure 2, assuming that it has reached sinusoidal steady state, calculate the followings.

(a) If a passive load is connected to terminal x-y, what is(are) passive element(s) to be used to achieve a maximum average power transfer.(5 pts)

(b) What can the maximum average power be transferred in watts?(5 pts)

(c) Based on (b), calculate the effective power being consumed by the 2Ω–resistor.(5pts)

(d) Based on (b), calculate the real power being absorbed(or delivered) by the 0.8 V_{xy} dependent source.(5pts)

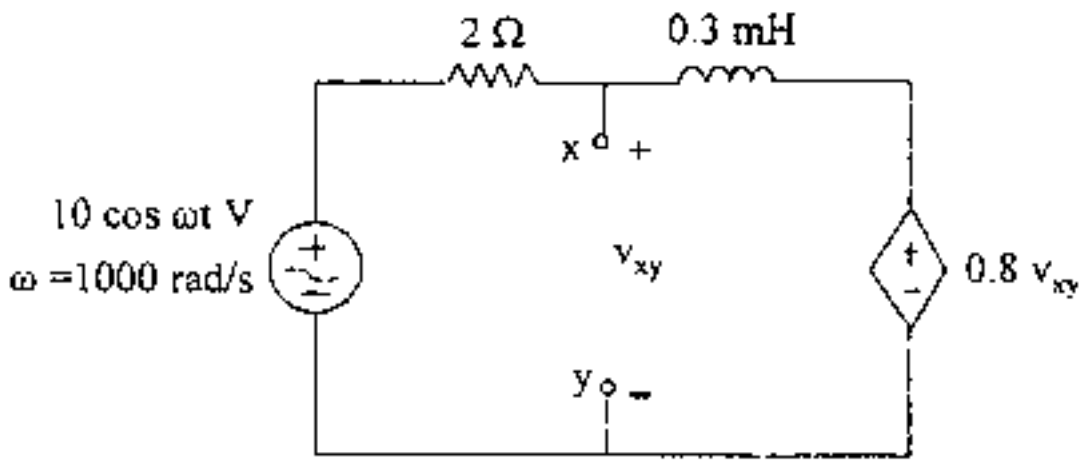


Figure 2

Prob.3 For a switching circuit shown in Figure 3(a), answer the following questions, and provide any assumption needed to justify your reasoning and/or calculations.

(a) If now, your are given V_s = 12 volts, L =0.1 H, C=1000 μF, T_{ON}= 8 ms, T_{OFF}=2 ms, calculate Δl as shown in Figure 3(b) in Amps.(4 pts)

(b) With the given waveforms of the switch S and the inductor current I_L. Plot the corresponding waveforms of V_L and I_D, versus time, respectively.(6 pts)

(c) If the load is purely resistive and R_L=1KΩ, plot I_o versus time.(5 pts)

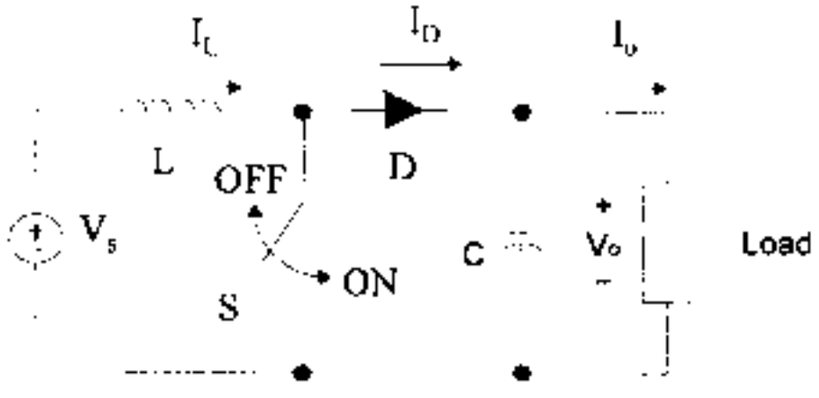


Figure 3(a)

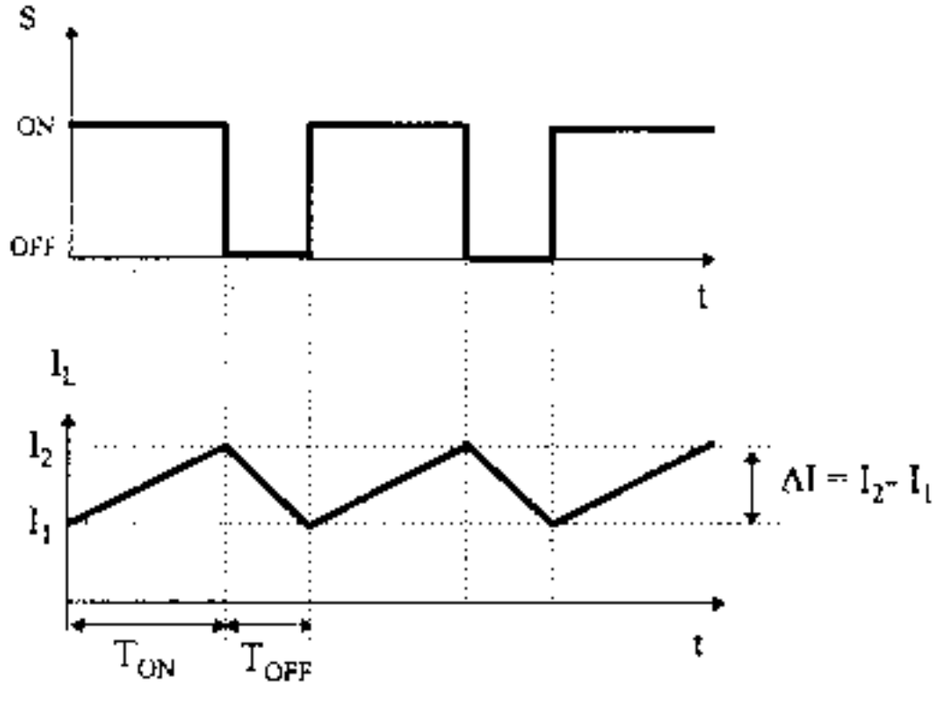


Figure 3(b)

Prob.4 Please choose the items from (a) to (k) which describe the terminology from (1) to (5) given as follows. (Note: in multiple choices) (5 pts)

(1)Gallium Arsenide. (2) Bridge Rectifier. (3) Miller Capacitance.
(4) Schmitt Triggering Circuit. (5) Glitches.

(a) Semiconductor for opto-electronic devices.
(b) Commonly found in circuits with large capacitors.
(c) Threshold voltage larger than 0.7 volt.
(d) Reverse-biased junction contributes the effect.
(e) Group III-V compound.
(f) Usually need to know the gain value.
(g) Immune to noisy signal.
(h) Digital circuits.
(i) Unexpected signals.
(j) Diode laser.
(k) Implemented by operational amplifiers.

Prob.5 Sketch v_o versus time for the circuit shown in Fig. 4. Assume $V_\gamma = 0.7$ V and the RC time constant is large compared to the input frequency. (5 pts)

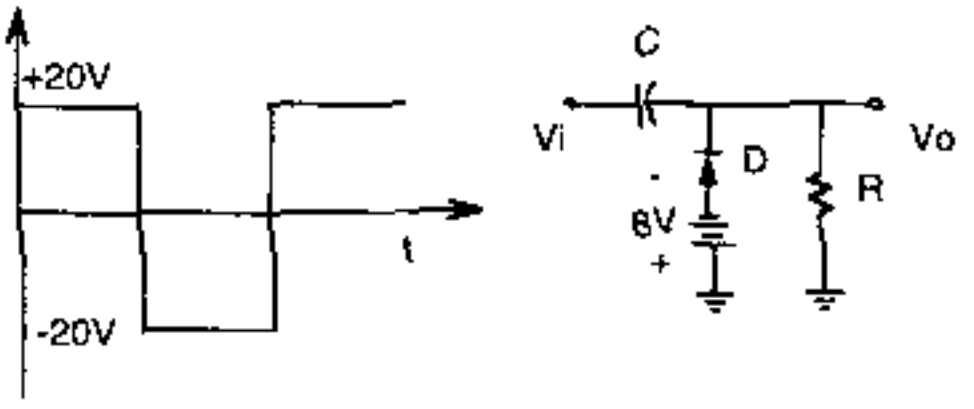


Figure 4

Prob.6 Design a 3-bit counter circuit which uses JK Flip-Flop according to the following steps. (15 pts)

(a) Set the counter go with the sequence as 000,001,010,011,100; then repeat again.
(b) List the truth table of the JK Flip-Flop.
(c) Simplify the state logic by the K-map.
(d) Draw the circuit diagram.
(e) Verify the circuit by timing diagram.

Prob.7 If f(X,Y,Z)=Σ(0,2,4,5,7);

(a) prove that f(X,Y,Z)=Π(1,3,6). (3 pts)

(b) implement f(X,Y,Z) by making use of a 3 to 8 decoder and a OR logic IC. (2 points)

Prob.8 For the Log Amplifier implemented with a diode as shown in Figure 5,

(a) derive the gain A_v. (7 pts)

(b) what happens if v_i goes negative ? Please explain. (3 pts)
(Hint: $i_D = I_S(e^{v_D/V_T} - 1)$)

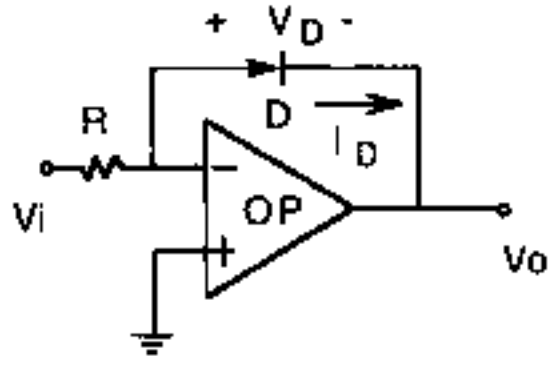
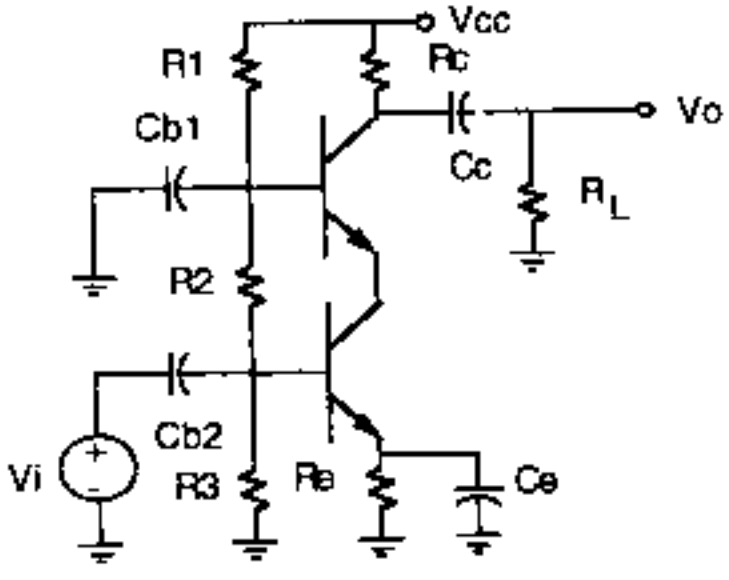


Figure 5

Prob.9 For a cascode BJT amplifier circuit as shown in Figure 6, if Q_1 and Q_2 are the same BJT with the hybrid-π parameters r_π and g_m.

(a) Please derive the voltage gain A_v. (8 pts)

(b) Please write down at least one of the advantages of the circuits. (2 pts)



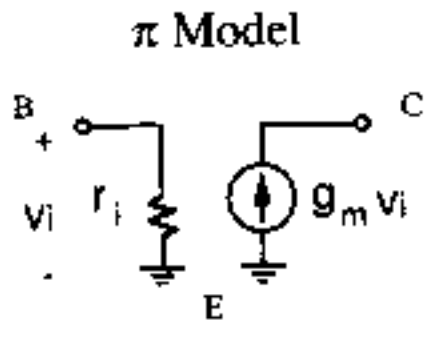


Figure 6