

## Essay Questions

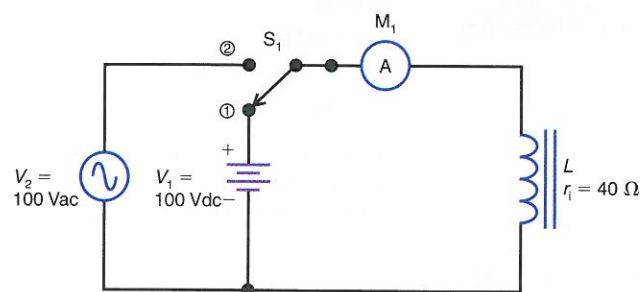
1. Explain briefly why  $X_L$  limits the amount of alternating current.
2. Give two differences and one similarity between  $X_L$  and  $R$ .
3. Explain why  $X_L$  increases with higher frequencies and more inductance.
4. Give two differences between the inductance  $L$  of a coil and its reactance  $X_L$ .
5. Why are the waves in Fig. 20-7a and b considered  $90^\circ$  out of phase, whereas the waves in Fig. 20-7b and c have the same phase?
6. Referring to Fig. 20-3, how does this graph show a linear proportion between  $X_L$  and frequency?
7. Referring to Fig. 20-4, how does this graph show a linear proportion between  $X_L$  and  $L$ ?
8. Referring to Fig. 20-3, tabulate the values of  $L$  that would be needed for each frequency listed but for an  $X_L$  of  $2000 \Omega$ . (Do not include 0 Hz.)
9. (a) Draw the circuit for a  $40\text{-}\Omega$   $R$  across a  $120\text{-V}$ ,  $60\text{-Hz}$  source. (b) Draw the circuit for a  $40\text{-}\Omega$   $X_L$  across a  $120\text{-V}$ ,  $60\text{-Hz}$  source. (c) Why is  $I$  equal to  $3\text{ A}$  for both circuits? (d) Give two differences between the circuits.
10. Why are coils for rf applications generally smaller than af coils?

## Problems

### SECTION 20-1 HOW $X_L$ REDUCES THE AMOUNT OF $I$

- 20-1 How much is the inductive reactance,  $X_L$ , of a coil for a steady dc current?
- 20-2 List two factors that determine the amount of inductive reactance a coil will have.
- 20-3 In Fig. 20-9, how much dc current will be indicated by the ammeter,  $M_1$ , with  $S_1$  in position 1?

Figure 20-9

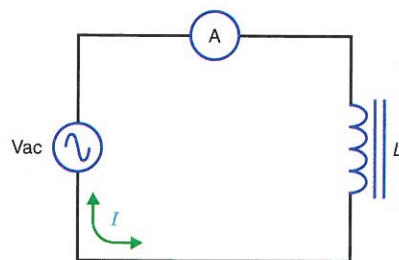


- 20-4 In Fig. 20-9, how much inductive reactance,  $X_L$ , does the coil have with  $S_1$  in position 1? Explain your answer.
- 20-5 In Fig. 20-9, the ammeter,  $M_1$ , reads an ac current of  $25\text{ mA}$  with  $S_1$  in position 2.
  - a. Why is there less current in the circuit with  $S_1$  in position 2 compared to position 1?
  - b. How much is the inductive reactance,  $X_L$ , of the coil? (Ignore the effect of the coil resistance,  $r_L$ .)
- 20-6 In Fig. 20-10, how much is the inductive reactance,  $X_L$ , for each of the following values of  $V_{ac}$  and  $I$ ?
  - a.  $V_{ac} = 10\text{ V}$  and  $I = 2\text{ mA}$ .
  - b.  $V_{ac} = 50\text{ V}$  and  $I = 20\text{ }\mu\text{A}$ .
  - c.  $V_{ac} = 12\text{ V}$  and  $I = 15\text{ mA}$ .

- d.  $V_{ac} = 6\text{ V}$  and  $I = 40\text{ }\mu\text{A}$ .
- e.  $V_{ac} = 120\text{ V}$  and  $I = 400\text{ mA}$ .

### SECTION 20-2 $X_L = 2\pi fL$

Figure 20-10



- 20-7 Calculate the inductive reactance,  $X_L$ , of a  $100\text{-mH}$  inductor at the following frequencies:
  - a.  $f = 60\text{ Hz}$ .
  - b.  $f = 120\text{ Hz}$ .
  - c.  $f = 1.592\text{ kHz}$ .
  - d.  $f = 10\text{ kHz}$ .
- 20-8 Calculate the inductive reactance,  $X_L$ , of a  $50\text{-}\mu\text{H}$  coil at the following frequencies:
  - a.  $f = 60\text{ Hz}$ .
  - b.  $f = 10\text{ kHz}$ .
  - c.  $f = 500\text{ kHz}$ .
  - d.  $f = 3.8\text{ MHz}$ .
- 20-9 What value of inductance,  $L$ , will provide an  $X_L$  value of  $1\text{ k}\Omega$  at the following frequencies?
  - a.  $f = 318.3\text{ Hz}$ .
  - b.  $f = 1.591\text{ kHz}$ .
  - c.  $f = 5\text{ kHz}$ .
  - d.  $f = 6.36\text{ kHz}$ .

- 20-10 At what frequency will a  $30\text{-mH}$  inductor provide an  $X_L$  value of
  - a.  $50\text{ }\Omega$ ?
  - b.  $200\text{ }\Omega$ ?
  - c.  $1\text{ k}\Omega$ ?
  - d.  $40\text{ k}\Omega$ ?
- 20-11 How much is the inductance of a coil that draws  $15\text{ mA}$  from a  $24\text{-Vac}$  source whose frequency is  $1\text{ kHz}$ ?
- 20-12 At what frequency will a stray inductance of  $0.25\text{ }\mu\text{H}$  have an  $X_L$  value of  $100\text{ }\Omega$ ?
- 20-13 A  $25\text{-mH}$  coil draws  $2\text{ mA}$  of current from a  $10\text{-Vac}$  source. What is the value of current drawn by the inductor when
  - a. the frequency is doubled?
  - b. the frequency is reduced by one-half?
  - c. the inductance is doubled to  $50\text{ mH}$ ?
  - d. the inductance is reduced by one-half to  $12.5\text{ mH}$ ?
- 20-14 A coil has an inductive reactance,  $X_L$ , of  $10\text{ k}\Omega$  at a given frequency. What is the value of  $X_L$  when the frequency is
  - a. cut in half?
  - b. doubled?
  - c. quadrupled?
  - d. increased by a factor 10?
- 20-15 Calculate the inductive reactance,  $X_L$ , for the following inductance and frequency values:
  - a.  $L = 7\text{ H}$ ,  $f = 60\text{ Hz}$ .
  - b.  $L = 25\text{ }\mu\text{H}$ ,  $f = 7\text{ MHz}$ .
  - c.  $L = 500\text{ mH}$ ,  $f = 318.31\text{ Hz}$ .
  - d.  $L = 1\text{ mH}$ ,  $f = 159.2\text{ kHz}$ .

- 20-16 Determine the inductance value for the following frequency and  $X_L$  values:
  - a.  $X_L = 50\text{ }\Omega$ ,  $f = 15.91\text{ kHz}$ .
  - b.  $X_L = 2\text{ k}\Omega$ ,  $f = 5\text{ kHz}$ .
  - c.  $X_L = 10\text{ }\Omega$ ,  $f = 795.7\text{ kHz}$ .
  - d.  $X_L = 4\text{ k}\Omega$ ,  $f = 6\text{ kHz}$ .
- 20-17 Determine the frequency for the following inductance and  $X_L$  values:
  - a.  $L = 80\text{ mH}$ ,  $X_L = 1\text{ k}\Omega$ .
  - b.  $L = 60\text{ }\mu\text{H}$ ,  $X_L = 200\text{ }\Omega$ .
  - c.  $L = 5\text{ H}$ ,  $X_L = 100\text{ k}\Omega$ .
  - d.  $L = 150\text{ mH}$ ,  $X_L = 7.5\text{ k}\Omega$ .

### SECTION 20-3 SERIES OR PARALLEL INDUCTIVE REACTANCES

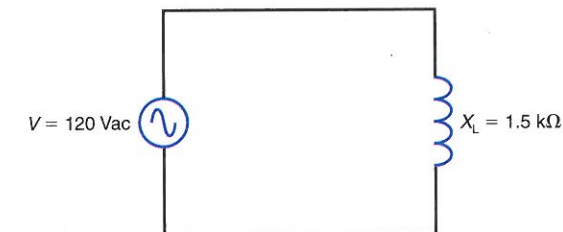
- 20-18 How much is the total inductive reactance,  $X_{L_T}$ , for the following series inductive reactances:
  - a.  $X_{L_1} = 250\text{ }\Omega$  and  $X_{L_2} = 1.5\text{ k}\Omega$ .
  - b.  $X_{L_1} = 200\text{ }\Omega$ ,  $X_{L_2} = 400\text{ }\Omega$  and  $X_{L_3} = 800\text{ }\Omega$ .
  - c.  $X_{L_1} = 10\text{ k}\Omega$ ,  $X_{L_2} = 30\text{ k}\Omega$  and  $X_{L_3} = 15\text{ k}\Omega$ .
  - d.  $X_{L_1} = 1.8\text{ k}\Omega$ ,  $X_{L_2} = 2.2\text{ k}\Omega$  and  $X_{L_3} = 1\text{ k}\Omega$ .

- 20-19 What is the equivalent inductive reactance,  $X_{L_{eq}}$ , for the following parallel inductive reactances?
  - a.  $X_{L_1} = 1.2\text{ k}\Omega$  and  $X_{L_2} = 1.8\text{ k}\Omega$ .
  - b.  $X_{L_1} = 1.5\text{ k}\Omega$  and  $X_{L_2} = 1\text{ k}\Omega$ .
  - c.  $X_{L_1} = 1.2\text{ k}\Omega$ ,  $X_{L_2} = 400\text{ }\Omega$  and  $X_{L_3} = 300\text{ }\Omega$ .
  - d.  $X_{L_1} = 1\text{ k}\Omega$ ,  $X_{L_2} = 4\text{ k}\Omega$ ,  $X_{L_3} = 800\text{ }\Omega$ , and  $X_{L_4} = 200\text{ }\Omega$ .

### SECTION 20-4 OHM'S LAW APPLIED TO $X_L$

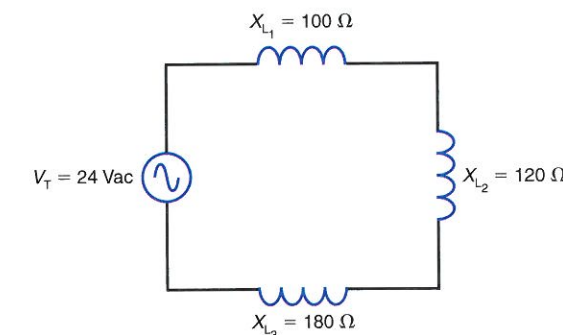
- 20-20 In Fig. 20-11, calculate the current,  $I$ .

Figure 20-11



- 20-21 In Fig. 20-11, what happens to the current,  $I$ , when the frequency of the applied voltage
  - a. decreases?
  - b. increases?
- 20-22 In Fig. 20-12, solve for
  - a.  $X_{L_T}$ .
  - b.  $I$ .
  - c.  $V_{L_1}$ ,  $V_{L_2}$ , and  $V_{L_3}$ .

Figure 20-12



- 20-23 In Fig. 20-12, solve for  $L_1$ ,  $L_2$ ,  $L_3$ , and  $L_T$  if the frequency of the applied voltage is  $1.591\text{ kHz}$ .
- 20-24 In Fig. 20-13, solve for
  - a.  $X_{L_1}$ ,  $X_{L_2}$ , and  $X_{L_3}$ .
  - b.  $X_{L_T}$ .
  - c.  $I$ .
  - d.  $V_{L_1}$ ,  $V_{L_2}$ , and  $V_{L_3}$ .
  - e.  $L_T$ .