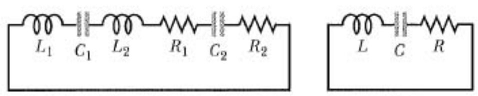
HW-CH31

1. A single loop consists of inductors (L_1,L_2,...), capacitors (C_1,C_2,...), and resistors (R_1,R_2,...) connected in series as shown, for example, in Fig. (a). Show that regardless of the sequence of these circuit elements in the loop, the behavior of this circuit is identical to that of the simple LC circuit shown in Fig. (b).



(a) (b)

2. A series circuit containing inductance L_1 and capacitance C_1 oscillates at angular frequency ω. A second series circuit, containing inductance L_2 and capacitance C_2, oscillates at the same angular frequency. In terms of ω, what is the angular frequency of oscillation of a series circuit containing all four of these elements? Neglect resistance.

3. In an oscillation series RLC circuit, show that $\Delta U/U$, the fraction of the energy lost per cycle of oscillation, is given to a close approximation by $2\pi R/\omega L$. The quantity $\omega L/R$ is often called the Q of the circuit (for quality). A high-Q circuit has low resistance and a low fractional energy loss($= 2\pi/Q$) per cycle.

4. The fractional half-width $\Delta\omega_d$ of a resonance curve, such as the ones in Fig. 31-16 (the figure in the subsection "Resonance"), is the width of the curve at half the maximum value of I. Show that $\Delta\omega_d/\omega = R(3C/L)^{0.5}$, where ω is the angular frequency at resonance. Note that the ratio $\Delta\omega_d$ increases with R, as Fig. 31-16 shows.

5. What is the maximum value of an ac voltage whose rms value is $100V$?

6. Figure 31-36 shows an "antotransformer." It consists of a single coil (with an iron core). Three taps T_i are provided. Between taps T_1 and T_2 there are 200 turns, and between taps T_2 and T_3 there are 800turns. Any two taps can be chosen as the primary terminals, and any two taps can be chosen as the secondary terminals. For choices producing a step-up transformer, what are the (a) smallest, (b) second smallest, and (c) largest values of the ratio V_s/V_p? For a step-down transformer, what are the (d) smallest, (e) second smallest, and (f) largest values of V_s/V_p?

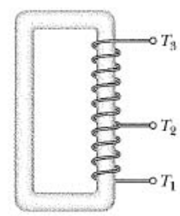
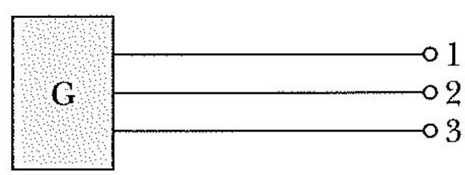


Fig. 31-36
Problem 64.

7. In Fig. 31-37, a three-phase generator G produces electrical power that is transmitted by means of three wires. The electric potentials (each relative to a common reference level) are $V_1 = A\sin(\omega_d t)$ for wire 1, $V_2 = A\sin(\omega_d t - 120°)$ for wire 2, and $V_3 = A\sin(\omega_d t - 240°)$ for wire 3. Some types of industrial equipment(for example, motors) have three terminals and are designed to be connected directly to these three wires. To use a more conventional two-terminal device (for example, a lightbulb), one connects it to any two of the three wires. Show that the potential difference between any two of the wires (a) oscillates sinusoidally with angular frequency ω_d and (b) has an amplitude of $A\sqrt{3}$.



Three-wire transmission line

Fig. 31-37 Problem 77.

8. A series circuit with resistor-inductor-capacitor combination R_1, L_1, C_1. has the same resonant frequency as a second circuit with a different combination R_2, L_2, C_2. You now connect the two combinations in series. Show that this new circuit has the same resonant frequency as the separate circuits.