Ch 32. Induction

1. A toroid has a major radius R and a minor radius r, and is tightly wound with N turns of wire, as shown in Figure P32.12. If $R >> r$, the magnetic field in the region enclosed by the wire of the torus, of cross-sectional area $A = \pi r^2$, is essentially the same as the magnetic field of a solenoid that has been bent into a large circle of radius R. Modeling the field as the uniform field of a long solenoid, show that the self-inductance of such a toroid is approximately

$$L \approx \frac{\mu_0 N^2 A}{2\pi R}$$

(An exact expression of the inductance of a toroid with a rectangular cross section is derived in Problem 64.)

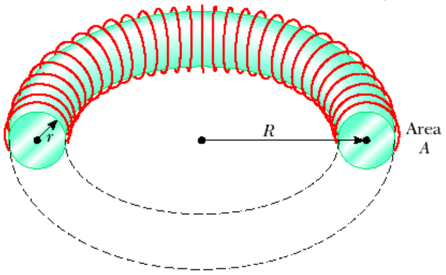


Figure P32.12

2. A self-induced emf in a solenoid of inductance L changes in time as $\mathcal{E} = \mathcal{E}_0 e^{-kt}$. Find the total charge that passes through the solenoid, assuming the charge is finite.

3. Show that $I = I_0\, e^{-t/\tau}$ is a solution of the differential equation

$$IR + L\frac{dI}{dt} = 0$$

where $\tau = L/R$ and I_0 is the current at $t = 0$.

4. Assume that the magnitude of the magnetic field outside a sphere of radius R is $B = B_0(R/r)^2$, where B_0 is a constant. Determine the total energy stored in the magnetic field outside the sphere and evaluate your result for $B_0 = 5.00 \times 10^{-5}$ T and $R = 6.00 \times 10^6$ m, values appropriate for the Earth's magnetic field.

5. An 820-turn wire coil of resistance 24.0 **Ω** is placed around a 12 500-turn solenoid 7.00 cm long, as shown in Figure P32.68. Both coil and solenoid have cross-sectional areas of 1.00×10^{-4} m^2. (a) How long does it take the solenoid current to reach 63.2% of its maximum value? Determine (b) the average back emf caused by the self-inductance of the solenoid during this time interval, (c) the average rate of change in magnetic flux through the coil during this time interval, and (d) the magnitude of the average induced current in the coil.

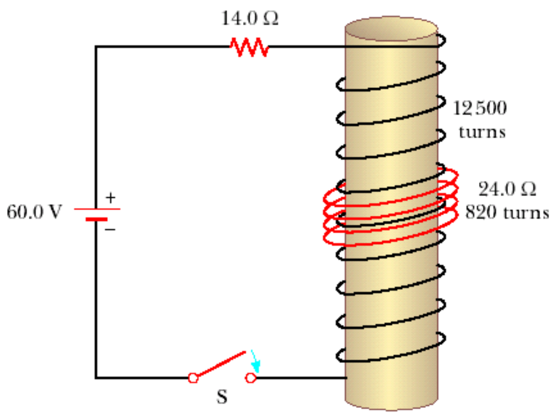


Figure P32.68

Ch 33. 교류회로

1. In a purely inductive AC circuit, as shown in Figure 33.6, $\Delta V_{max} = 100$ V. (a) The maximum current is 7.50 A at 50.0 Hz. Calculate the inductance *L*. (b) **What If?** At what angular frequency ω is the maximum current 2.50 A?

2. What maximum current is delivered by an AC source with $\Delta V_{max} = 48.0$ V and $f = 90.0$ Hz when connected across a 3.70-μF capacitor?

3. An *RLC* circuit consists of a 150-**Ω** resistor, a 21.0-μF capacitor, and a 460-mH inductor, connected in series with a 120-V, 60.0-Hz power supply. (a) What is the phase angle between the current and the applied voltage? (b) Which reaches its maximum earlier, the current or the voltage?

4. An AC source with $\Delta V_{max} = 150$ V and $f = 50.0$ Hz is connected between points *a* and *d* in Figure P33.26. Calculate the maximum voltages between points (a) *a* and *b*, (b) *b* and *c*, (c) *c* and *d*, and (d) *b* and *d*.

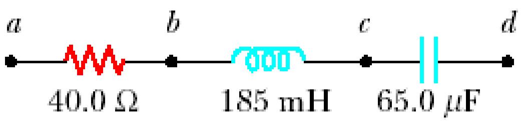


Figure P33.26

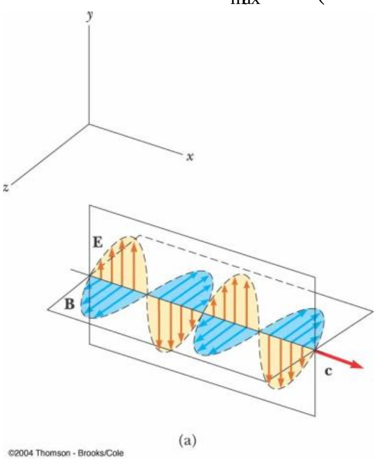
5. A transformer has $N_1 = 350$ turns and $N_2 = 2\ 000$ turns. If the input voltage is $\Delta v(t) = (170\text{ V})\cos \omega t$, what rms voltage is developed across the secondary coil?

Ch 34. 전자기파

1. A very long, thin rod carries electric charge with the linear density 35.0 nC/m. It lies along the *x* axis and moves in the *x* direction at a speed of 15.0 Mm/s. (a) Find the electric field the rod creates at the point (0, 20.0 cm, 0). (b) Find the magnetic field it creates at the same point. (c) Find the force exerted on an electron at this point, moving with a velocity of (240**î**) Mm/s.

2. Figure 34.3 shows a plane electromagnetic sinusoidal wave propagating in the *x* direction. Suppose that the wavelength is 50.0 m, and the electric field vibrates in the *xy* plane with an amplitude of 22.0 V/m. Calculate (a) the frequency of the wave and (b) the magnitude and direction of **B** when the electric field has its maximum value in the negative *y* direction. (c) Write an expression for **B** with the correct unit vector, with numerical values for B_{max}, *k*, and *ω*, and with its magnitude in the form

$$B = B_{max}\cos(kx - \omega t)$$



(a)

3. In SI units, the electric field in an electromagnetic wave is described by

$$E_y = 100\sin(1.00\times10^7 x - \omega t)$$

Find (a) the amplitude of the corresponding magnetic field oscillations, (b) the wavelength *λ*, and (c) the frequency *f*.

4. The filament of an incandescent lamp has a 150-**Ω** resistance and carries a direct current of 1.00 A. The filament is 8.00 cm long and 0.900 mm in radius. (a) Calculate the Poynting vector at the surface of the filament, associated with the static electric field producing the current and the current's static magnetic field. (b) Find the magnitude of the static electric and magnetic fields at the surface of the filament.

5. In a region of free space the electric field at an instant of time is **E** = $(80.0\hat{\mathbf{i}} + 32.0\hat{\mathbf{j}} - 64.0\hat{\mathbf{k}})$N/C and the magnetic field is B = $(0.200\hat{\mathbf{i}} + 0.0800\hat{\mathbf{j}} + 0.290\hat{\mathbf{k}})\mu$T. (a) Show that the two fields are perpendicular to each other. (b) Determine the Poynting vector for these fields.