21. (II) The generator of a car idling at 1100 rpm produces 12.4 V. What will the output be at a rotation speed of 2500 rpm, assuming nothing else changes?

22. (II) Show that the rms output (Section 18–7) of an ac generator is $V_{\text{rms}} = NAB\omega/\sqrt{2}$, where $\omega = 2\pi f$.

23. (II) A simple generator has a 320-loop square coil 21.0 cm on a side. How fast must it turn in a 0.650-T field to produce a 120-V peak output?

24. (II) A 450-loop circular armature coil with a diameter of 8.0 cm rotates at 120 rev/s in a uniform magnetic field of strength 0.55 T. (*a*) What is the rms voltage output of the generator? (*b*) What would you do to the rotation frequency in order to double the rms voltage output?

25. (II) A generator rotates at 85 Hz in a magnetic field of 0.030 T. It has 1000 turns and produces an rms voltage of 150 V and an rms current of 70.0 A. (*a*) What is the peak current produced? (*b*) What is the area of each turn of the coil?

* 21–6 Back EMF and Torque

* 26. (I) A motor has an armature resistance of 3.25 Ω. If it draws 8.20 A when running at full speed and connected to a 120-V line, how large is the back emf?

* 27. (I) The back emf in a motor is 72 V when operating at 1800 rpm. What would be the back emf at 2500 rpm if the magnetic field is unchanged?

* 28. (II) The back emf in a motor is 95 V when the motor is operating at 1000 rpm. How would you change the motor's magnetic field if you wanted to reduce the back emf to 65 V when the motor was running at 2500 rpm?

* 29. (II) What will be the current in the motor of Example 21–9 if the load causes it to run at half speed?

21–7 Transformers

[Assume 100% efficiency, unless stated otherwise.]

30. (I) A transformer is designed to change 120 V into 10,000 V, and there are 164 turns in the primary coil. How many turns are in the secondary coil?

31. (I) A transformer has 320 turns in the primary coil and 120 in the secondary coil. What kind of transformer is this, and by what factor does it change the voltage? By what factor does it change the current?

32. (I) A step-up transformer increases 25 V to 120 V. What is the current in the secondary coil as compared to the primary coil?

33. (I) Neon signs require 12 kV for their operation. To operate from a 240-V line, what must be the ratio of secondary to primary turns of the transformer? What would the voltage output be if the transformer were connected backward?

34. (II) A model-train transformer plugs into 120-V ac and draws 0.35 A while supplying 7.5 A to the train. (*a*) What voltage is present across the tracks? (*b*) Is the transformer step-up or step-down?

35. (II) The output voltage of a 95-W transformer is 12 V, and the input current is 22 A. (*a*) Is this a step-up or a step-down transformer? (*b*) By what factor is the voltage multiplied?

36. (II) A transformer has 330 primary turns and 1340 secondary turns. The input voltage is 120 V and the output current is 15.0 A. What are the output voltage and input current?

37. (II) If 30 MW of power at 45 kV (rms) arrives at a town from a generator via 4.0-Ω transmission lines, calculate (*a*) the emf at the generator end of the lines, and (*b*) the fraction of the power generated that is wasted in the lines.

38. (III) 65 kW is to arrive at a town over two 0.100-Ω lines. Estimate how much power is saved if the voltage is stepped up from 120 V to 1200 V and then down again, rather than simply transmitting at 120 V. Assume the transformers are each 99% efficient.

* 21–9 Inductance

* 39. (I) If the current in a 180-mH coil changes steadily from 25.0 A to 10.0 A in 350 ms, what is the magnitude of the induced emf?

* 40. (I) What is the inductance of a coil if the coil produces an emf of 2.50 V when the current in it changes from −28.0 mA to +31.0 mA in 12.0 ms?

* 41. (I) What is the inductance L of a 0.60-m-long air-filled coil 2.9 cm in diameter containing 10,000 loops?

* 42. (I) How many turns of wire would be required to make a 130-mH inductance out of a 30.0-cm-long air-filled coil with a diameter of 5.2 cm?

* 43. (II) An air-filled cylindrical inductor has 2800 turns, and it is 2.5 cm in diameter and 28.2 cm long. (*a*) What is its inductance? (*b*) How many turns would you need to generate the same inductance if the core were iron-filled instead? Assume the magnetic permeability of iron is about 1200 times that of free space.

* 44. (II) A coil has 2.25-Ω resistance and 440-mH inductance. If the current is 3.00 A and is increasing at a rate of 3.50 A/s, what is the potential difference across the coil at this moment?

* 45. (III) A long thin solenoid of length l and cross-sectional area A contains N_1 closely packed turns of wire. Wrapped tightly around it is an insulated coil of N_2 turns, Fig. 21–52. Assume all the flux from coil 1 (the solenoid) passes through coil 2, and calculate the mutual inductance.

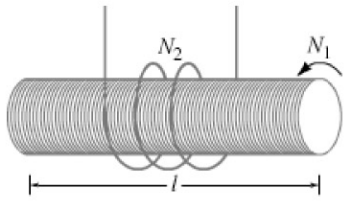

FIGURE 21–52 Problem 45.

* 46. (III) The wire of a tightly wound solenoid is unwound and used to make another tightly wound solenoid of twice the diameter. By what factor does the inductance change?

* 21–10 Magnetic Energy Storage

* 47. (I) The magnetic field inside an air-filled solenoid 36 cm long and 2.0 cm in diameter is 0.80 T. Approximately how much energy is stored in this field?

* 48. (II) At a given instant the current through an inductor is 50.0 mA and is increasing at the rate of 115 mA/s. What is the initial energy stored in the inductor if the inductance is known to be 60.0 mH, and how long does it take for the energy to increase by a factor of 10 from the initial value?