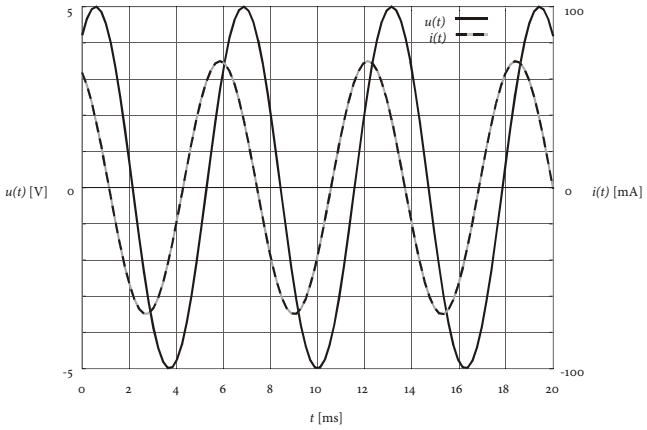
AC Circuits

1. How long does it take for an ac signal with frequency 25 Hz to drop from the maximum to one half?
2. A *light emitting diode* (LED) runs on an ac voltage with amplitude 7 V. The current can flow through the diode only in one direction and only when the voltage is greater than the threshold value 2.5 V. Using a construction, determine the fraction of a period during which the LED emits light.
3. Using the diagram below, answer the following questions:
   a) Determine the amplitude and the period of the voltage signal (solid line). Calculate its rms value, frequency and angular frequency.
   b) Determine impedance and phase shift of the circuit and calculate the effective power.



4. An ac motor runs on ac voltage with a frequency of 25 Hz and an amplitude of 12 V. Its impedance is 450 Ω. The current lags behind the voltage by 15 ms. Calculate the current's amplitude and the phase shift.
5. The current through a coil on an ac voltage with frequency 2.5 kHz and amplitude 4.8 V is measured to be 18 mA. Calculate the inductance of the coil.
6. In the US of America, the household voltage is 110 V/60 Hz. What is the ratio of the current flowing through two identical coils connected to the European and the American household voltage?
7. A *capacitor* is an electric part whose impedance is inversely proportional to the frequency:

$$Z_C = \frac{1}{\omega \cdot C},$$

   where C is the *capacitance* of the capacitor. It causes a phase shift of 90° between current and voltage.

   Sketch the voltage and current vs. time graphs for a capacitor with capacitance 330 nF on an ac voltage with amplitude 15 V and frequency 50 Hz.
8. The impedance of a resistor and a coil in series can be calculated using the following formula:

$$Z = \sqrt{R^2 + Z_L^2}$$

   Calculate the current amplitude in a circuit containing a resistor with resistance 50 Ω and a coil with inductance 15 mH on a voltage with frequency 1.4 kHz and amplitude 24 V.
9. An ac motor is labelled as "230 V/0.3 A/50 W". What do these numbers stand for? Calculate the motor's power factor and phase shift.
10. A high voltage transformer with 500 turns in its primary and 23'000 turns in its secondary coil is connected to 230 V. Calculate the voltage across the secondary coil.
11. The voltage of high voltage power lines shall be increased from 230 kV to 380 kV. By how many percents are the transmission losses reduced?

Solutions: 1. 6.7 ms; 2.40 %; 3. 5 V, 6.2 ms, 3.5 V, 160 Hz, 1'000 s^{-1}; 70 Ω, 1.0 rad = 58°; 4. 27 mA, 3π/4 = 135°; 5. 17 mH; 6. 5 : 2; 8. 170 mA; 9. 0.72, 43.5°; 10. 10.6 kV; 11. –63 %