

# General Physics A (II) – Spring Semester 2019

## Homework Set 6

Due: 06/05/2019 (Wednesday)

**Problems 1~5 [Benson, P=Problem] 60pts**

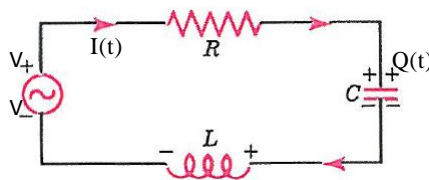
Ch 31: P2, P3

Ch 32: P3, P10, P12

Ch 33: P4

**Python exercise 40pts**

Consider the AC circuit shown in the figure. Suppose the voltage source is  $V_+ - V_- = V(t) = V_0 \sin \omega t$ . Assume the current flowing out from the  $V_+$  end is  $I(t)$ , and the charge stored in the capacitor (on the side connecting to  $V_+$ ) is  $Q$ .



1. Write down the differential equations for  $Q$  and  $I$  using the Kirchhoff's rules. Express your answer in the form of

$$\frac{d}{dt} \begin{pmatrix} Q \\ I \end{pmatrix} = M \begin{pmatrix} Q \\ I \end{pmatrix} + \mathcal{E}.$$

Find the matrix  $M$  and the column vector  $\mathcal{E}$ .

2. Suppose  $V_0 = 1$  V,  $\omega = 2\pi \times 3$  kHz,  $R = 5$   $\Omega$ ,  $C = 10$   $\mu$ F,  $L = 200$   $\mu$ H. At  $t = 0$ ,  $Q(0) = 0$  and  $I(0) = 0$ . Write a python program that evolves the differential equations by iteration. Plot  $Q(t)$  and  $I(t)$  for  $t > 0$ . Do not forget to specify the units and the time step you choose for time evolution.
3. For the steady state (time is large enough), from the curves obtained in (2), determine the phase leading or lagged by  $I(t)$  compared to  $V(t)$ .
4. Numerically determine (from  $P_{device} = I_{device}V_{device}$ ) and plot the power dissipated or stored in each device, and check the validity of the law of conservation of energy.