

Chapter 01: Solutions to EXERCISE PROBLEMS:

E1.1: Charge, $i(t)$ flowing into a circuit is expressed to be:

$$i(t) = e^{-t} \cdot (t^2 + 2t) \text{ for } t \geq 0 \text{ s}$$

- Plot $i(t)$.
- What is the peak value of $i(t)$ and when does it occur?
- Find the total charge flowing into circuit.
- Find the expression for current entering the circuit and plot it.

Solution:

$$\frac{di}{dt} = 2 \cdot e^{-t} \cdot (t+1) - e^{-t} \cdot (t^2 + 2t) = e^{-t} \cdot (2 - t^2)$$

It can be seen that

$$\frac{di}{dt} = 0, \quad \text{when } t = \sqrt{2}$$

From the plot of $i(t)$, it can be seen

$$\frac{d^2i(\sqrt{2})}{dt^2} < 0$$

$\therefore i(\sqrt{2})$ is the maximum value of $i(t)$

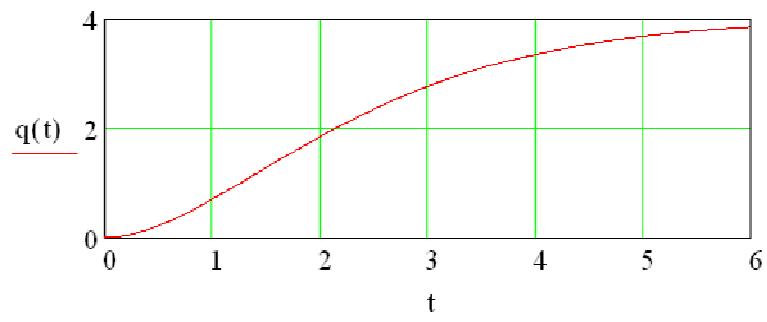
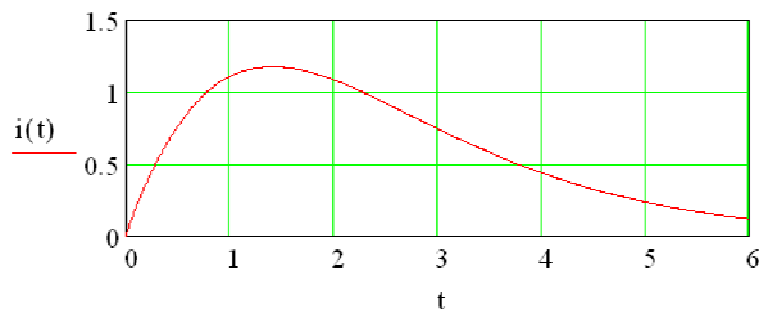
$$i(\sqrt{2}) = 1.174 \text{ A}$$

Total charge Q is found out as follows.

$$q(t) = e^{-t} \cdot (t^2 + 2t) \text{ for } t \geq 0 \text{ s}$$

$$Q = \int_0^{\infty} e^{-t} \cdot (t^2 + 2t) \cdot dt = 4 \text{ Coulombs}$$

The plots of charge and current are shown next.



E1.2: Energy, $w(t)$ absorbed by a circuit is expressed to be:

$$w(t) = \frac{1}{3}t^3 + t^2 \text{ J for } 0 \leq t \leq 3 \text{ s}$$

- a. Find the expression for power during the interval $0 \leq t \leq 3 \text{ s}$.
- b. Given that current, $i(t)$ is expressed as:

$$\begin{aligned} i(t) &= t \text{ A for } 0 \leq t \leq 3 \text{ s} \\ &= 0 \text{ A for } t < 0 \text{ s} \\ &= 0 \text{ A for } t > 3 \text{ s} \end{aligned}$$

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- c. find an expression for voltage $v(t)$.
Sketch the waveforms of $i(t)$ and $v(t)$.

Solution:

$$w(t) = \frac{1}{3}t^3 + t^2 \text{ J for } 0 \leq t \leq 3 \text{ s}$$

$$p(t) = \frac{dw(t)}{dt} = t^2 + 2 \cdot t \text{ for } 0 \leq t \leq 3 \text{ s}$$

$$i(t) = t \text{ for } 0 \leq t \leq 3 \text{ s}$$

$$v(t) = (t + 2) \text{ for } 0 \leq t \leq 3 \text{ s}$$

E1.3 A laser generates 100 -mJ laser pulses of 25 ns duration.

- a. What is the peak instantaneous power of the laser /
- b. If 50 pulses are generated per second, what is the average power output of the laser ?

Solution:

$$\text{Peak power} = 4 \text{ MW}$$

$$\text{Power} = 5 \text{ W}$$

E1.4 A 12 V battery supplies 5 A for 1 hour and the charge supplied by the battery during this period amounts to one-tenth the AH rating of the battery. What is the AH rating of the battery?

Solution:

$$\text{AH capacity of battery} = 50 \text{ AH}$$
