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EK307 - Electric Circuits
Homework 1

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Problem 1:

1.a)

Solution:

$$i(t) = \frac{d}{d}t(3t + 8)\ \text{mC} = 3\ \text{mA} \quad [1]$$

1.b)

Solution:

$$i(t) = \frac{d}{d}t(8t^2 + 4t - 2)C = (16t + 4)A \quad [2]$$

1.c)

Solution:

$$i(t) = \frac{d}{d}t(3e^{-t} - 5e^{-2t})\ \text{nC} = (-3e^{-t} + 10e^{-2t})\ \text{nA} \quad [3]$$

1.d)

Solution:

$$i(t) = \frac{d}{d}t(10\sin(120\pi t))\ \text{pC} = 1200\pi\cos(120\pi t)\ \text{pA} \quad [4]$$

1.e)

Solution:

$$i(t) = \frac{d}{d}t(20e^{-4t}\cos(50t))\ \mu\text{C} = -20e^{-4t}(4\cos(50t) + 50\sin(50t))\ \mu\text{A} \quad [5]$$

Problem 2:

2.a)

Solution:
At $t = 1$ ms, current is the slope of the line:

$$i = \frac{dq}{dt} = \frac{30 \text{ mC}}{2 \text{ ms}} = 15A \quad [6]$$

2.b)

Solution:
At $t = 6$ ms, the graph is flat, so the slope is zero:

$$i = 0A \quad [7]$$

2.c)

Solution:
At $t = 10$ ms, current is the slope of the line:

$$i = \frac{dq}{dt} = \frac{-30 \text{ mC}}{4 \text{ ms}} = -7.5A \quad [8]$$

Problem 3:

Solution:

$$Q = \int i(t)dt \quad [9]$$

$$Q = \left(\frac{1}{2} \cdot \text{base} \cdot \text{height}\right)_{\text{triangle}} + (\text{width} \cdot \text{height})_{\text{rectangle}} \quad [10]$$

$$Q = \left(\frac{1}{2} \cdot 1\text{ms} \cdot 10\text{mA}\right) + (1\text{ms} \cdot 10\text{mA}) \quad [11]$$

$$Q = 5 \text{ μC} + 10 \text{ μC} = 15 \text{ μC} \quad [12]$$

Problem 4:

Solution:

$$Q = I \times t = (90 \times 10^{-3}A) \times \left(12h \times 3600\frac{s}{h}\right) = 3888C \quad [13]$$

$$W = V \times Q = 1.5V \times 3888C = 5832J \quad [14]$$

Problem 5:

Solution:

$$Q = I \times t = (40 \times 10^3 A) \times (1.7 \times 10^{-3} s) = 68C \quad [15]$$

Problem 6:

6.a)

Solution:

$$W_{\text{total}} = (200W)(18h) + (800W)(2h)(1200W)(4h) \quad [16]$$

$$W_{\text{total}} = 10000 \text{ Wh} = 10 \text{ kWh} \quad [17]$$

6.b)

Solution:

$$P_{\text{avg}} = \frac{\text{Total Energy}}{\text{Total Time}} = \frac{10000 \text{ Wh}}{24h} \approx 417W \quad [18]$$

Problem 7:

7.a)

Solution:
Current `i`:

$$8A = 2A + i \implies i = 6A \quad [19]$$

7.b)

Solution:

$$\sum P = -8A \times 9V + 6A \times 9V + 2A \times 3V + 2A \times 6V = \quad [20]$$

$$\sum P = -72W + 54W + 6W + 12W = 0W \quad [21]$$

End of Homework 1