LAHORE UNIVERSITY OF MANAGEMENT SCIENCES
Department of Electrical Engineering

EE 240 Circuits I
Quiz 1 Solutions

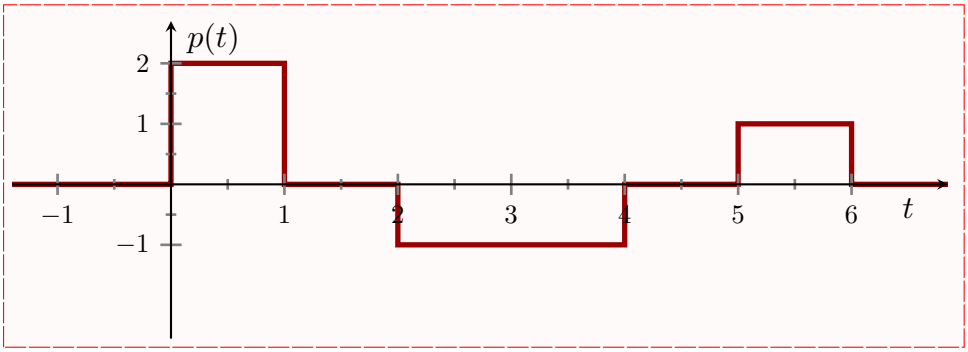
Name: _____

Campus ID: _____

Total Marks: 10
Time Duration: 15 minutes

Question 1 (4 marks)

The power (in Watts) dissipated in a circuit element is plotted against time (in seconds) below. Calculate and plot the energy against time.



Solution: We know that

$$w(t) = \int_{\tau=\infty}^{t} p(\tau)\, d\tau$$

We have

$$p(t) = \begin{cases} 2, & 0 \le t < 1 \\ 0, & 1 \le t < 2 \\ -1, & 2 \le t < 4 \\ 0, & 4 \le t < 5 \\ 1, & 5 \le t < 6 \\ 0, & \text{otherwise} \end{cases}$$

Since $p(t)$ is a piecewise function, we compute $w(t)$ for different ranges of t:

For $0 \le t < 1$:

$$w(t) = \int_0^t 2\, d\tau = 2t \quad \text{for } 0 \le t < 1$$

For $1 \le t < 2$:

$$w(t) = \int_0^1 2\, d\tau + \int_1^t 0\, d\tau = 2 + 0 = 2 \quad \text{for } 1 \le t < 2$$

For $2 \le t < 4$:

$$w(t) = \int_0^1 2\, d\tau + \int_1^2 0\, d\tau + \int_2^t (-1)\, d\tau = 2 + (-1)(t-2) = 2 - (t-2) = 4 - t \quad \text{for } 2 \le t < 4$$

For $4 \le t < 5$:

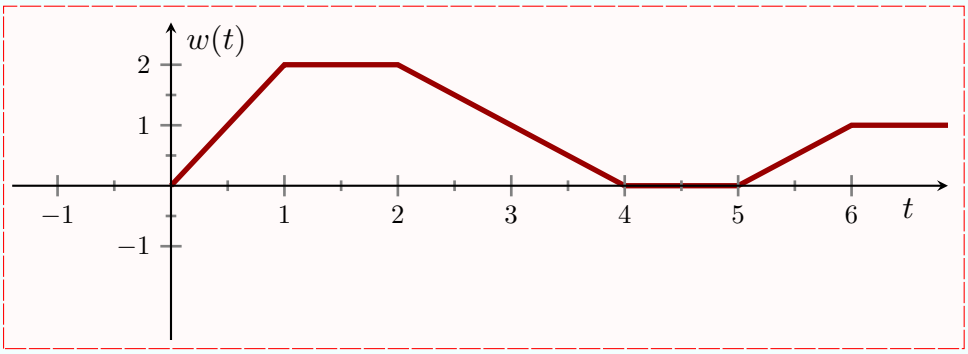
$$w(t) = \int_0^1 2\, d\tau + \int_1^2 0\, d\tau + \int_2^4 (-1)\, d\tau + \int_4^t 0\, d\tau = 2 + (-1)(4-2) = 2 - 2 = 0 \quad \text{for } 4 \le t < 5$$

For $5 \le t < 6$:

$$w(t) = \int_0^1 2\,d\tau + \int_1^2 0\,d\tau + \int_2^4 (-1)\,d\tau + \int_4^5 0\,d\tau + \int_5^t 1\,d\tau = 0 + (t-5) = t-5 \quad \text{for } 5 \le t < 6$$

Combining these yield (plotted below)

$$w(t) = \begin{cases} 2t, & 0 \le t < 1 \\ 2, & 1 \le t < 2 \\ 4-t, & 2 \le t < 4 \\ 0, & 4 \le t < 5 \\ t-5, & 5 \le t < 6 \\ 0, & \text{otherwise} \end{cases}$$



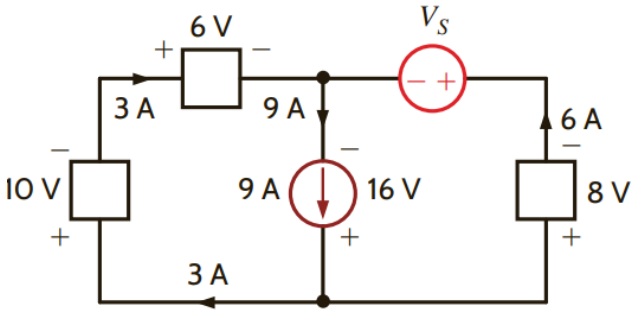
Question 2 (2 marks)

A lightning bolt carrying 30,000 A lasts for 50 micro-seconds. If the lightning strikes an airplane flying at 20,000 feet, what is the charge deposited on the plane?

Solution: $q = i(t) * t = 30,000 * 50 * 10^{-6} = 1.5$ C

Question 3 (4 marks)

Determine whether the source V_s n the given network is supplying or absorbing power. Additionally, calculate the amount of power involved.



Solution:

$$P_{10V} = 10 * 3 = 30 \text{ W absorbed}$$
$$P_{6V} = 10 * 3 = 18 \text{ W absorbed}$$
$$P_{9A} = 16 * -9 = -144 \text{ W supplied}$$
$$P_{8V} = 8 * 6 = 48 \text{ W absorbed}$$
$$P_{V_s} = 6V_s$$

According to Tellegen's Theorem:

$$\text{Power absorbed} = \text{Power supplied}$$
$$30 + 18 + 48 + 6V_s = 144$$
$$V_s = 8 \text{ V}$$

$P_{V_s} = 48$ W absorbed