Circuits I – Tutorial 01

Basic Concepts

#	Student ID	Student Name	Grade (10)
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Q1	**1.5** Determine the total charge transferred over the time interval of $0 \leq t \leq 10$ s when $i(t) = \frac{1}{2}t$ A.
Sol 1	$q = \int i dt = \int_0^{10} \frac{1}{2} t dt = \frac{t^2}{4}\Big\|_0^{10} = \underline{25\ \text{C}}$

Q2	**1.11** A rechargeable flashlight battery is capable of delivering 90 mA for about 12 h. How much charge can it release at that rate? If its terminal voltage is 1.5 V, how much energy can the battery deliver?
Sol 2	q= it = 90 x10^{-3} x 12 x 60 x 60 = **3.888 kC** E = pt = ivt = qv = 3888 x1.5 = **5.832 kJ**

Q3	**1.13** The charge entering the positive terminal of an element is $q = 5 \sin 4\pi t$ mC while the voltage across the element (plus to minus) is $v = 3 \cos 4\pi t$ V (a) Find the power delivered to the element at $t = 0.3$ s. (b) Calculate the energy delivered to the element between 0 and 0.6 s.

Sol 3

(a) $i = [dq/dt] = 20\pi\cos(4\pi t)$ mA

$p = vi = 60\pi\cos^2(4\pi t)$ mW

At t=0.3s,

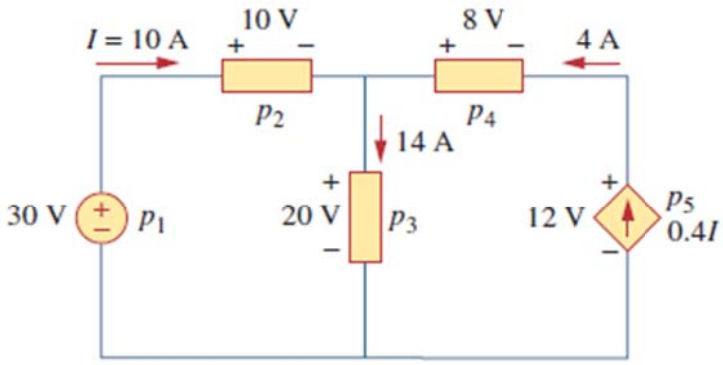
$$p = vi = 60\pi\cos^2(4\pi 0.3)\ \text{mW} = \mathbf{123.37\ mW}$$

(b) $$W = \int p\,dt = 60\pi \int_0^{0.6} \cos^2(4\pi t)\,dt = 30\pi \int_0^{0.6} [1 + \cos(8\pi t)]\,dt$$

$$W = 30\pi[0.6+(1/(8\pi))[\sin(8\pi 0.6)-\sin(0)]] = \mathbf{58.76\ mJ}$$

Q4

1.18 Find the power absorbed by each of the elements in Fig. 1.29.



Sol 4

$p_1 = 30(-10) = \mathbf{-300\ W}$
$p_2 = 10(10) = \mathbf{100\ W}$
$p_3 = 20(14) = \mathbf{280\ W}$
$p_4 = 8(-4) = \mathbf{-32\ W}$
$p_5 = 12(-4) = \mathbf{-48\ W}$

Q5	**1.28** A 60-W incandescent lamp is connected to a 120-V source and is left burning continuously in an otherwise dark staircase. Determine: (a) the current through the lamp. (b) the cost of operating the light for one non-leap year if electricity costs 9.5 cents per kWh.
Sol 5	(a) $i = \frac{P}{V} = \frac{60}{120}$ $= \mathbf{500\ mA}$ (b) $W = pt = 60 \times 365 \times 24\ \text{Wh} = 525.6\ \text{kWh}$ $\text{Cost} = \$0.095 \times 525.6$ $= \mathbf{\$49.93}$

Q6	**1.36** A battery may be rated in ampere-hours (Ah). A lead-acid battery is rated at 160 Ah. (a) What is the maximum current it can supply for 40 h? (b) How many days will it last if it is discharged at 1 mA?
Sol 6	(a) $i = \frac{160\text{A} \cdot \text{h}}{40} = \underline{4\ \text{A}}$ (b) $t = \frac{160\text{Ah}}{0.001\text{A}} = \frac{160{,}000\text{h}}{24\text{h / day}} = \underline{6{,}667\ \text{days}}$