EE101 Lecture #2 Jan 10, 2018

sewebsite https://courses.soe.ucsc.edu/courses/ee101/winter18/01

TAs

Emily Enlow	eenlow@ucsc.edu
Imran Hossain	ghossain@ucsc.edu
Tae Sung Kim	tkim@ucsc.edu
Tuwin Lam	tulam@ucsc.edu

Text C.K. Alexander & M.N.O. Sadiku Fundamentals of Electric Circuits

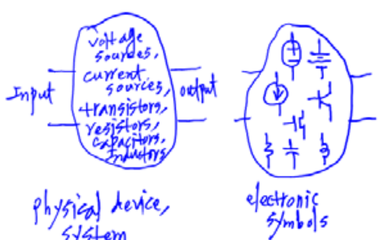
<connect>
http://connect.mheducation.com/class/s-kang-winter2018-mwf240

Course Grading

Weekly Quizze, based on weekly HWs (Best 7 out of 9 Quizzes) 20%
Submit HW solutions to your TA

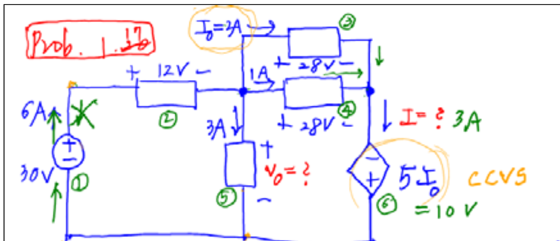
Mid-term Examination (Feb 7, 1 page of formulas allowed) 30%

Final Examination (March 20, 2 pages of formulas allowed) 50%



1) Formulate circuit equations using model equations for elements and circuit laws (KCL, KVL)
2) Solve for outputs for given inputs

Prob. 1.17

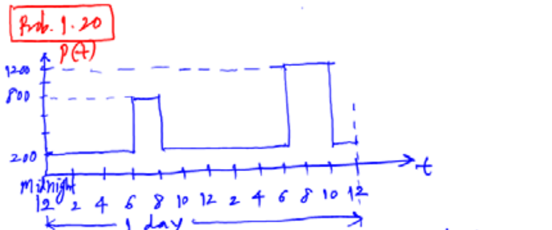


Find the power absorbed in each element (1 - 6).

	V	I	Power absorbed
1	30	−6	−180W
2	12	6	72W
3	28	2	56W
4	28	1	28W
5	18	3	54W
6	−10	3	−30W

−210W
+210
―――
0

Prob. 1.20



a) Total energy consumed in one day in KWh ?

$200 \times 6 + 800 \times 2 + 200 \times 10 + 1200 \times 4 + 200 \times 2$
$= 1200 + 1600 + 2000 + 4800 + 400 = 10\ \text{KWh}$

b) Average power per our over 24 hour period ?

$P_{avg} = \frac{1}{T}\int_0^T p(\tau)\,d\tau = \frac{10\ \text{KWh}}{24\ \text{h}} \cong 0.416\ \text{KW}$

Prob. 1.9

$q(t) = \int_{-\infty}^{t} i(\tau)\,d\tau$

$q(0) = 0$

Find the total charge that passed through the element:

(a) t = 1 s, i.e. q(t=1)

$0 + \int_0^{t=1} i(\tau)\,d\tau = 10\,A \cdot 1\,s = 10$ Coulomb [C]

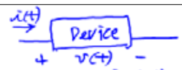
(b) t = 3 s, i.e. q(t=3)

$0 + \int_0^{t=3} i(\tau)\,d\tau = 10 + 7.5 + 5 = 22.5\ C$

(c) t = 5 s, i.e. q(t=5)

$0 + \int_0^{t=5} i(\tau)\,d\tau = 22.5 + 7.5 = 30\ C$

Prob. 1.14



For $t \geq 0$, $v(t) = 10\cos 2t\,[V]$, $i(t) = 20(1 - e^{-0.5t})\,[mA]$

a) Find the charge in the device at $t = 2s$
(assume initial charge at $t = 0$ is zero)
$e = 2.718$ $e^{-1} = 0.368$

$$0 + \int_0^{t=2} i(\tau)d\tau = \int_0^2 20(1 - e^{-0.5\tau})\,d\tau \quad [mA \cdot s]$$

$$= 20\left[\tau - \frac{e^{-0.5\tau}}{-0.5}\right]_0^2 = 20\left[2 - \frac{e^{-1} - 1}{-0.5}\right]$$

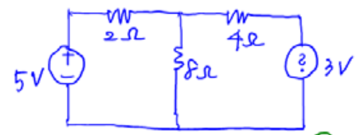
$$= 20[2 + (0.368 - 1) \times 2] = 20(2 - 1.262) = 14.76\ mC$$

b) The power consumed by the device at $t = \pi\,s$
($e^{-\frac{\pi}{2}} \approx 0.208$)

$$P(t) = v(t)\,i(t) = 10\underbrace{\cos(2\pi)}_{=1} \times 20\overbrace{(1 - \underbrace{e^{-0.5\pi}}_{0.208})}^{0.792}$$

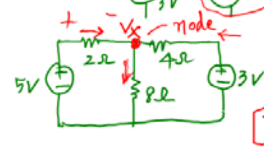
$$= 200 \times 0.792 = 158.4\ V\cdot mA = 0.1584\ W$$

Example 1.10



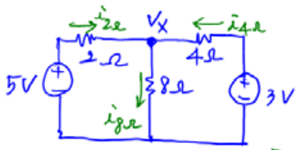
What is the polarity (?)

Case A (?)3V = (±)3V (Case B (?)3V = (∓)3V)
is already presented using a loop analysis



Let's try to find V_X

[This is called Nodal Analysis]



Current $i_{2\Omega}[A] = \frac{[5 - V_X][V]}{2[\Omega]}$ [Ohm's Law $v = Ri$, $i = \frac{v}{R}$]

$$i_{4\Omega}[A] = \frac{3 - V_X[V]}{4[\Omega]}$$

$$i_{8\Omega}[A] = \frac{V_X[V]}{8[\Omega]}$$

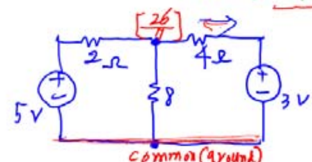
Also $i_{2\Omega} + i_{4\Omega} = i_{8\Omega}$ [Based on Kirchhoff's Current law $\sum_k i_k = 0$ at a node]

$$\frac{5 - V_X}{2} + \frac{3 - V_X}{4} = \frac{V_X}{8}$$

$$4(5 - V_X) + 2(3 - V_X) = V_X$$

$$20 + 6 - 4V_X - 2V_X = V_X$$

$$26 = 7V_X \Rightarrow V_X = \frac{26}{7}\,[V]$$



$$i_{2\Omega} = \frac{5 - \frac{26}{7}}{2} = \frac{9}{14}\,[A]$$

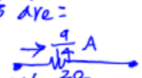
$$i_{4\Omega} = \frac{3 - \frac{26}{7}}{4} = -\frac{5}{28}\,[A]$$ (− means in opposite direction)

$$i_{8\Omega} = \frac{\left(\frac{26}{7}\right)}{8} = \frac{13}{28}\,[A]$$

$i_{8\Omega} = i_{2\Omega} + i_{4\Omega}$ (KCL ✓)

Also, Power absorbed in 2Ω, 4Ω, 8Ω resistors are:

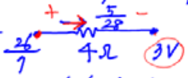
2Ω case



$$P_{2\Omega} = \left[\left(5 - \frac{26}{7}\right)[V]\right]\left[\frac{9}{14}A\right]$$

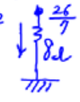
$$= \frac{9}{7}[V] \times \frac{9}{14}[A] = \frac{81}{98}\,[W]$$

4Ω case



$$P_{4\Omega} = \left(\frac{26}{7} - 3\right)[V] \times \frac{5}{28}[A] = \frac{5}{7} \times \frac{5}{28} = \frac{25}{196}\,[W]$$

8Ω case



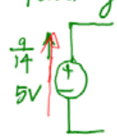
$$P_{8\Omega} = \frac{26}{7}[V] \times \frac{13}{28}[A] = \frac{169}{98}\,[W]$$

Total consumption

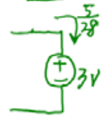
$$P_{total} = \frac{81}{98} + \frac{25}{196} + \frac{169}{98} = \frac{162 + 25 + 338}{196}$$

$$= \frac{525}{196} \underset{(\div 7)}{=} \frac{75}{28}\,[W]$$ ← conservation (net zero)

Power generated by two voltage sources:



$$P_{5V} = -5[V] \times \frac{9}{14} = \frac{-45}{14}$$ ← negative sign since this is supplied



$$P_{3V} = +3[V] \times \frac{5}{28}[A] = +\frac{15}{28}\,[W]$$

Total $P_{5V} + P_{3V} = -\frac{45}{14} + \frac{15}{28} = -\frac{75}{28}\,[W]$