E245B Exam II

November 6, 2001

Name:

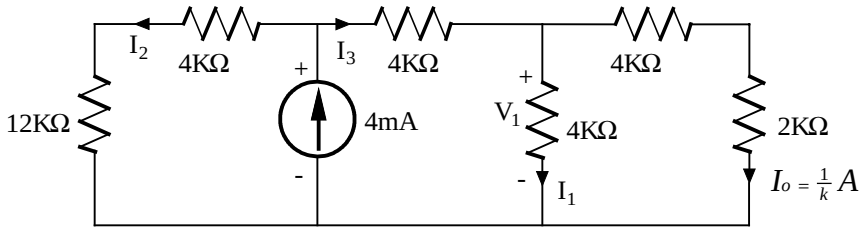
SSN:

Pledge:

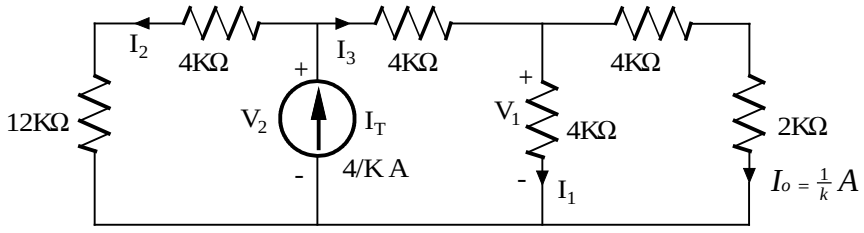
Questions are worth 20 points each.

Problem 1

Find I_o in the circuit shown using linearity and the assumption that I_o = 1mA.



Suggested Solution



If $I_o = \frac{1}{k} A$ Then $V_2 = \frac{1}{k}(4K + 2K) = 6V$, $I_1 = \frac{6}{4k} = \frac{3}{2} mA$

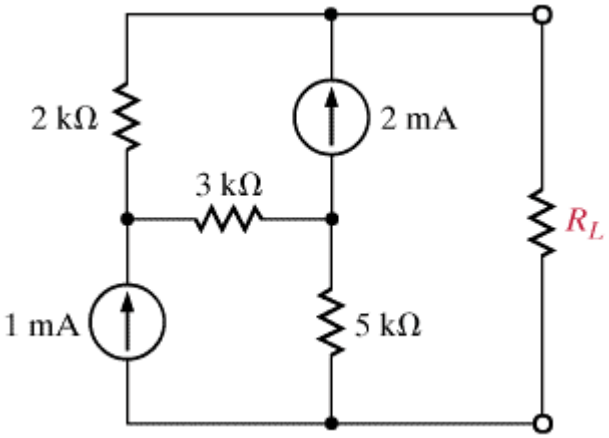
Then $I_2 = I_1 + I_o = \frac{5}{2} mA$ and $V_2 = V_1 + 4K I_2 = 16V$

Then $I_3 = \frac{V2}{4K + 12K} = 1mA \therefore I_T = I_2 + I_3 = \frac{7}{2} mA$

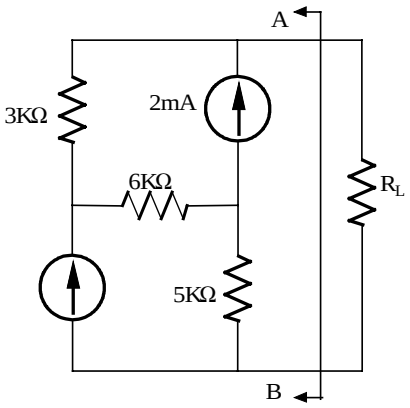
So $\frac{7/2mA}{1mA} = \frac{4mA}{x} \therefore x = \boxed{I_o = \frac{8}{7} mA}$

Problem 2

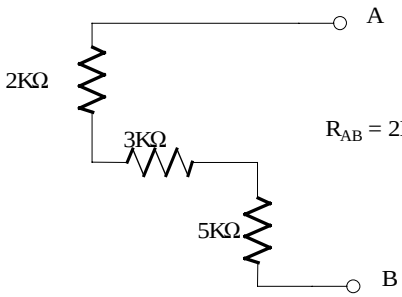
Find R_L for maximum power transfer and the maximum power that can be transferred in the network shown.



Suggested Solution

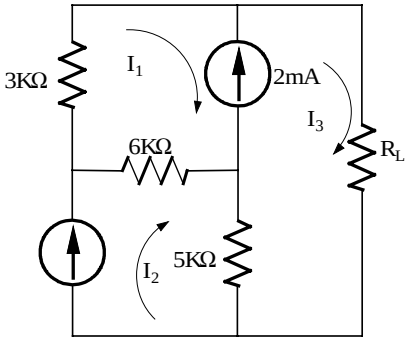


Find R_{AB}



R_{AB} = 2K + 3K + 5K = 10KΩ

Find maximum load tranfer



$I_3 - I_1 = 2mA \quad I_2 = 1mA$

$(2K)\, I_1 + (10K)\, I_3 + 5K\,(I_3 - I_2) + 3K\,(I_1 - I_2) = 0$

yields: I3 = 0.9mA

$P_L = I^2_3\, R_{AB}$

PL = 8.1 mW

Problem 3

The voltage across a 50-μF capacitor is shown in the figure. Determine the current waveform.

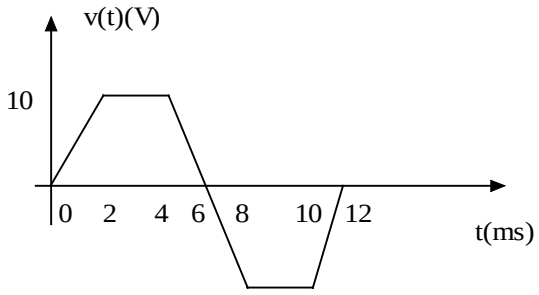
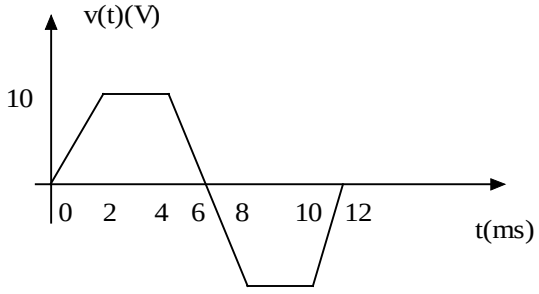


Figure P5.12

Suggested Solution

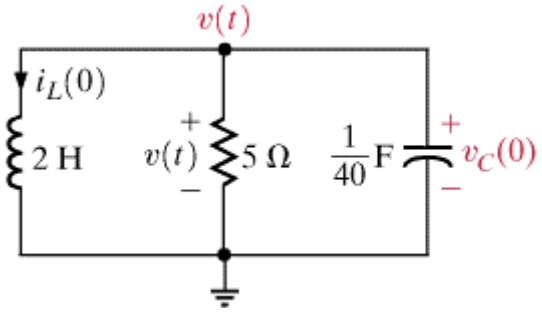
$C = 50\mu F$ $\quad i(t) = C\frac{dv}{dt}$

Time(ms)	$\frac{dv}{dt}$(V/ms)	i(t)(mA)
$0 \le t \le 2$	5	250
$2 \le t \le 4$	0	0
$4 \le t \le 8$	-5	-250
$8 \le t \le 10$	0	0
$10 \le t \le 12$	5	250
$t > 12$	0	0

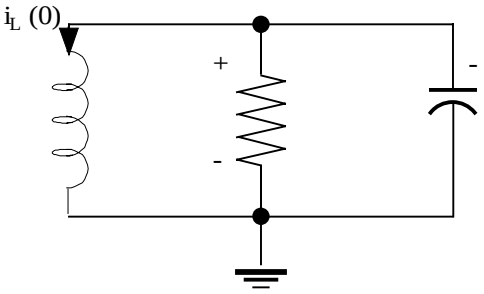


Problem 4

For the underdamped circuit shown in the figure determine the voltage v(t) if the initial conditions on the storage elements are $i_L(0)$=1 A and v_C (0) = 10 V.



Suggested Solution



Find V(t) if $i_L(0)$=1A and $v_c(0)$=10v

$$\frac{d^2v(t)}{dt^2}+\frac{1}{RC}\frac{dv(t)}{dt}+\frac{1}{LC}v(t)=0$$

The characteristic equation is

$$s^2+8s+20=0$$

$$s=-4\pm 2j$$

so

$$v(t)=k_1e^{-4t}\cos 2t+k_2e^{-4t}\sin 2t$$

at

$$t=0, v_c=10$$

$$v(t)=k_1=10$$

then

$$\frac{dv(t)}{dt} = -2k_1 e^{-4t}\sin 2t - 4k_1 e^{-4t}\cos 2t + 2k_2 e^{-4t}\cos 2t - 4k_2 e^{-4t}\sin 2t$$

at

$t = 0$

$$\frac{dv(t)}{dt} = -4k_1 + 2k_2 = -40 + 2k_2$$

also

$$\frac{cdv(t)}{dt} + \frac{v(t)}{R} + i_L(t) = 0$$

at

$t = 0$

$$\frac{dv(t)}{dt} = \frac{1}{c}\left(\frac{-v(t)}{R} - i_L(t)\right) = \frac{1}{c}\left(\frac{-10}{R} - 1\right)$$

if

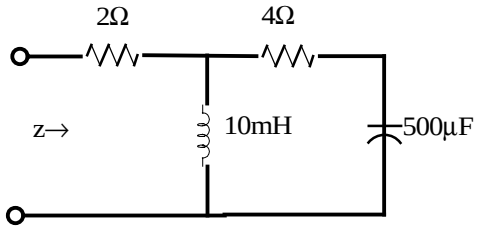
$-40 + 2k_2 = -120$

finally

$v(t) = 10e^{-4t}\cos 2t - 40e^{-4t}\sin 2t$

Problem 5

Find **Z(jω)** at a frequency of 60 Hz for the network shown.



Suggested Solution

$$Z_L = j\omega L = j(377)(10\times10^{-3}) = j3.77$$

$$Z_c = \frac{1}{j\omega C} = \frac{10^6}{j377(5)} = -j5.3$$

$$Z = 2 + \frac{j3.77(4 - j5.3)}{j3.77 + 4 - j5.3} = 2 + \frac{j15.08 + 20}{4 - j1.535} = 5.1 + j4.96\Omega$$