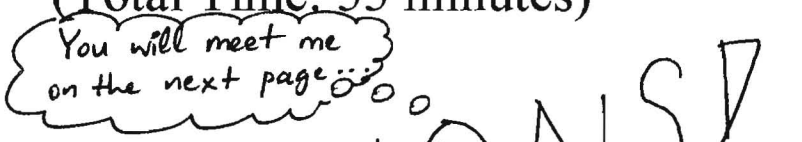
4/12/2006

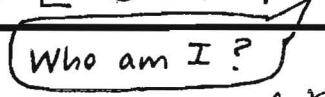
University of Portland
School of Engineering

EE 261-Electrical Circuits-3 cr. hrs.
Spring 2006
SOLUTIONS TO
Midterm Exam # 2

(Monday, March 27, 2006)
(Closed Book Exam, Two Formula Sheets Allowed)
(Total Time: 55 minutes)

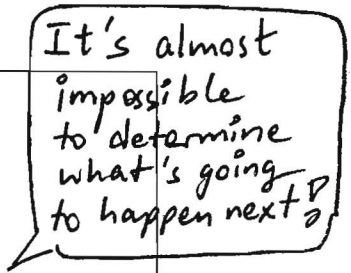


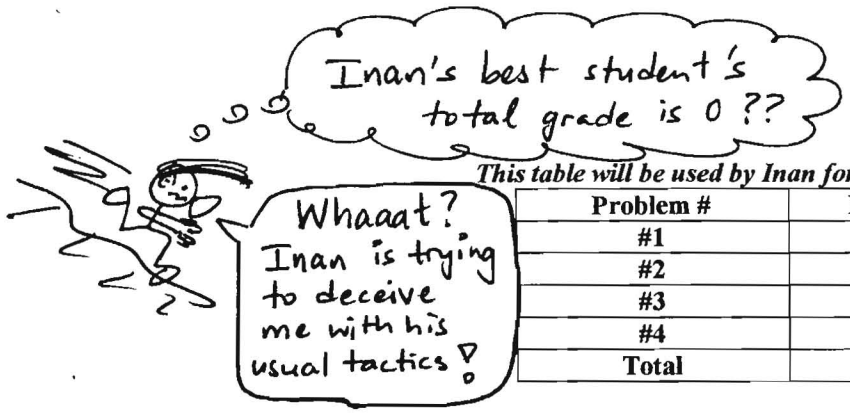
Name: SOLUTIONS



Signature: _____

> ***"An honest mind possesses a kingdom."***
> **Lucius Annaeus Seneca (4B.C.–65A.D.)**
>
> ***"Honest people are the true winners of the universe."***
> **Anonymous**





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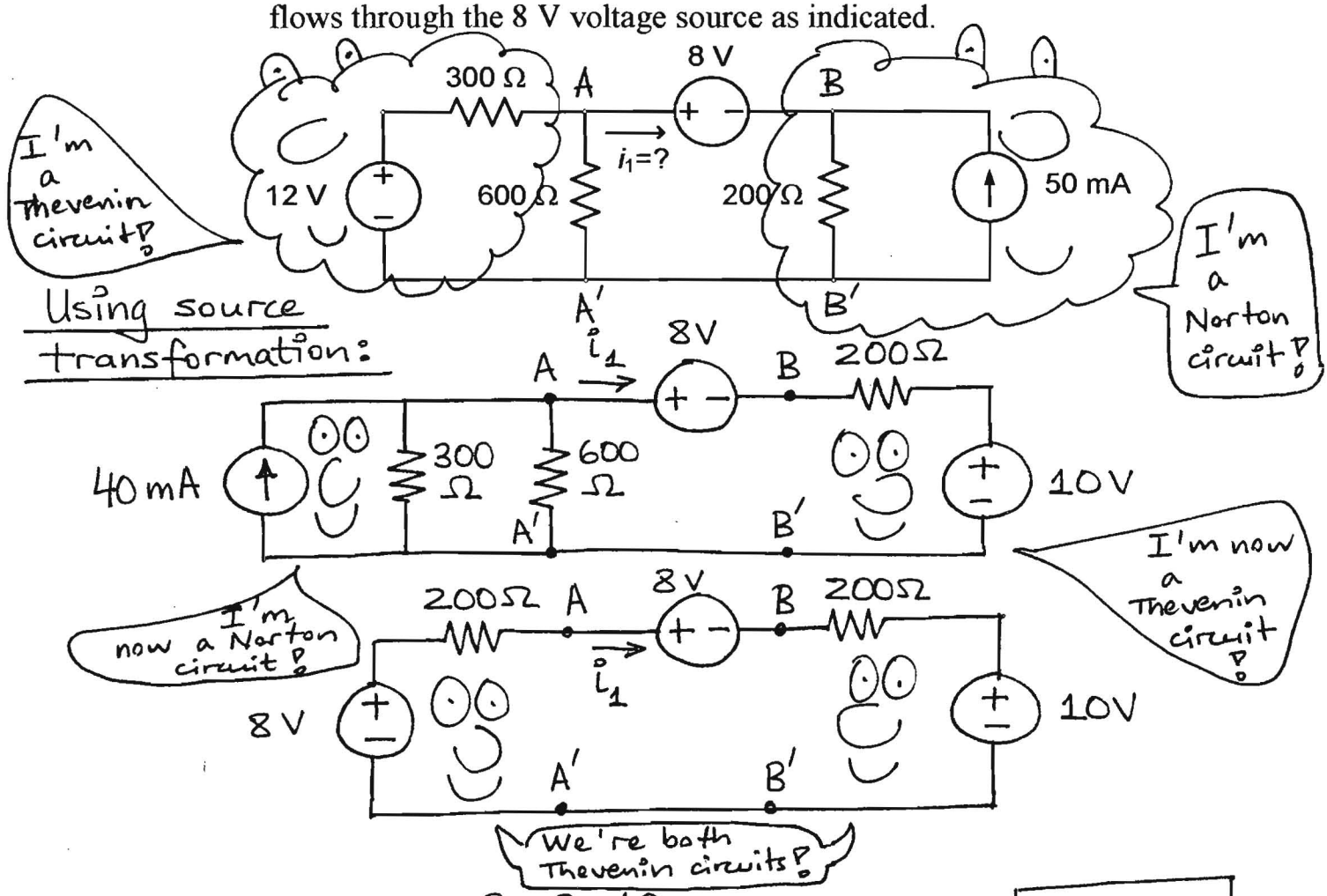
This table will be used by Inan for recording the grades!

Problem #	Points gained by Inan's best students
#1	0
#2	0
#3	0
#4	0
Total	0

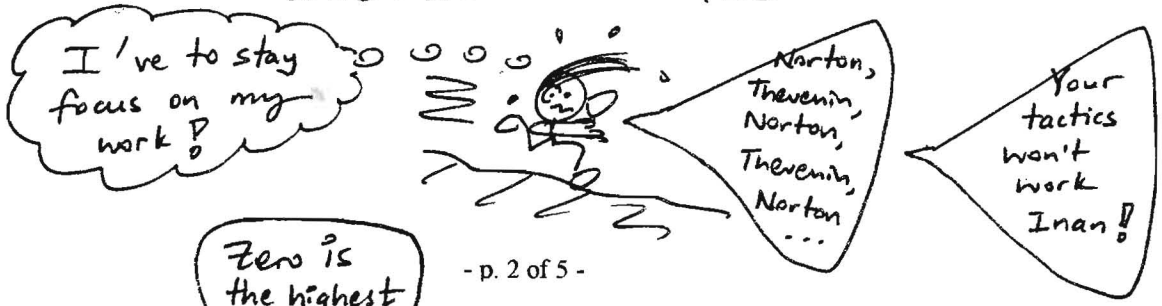
NOTE: On all the problems, please show all your work, and provide the appropriate units for your answers. Also mark on the schematic to show any currents or voltages that you define in your solution.

1. (25 Points) For the resistive circuit shown, find the current i_1 that flows through the 8 V voltage source as indicated.



Using source transformation:

$$\therefore\ i_1 = \frac{8-8-10}{200+200} = \frac{-10}{400} = \boxed{-25\text{ mA}}$$



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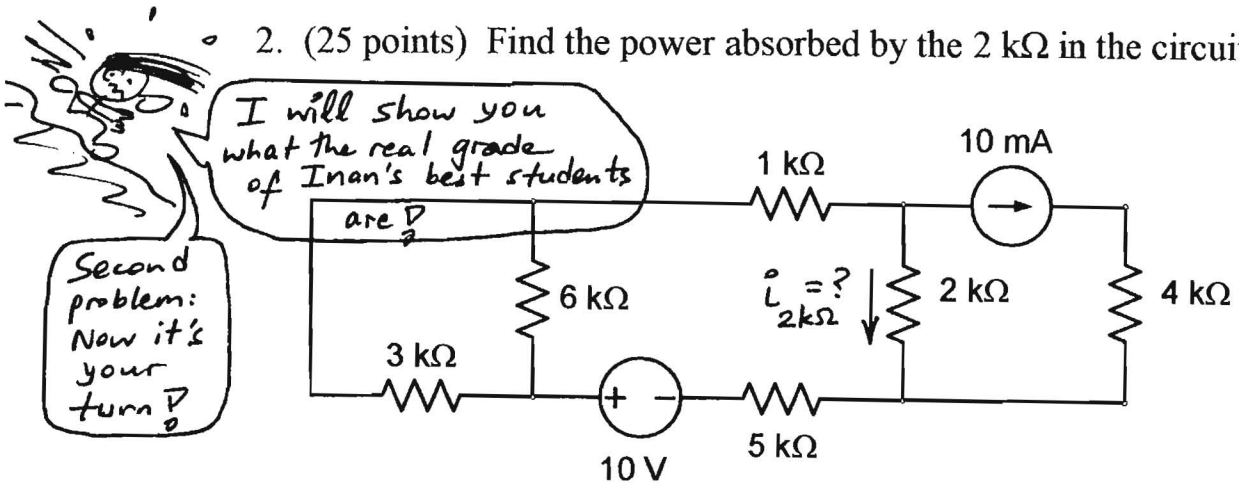
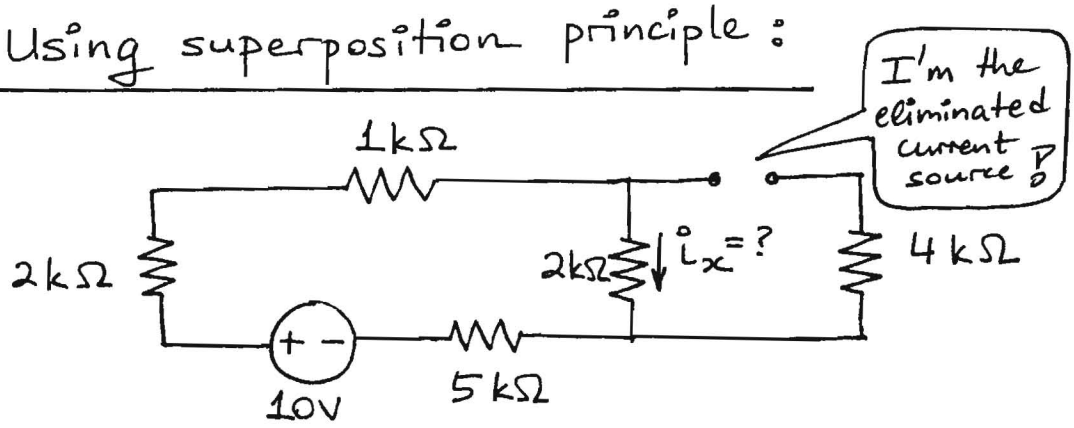
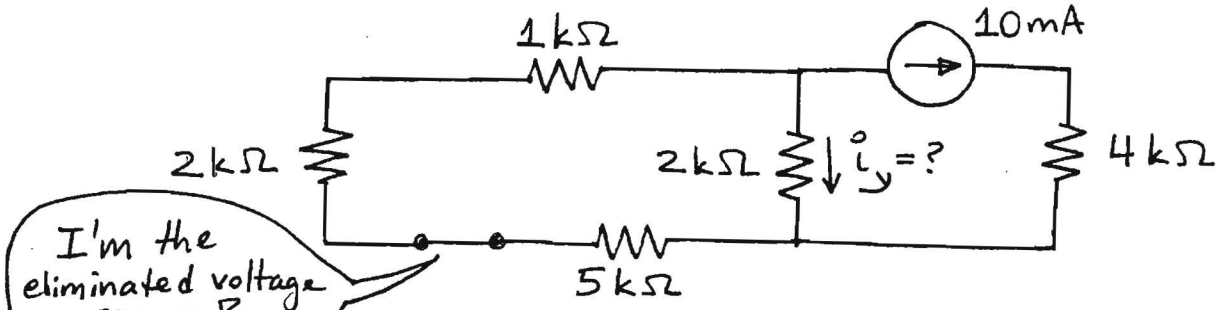
2. (25 points) Find the power absorbed by the 2 kΩ in the circuit shown.



Using superposition principle:



$$i_x = \frac{10\,V}{2k\Omega + 1k\Omega + 2k\Omega + 5k\Omega} = \frac{10V}{10k\Omega} = 1\,mA$$

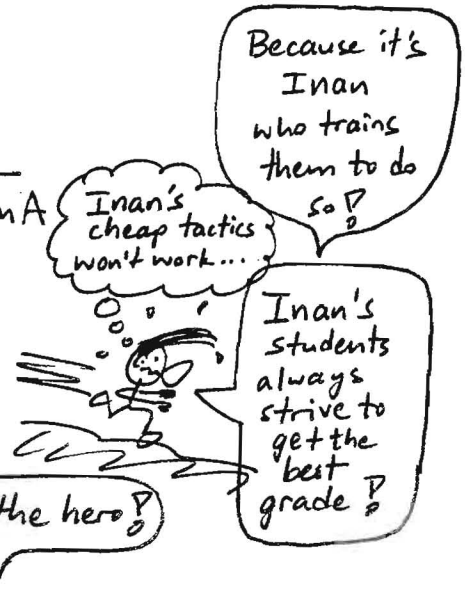


Using the current divider principle:

$$i_y = -\frac{8\,k\Omega}{10k\Omega}(10mA) = -8\,mA$$

$$\therefore i_{2k\Omega} = i_x + i_y = 1 - 8 = -7mA$$

$$\therefore P_{2k\Omega} = (-7mA)^2(2k\Omega) = \boxed{98\ mW}$$



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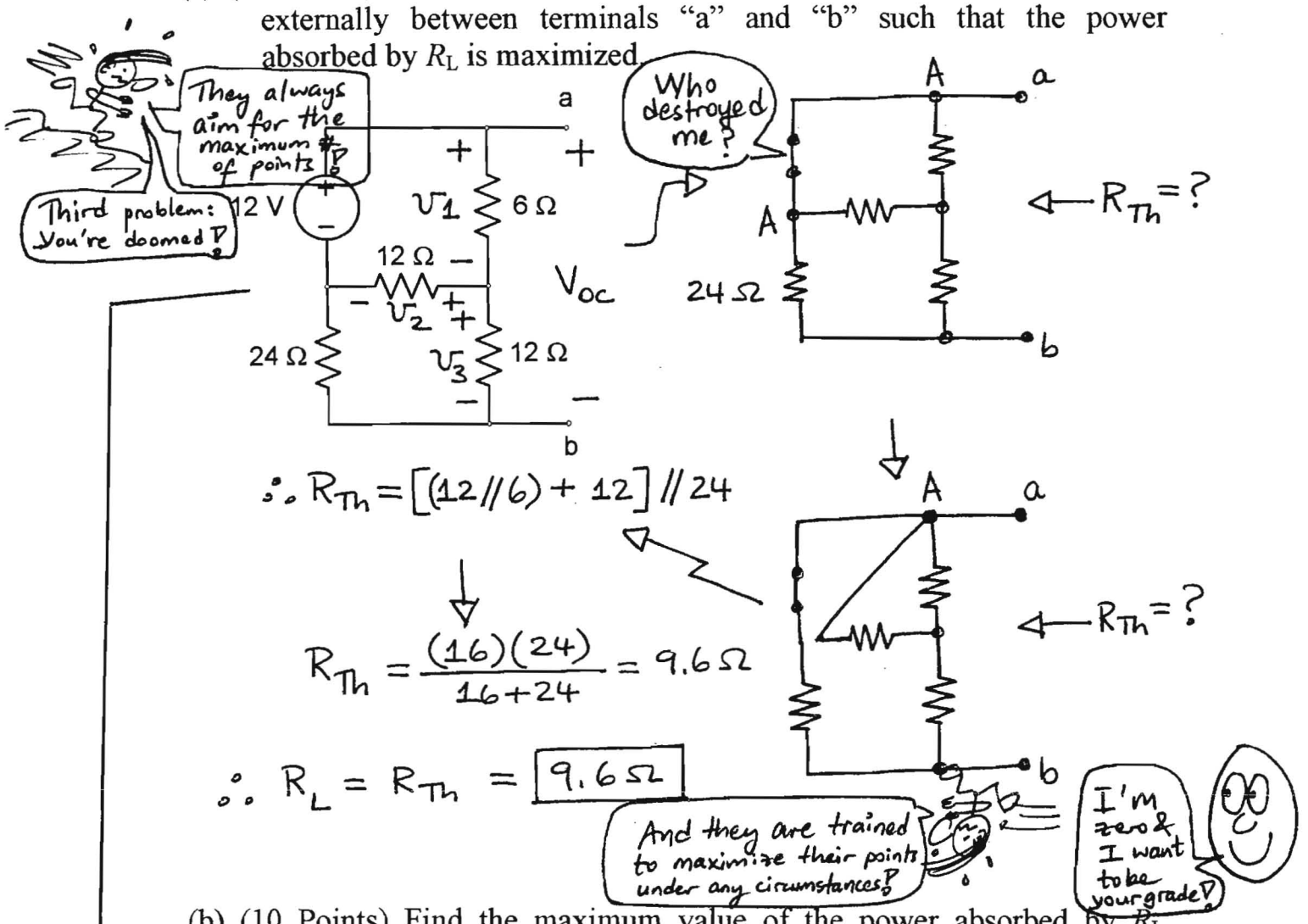
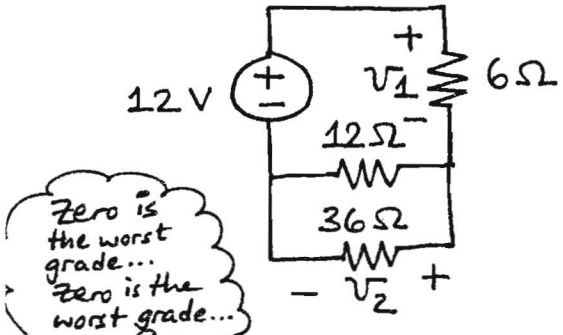
3. (Total: 25 points) Consider the circuit shown below.

(a) (15 Points) Find the value of the load resistance R_L to be connected externally between terminals "a" and "b" such that the power absorbed by R_L is maximized.



(b) (10 Points) Find the maximum value of the power absorbed by R_L.



Using voltage divider principle:

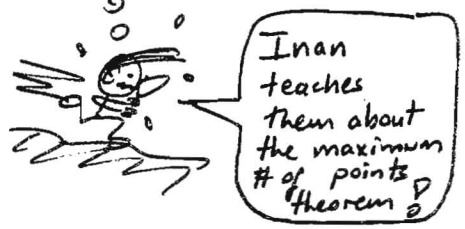
$$v_1 = \frac{6}{6+(12//36)}(12\text{V}) = 4.8\text{ V}$$

$$v_2 = 12 - v_1 = 7.2\text{ V}$$

$$v_3 = \frac{12}{24+12} v_2 = 2.4\text{V}$$

$$\therefore V_{Th} = V_{oc} = v_1 + v_3 = 4.8 + 2.4 = 7.2\text{V}$$

$$\therefore P_{L,max} = \frac{(7.2)^2}{4(9.6)} = \boxed{1.35\text{ W}}$$



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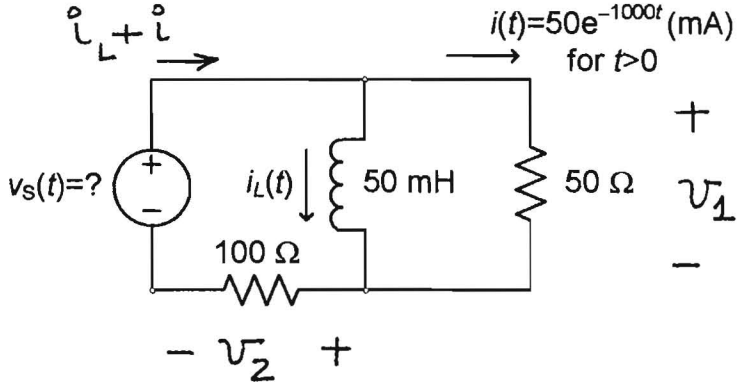
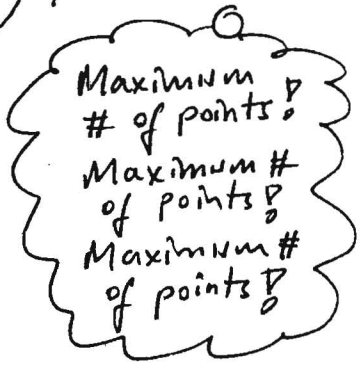
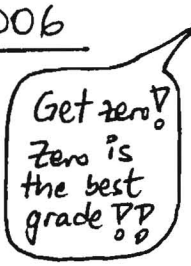
4. (25 points) In the circuit shown, given the initial condition $i_L(t = 0) = 15$ mA, find the source voltage $v_S(t)$ for $t > 0$. Note that the current through the 50 Ω resistor is also given.







$$v_1(t) = 50\,i(t) = 2.5e^{-1000t} \text{ (V)}$$

$$i_L(t) = i_L(0) + \frac{1}{L}\int_0^t v_1(\tau)\,d\tau$$

$$= 15\text{ mA} + 20\int_0^t 2.5e^{-1000\tau}\,d\tau$$

$$= 15\text{ mA} - \frac{50}{1000}\,e^{-1000\tau}\Big|_0^t = \left[65 - 50e^{-1000t}\right]\text{(mA)}$$

$$v_2(t) = 100\left[i(t) + i_L(t)\right] = 100\,(65\text{mA}) = 6.5\text{ V}$$

$$\therefore v_S(t) = v_1(t) + v_2(t) = \boxed{6.5 + 2.5e^{-1000t}\text{ (V)} \quad \text{for } t > 0}$$