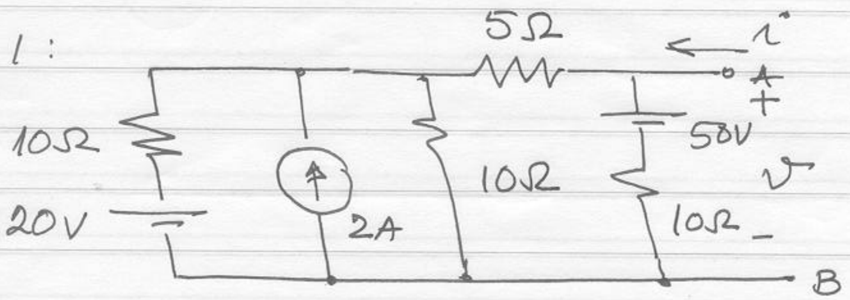
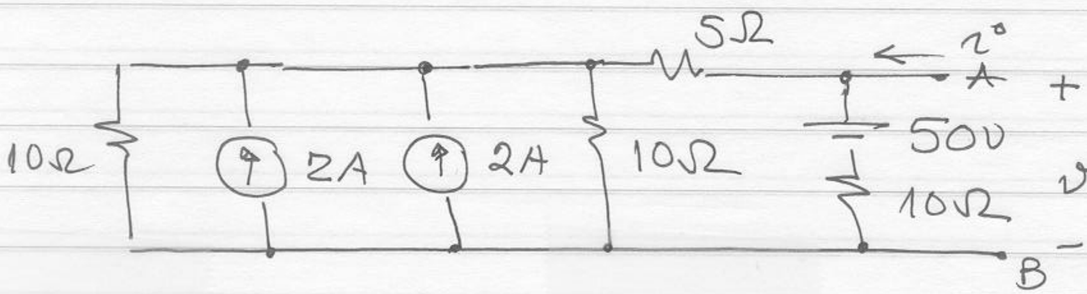
Solutions:

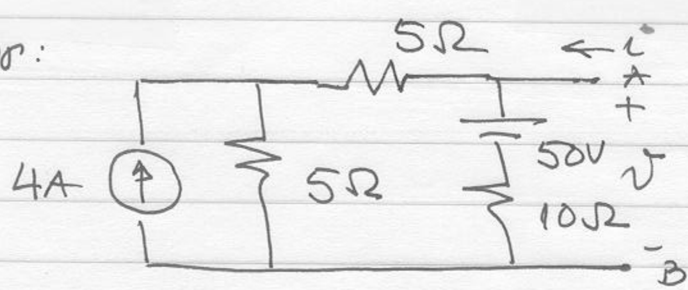
Problem 1:

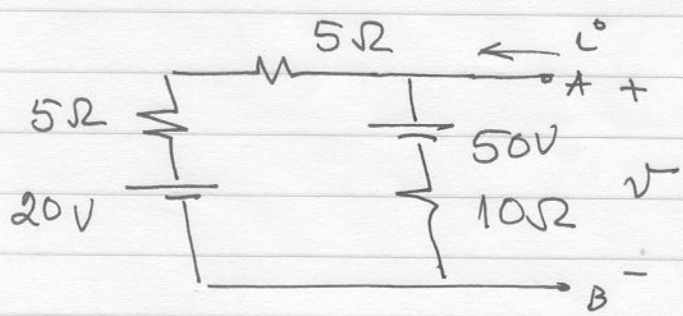


Source transformations lead to:

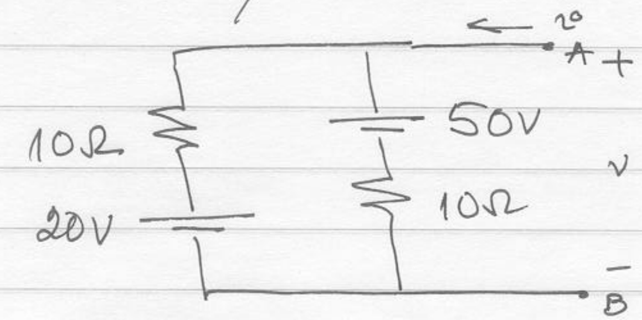


Or:

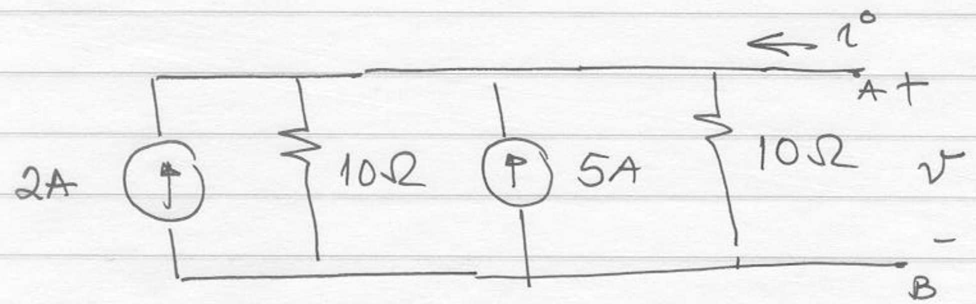


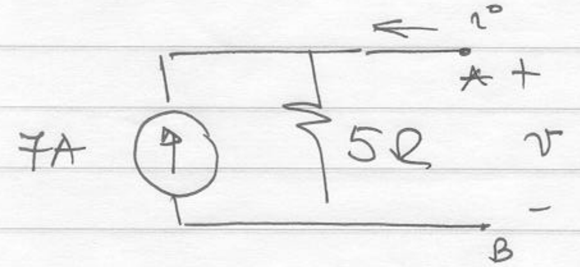


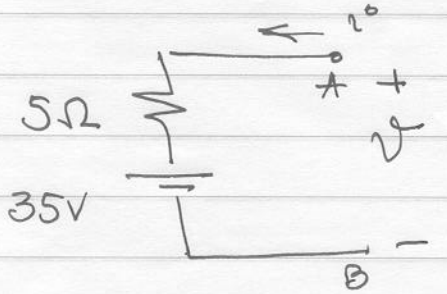
Which is equivalent to:



One can stop with the transformations here and find the v vs. i dependency by applying KCL, KVL, and the Ohm's Law. Or, alternatively, one more transformation gives:







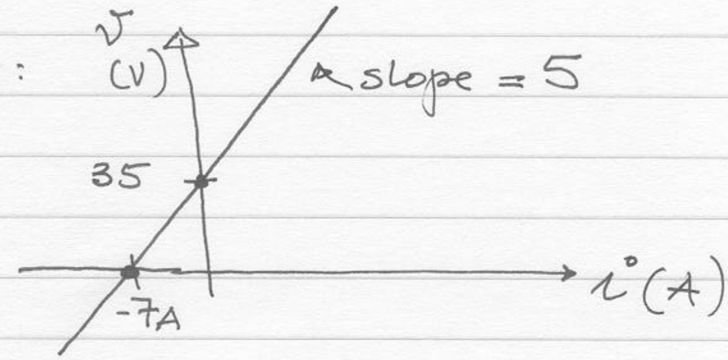
Hence, KVL gives:

$$v - 5 \cdot i^o - 35 = 0$$

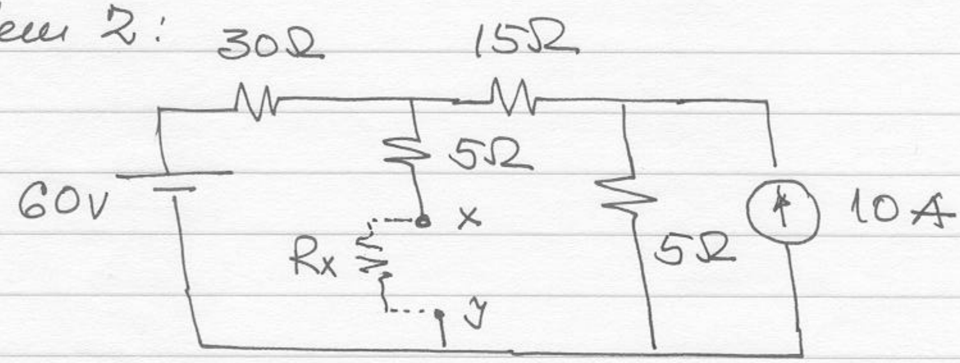
or:

$$v = 35 + 5 i^o$$

Plot:



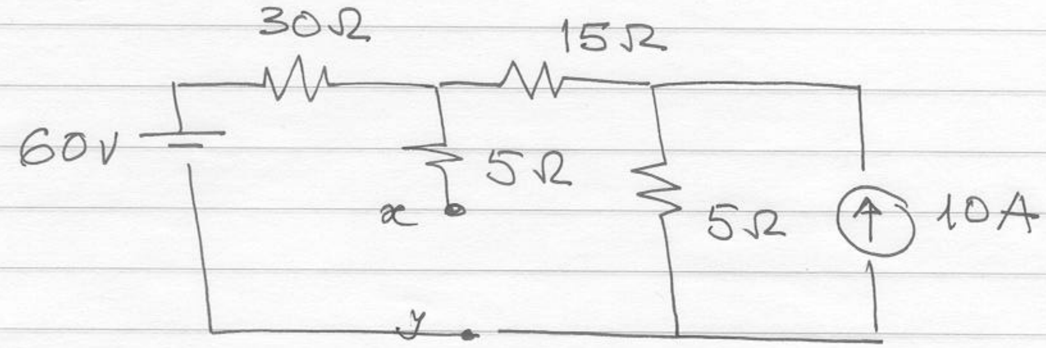
Problem 2:

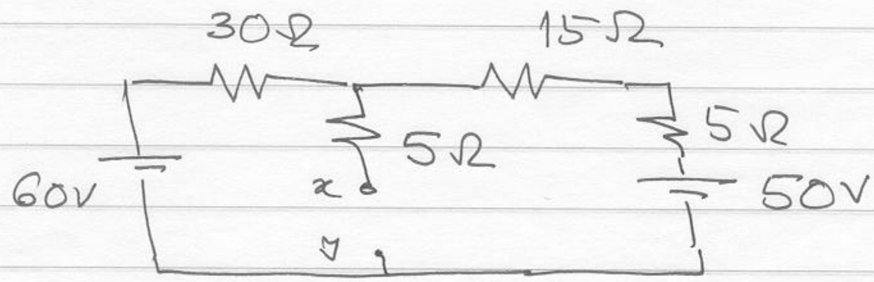


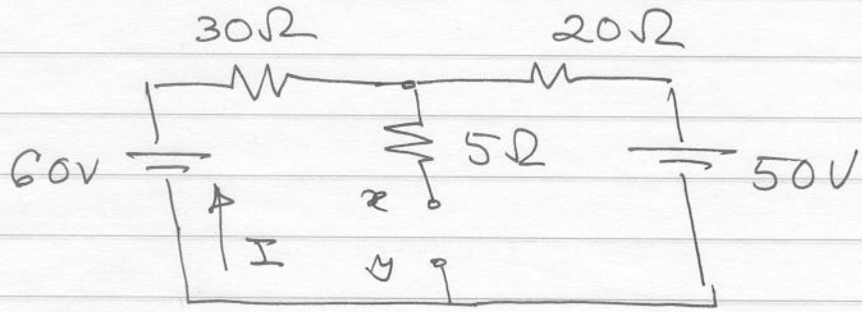
To find the Thevenin's equivalent, we first remove resistor R_x, and find the voltage across terminals x-y, and the resistance seen between x-y.

One can find V_T and R_T by applying KCL, KVL and the Ohm's Law to the circuit as is (with R_x removed and x-y open-circuited). Alternatively, an easier approach might be to perform some source transformations and simplify the circuit.

Let us analyze:







It is easy to now calculate:

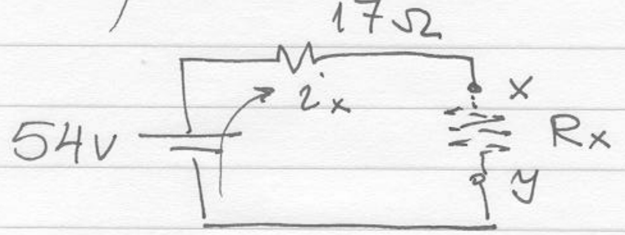
$$\dot{I} = \frac{60-50}{50}\,A \;;\quad i = 0.2\,A$$

$$V_T \equiv V_{x\text{-}y} \quad \text{or} \quad V_T = 60V - 30\,\Omega \times 0.2A$$

$$V_T = 54V$$

$$R_T = 5 + \frac{30 \times 20}{30+20}\,\Omega \;;\quad R_T = 17\Omega$$

Hence, everything between nodes x-y can be replaced with:



Maximum power transfer is achieved if the "Load" Rx is selected to "match" R_T:

$$R_x = 17\,\Omega$$

in this case,

$$i_x = \frac{54}{34}\,A$$

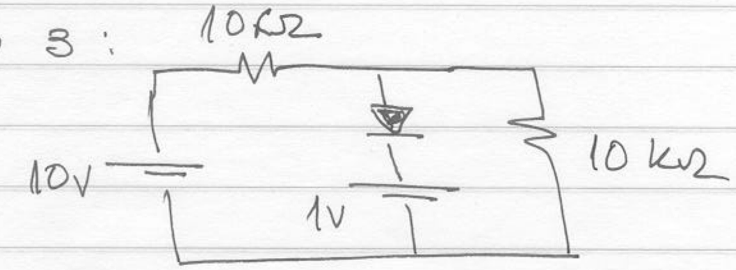
Power delivered to Rx is:

$$P_x = R_x (i_x)^2$$

$$P_x = 17 \times \left(\frac{54}{34}\right)^2 W$$

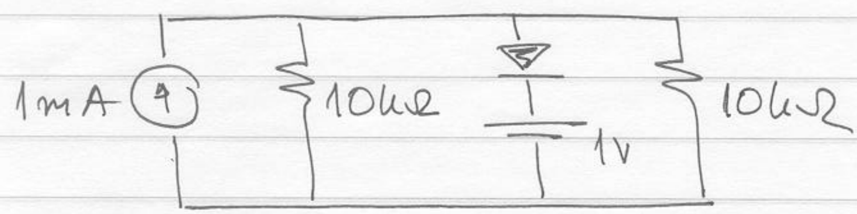
$$P_x = 42.88\ W$$

Problem 3:

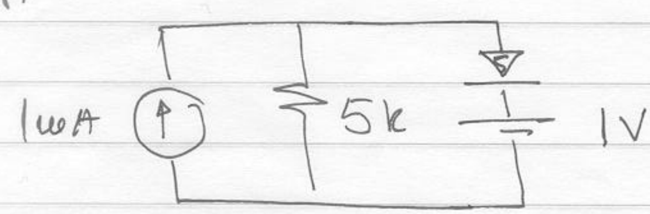


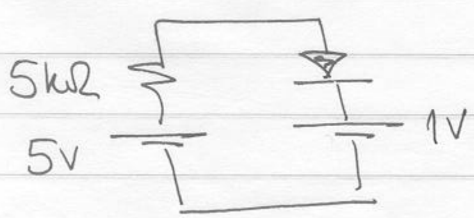
(Note: this is equivalent to choosing the units of (A) rather than (mA) on the diode characteristics.)

We need to transform the circuit in order to apply the "Load line" and graphically solve the circuit:

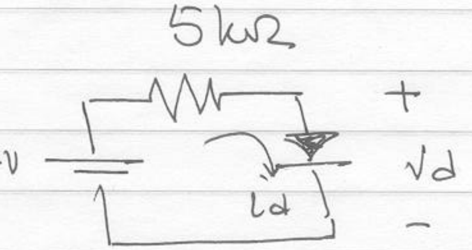


Or:



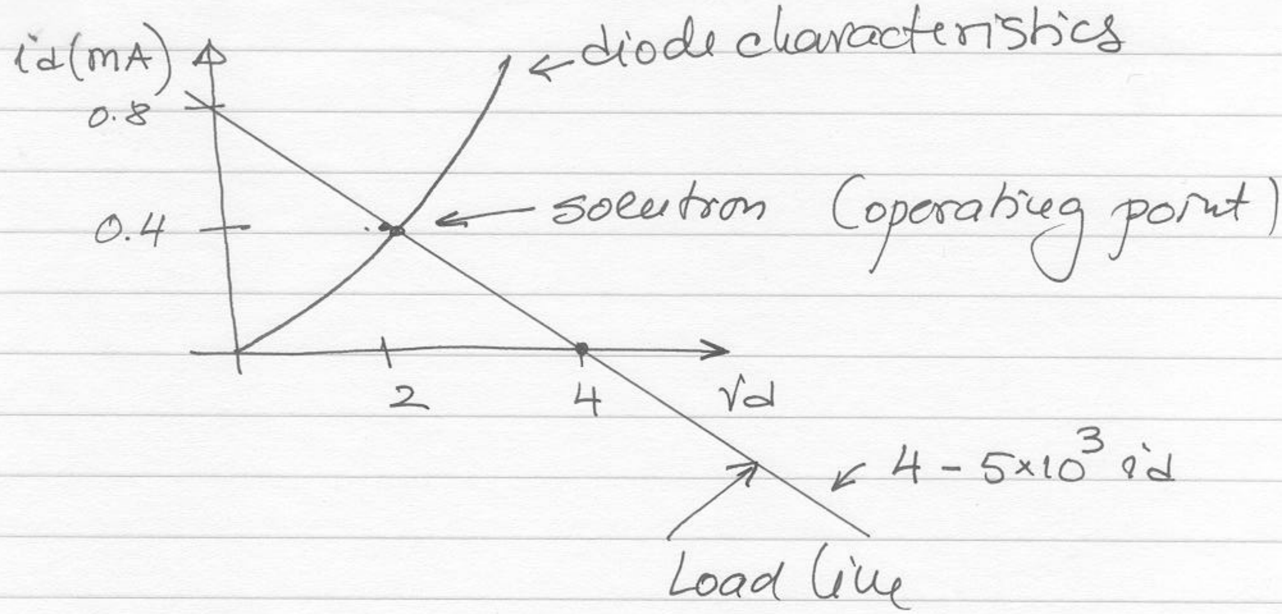


or:



KVL: $4 - 5\times10^{3} \cdot i_d - v_d = 0$

or: $v_d = 4 - 5\times10^{3} i_d$



Hence: $i_d \approx 0.4\, mA$

$v_d \approx 2\,V$

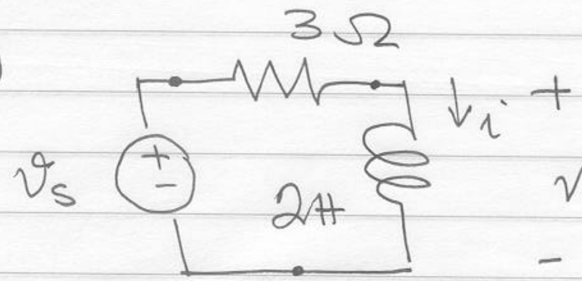
If the diode was modeled as an "ideal" switch, the solution would be:

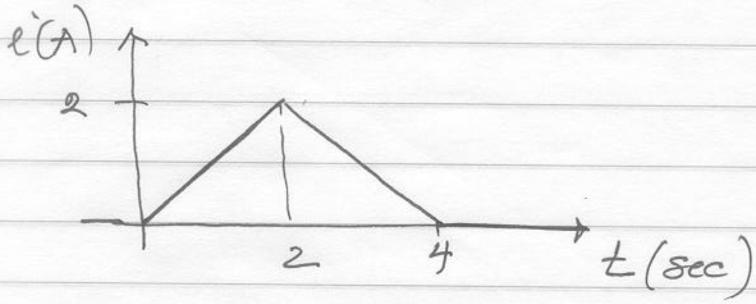
$$i_d = \frac{4V}{5k\Omega} \; ; \; i_d = 0.8\, mA$$

Note: diode is always "on", hence $v_d = 0$.

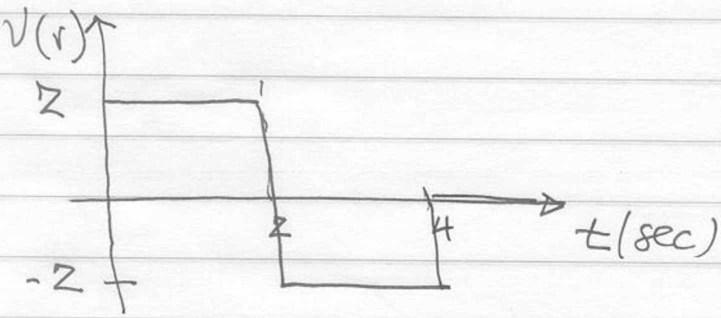
Problem 4:

(a)

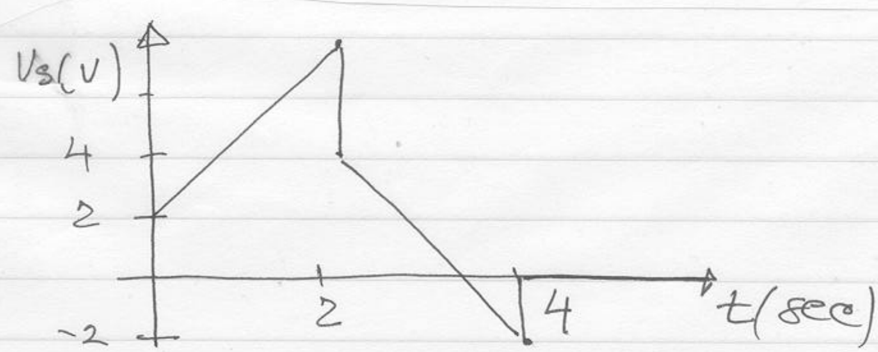




Since $v = L\frac{di}{dt}$, $L = 2H \Rightarrow v = 2\cdot\frac{di}{dt}$ (V)

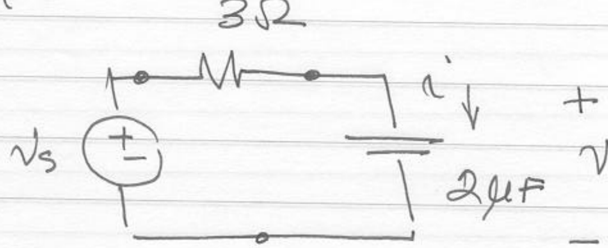


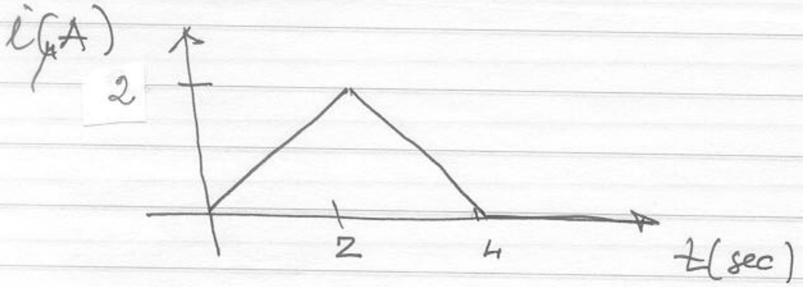
KVL gives: $v_s = 3\cdot i + v$



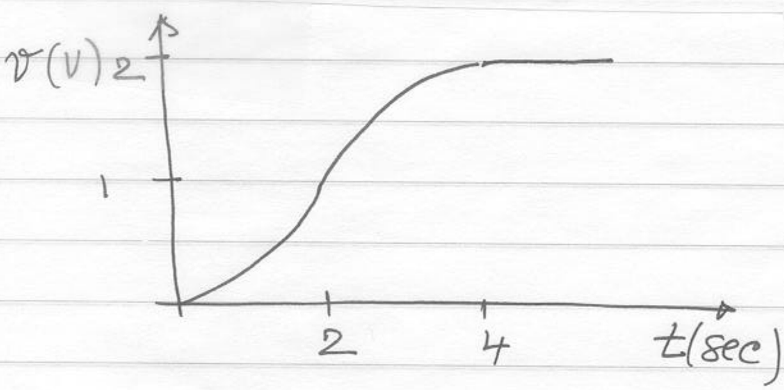
Problem 4 :

(b)





Since: $i = C\cdot\frac{dv}{dt}$; $C = 2\mu F \Rightarrow v = \frac{1}{2}\times 10^{6}\int_0^t i(x)\,dx$



(assume $v(0)=0$, i.e., no charge initially stored in the capacitor.)

$0<t<2$: $v = \frac{1}{2}\times 10^{6}\cdot\int_0^t 10^{-6}\cdot x\,dx$

$= \frac{1}{2}\cdot\int_0^t x\,dx$

$= \frac{1}{2}\,\frac{t^2}{2}$

$= \frac{1}{4}t^2$ at $t=0$ $v(0)=0$

$t=2$ $v(2)=1V$

$2 < t < 4$ $\quad v = \frac{1}{2} \times 10^6 \left\{ \int_0^2 10^{-6} x \, dx + \int_2^t 10^{-6} (4-x) \, dx \right\}$

$$v = v(2) + \frac{1}{2} \times 10^6 \int_2^t 10^{-6} (4-x) \, dx$$

$$v = 1 + \frac{1}{2} \int_2^t (4-x) \, dx$$

$$v = 1 + \frac{1}{2} (4t - 8) - \frac{1}{2} \cdot \frac{t^2 - 4}{2}$$

$$v = 1 + 2t - 4 - \frac{t^2}{4} + 1$$

$$v = -2 + 2t - \frac{t^2}{4} \qquad 2 < t < 4$$

Check: $v(2) = -2 + 4 - 4/4$

$v(2) = 1$ ✓

$v(4) = -2 + 8 - \frac{16}{4}$

$v(4) = 2$

$t > 4$: $\quad v = 2$ (constant)

Source voltage: $\quad V_s = 3i + v$