Sample Quiz Solutions

Problem # 1

(a) Period $T = 2$ `seconds`

(b) Frequency $f = 0.5$ `Hertz`

(c) DC voltage is the average across a period.

$$\text{DC Voltage} = \frac{1}{T}\int_0^T y(t)dt = 0.75\texttt{volts}$$

(d) RMS voltage is as follows

$$\text{RMS Voltage} = \frac{1}{T}\int_0^T y^2(t)dt = 0.777\texttt{volts}$$

Problem # 2

Both terminals of the op-amp are at 0 volts. So the current from the source is $5/1 = 5$ `mA`. None of this flows into the op-amp, so all of it goes around the top, through the $1K\Omega$ resistor. This cause a voltage drop of -5 `volts` across that resistor. So the output terminal of the op-amp is at -5 `volts`. Thus a current of 5 `mA` flows in the last resistor (at the right), from right to left.

(a) 5 `mA` flows through each resistor. So the power dissipated in each of the three resistors is $= I^2R = 25$ `m W`.

(b) The source delivers a current of 5 `mA`. SO it supples a power of 25 `m W`.

(c) The remaining power must come from the op-amp. This is $3 * 25 - 25 = 50$ `m W`.

Problem # 3

You first have to find the Thevenin equivalent of the circuit without the nonlinear element. I will just sketch the answers. You should get $V_{oc} = 25$ `volts`, and $I_{sc} = 5A$ (using my sign conventions for Thevenin equivalent circuits). Thus $R_T = 5\Omega$. Now sketch the $I - -V$ curve of the equivalent circuit on the graph provided, and find where they intersect. This is the operating point. The answer is $v = 10$ `volts` and $i = 3$ `amps`.

Problem # 4

This one is pretty easy. Use the ideal op-amp method. For the op-amp on the left, both terminals are at V_{in} and for the one on the right, both terminals are at ground. So, a current of V_{in}/R flows down through the resistor at the bottom left. None of this can come from the op-amp input terminal, so all of it flows left across the resistor at the top left. This implies that the voltage at the node where the four resistors join up is at $2V_{in}$ volts. The current through each of the the two middle (vertical) resistors is then $2V_{in}/R$ down. Now write KCL at this node. You find that $5V_{in}/R$ flow left through the resistor at the top right. Now you can easily find $V_{out} = 7V_{in}$.

Problem # 5

This is also reasonable. Because all you are aked to find is R_T use the direct method of shorting the independent voltage source. The answer is

$$R_T = \frac{3R}{A+5}$$

More details are posted outside my office.