

Basic Algebra

- We started with Basic Algebra in Term 1-2025, but digressed into trigonometry, Latitude/Longitude, sun's motion, GPS, Complex function plots, etc

- Let us restart it again!

- Algebraic Variables - can be any english letter or letters followed by numbers or sets of letters etc

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- We can extend the above example to two variables.

For ex. 2 apples + 3 oranges = \$8

With our algebraic conventions let us write it as:

$$2x + 3y = 8$$

$$\text{or } x = \frac{(8 - 3y)}{2}$$

- Theoretically, the above equation has "infinite" solutions!!

- 'x' can be calculated for each given value of 'y' and vice versa!

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- However, by convention the most commonly used letters in text books are as below:

Algebraic Variables $\Rightarrow x, y, z$
(possibly because of three dimensional axes)

Algebraic Constants $\Rightarrow a, b, c$

- However most practical applications do not necessarily use the above text book convention.

- Consider a simple example with a single variable.

$$2x = 6 \quad \therefore x = \frac{6}{2} = 3$$

- In practice, it may represent 2 apples cost 6 dollars, how much does each apple cost?

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- However, to get a unique solution we need two equations.

$$\text{Ex-1} \quad 2x + 3y = 8 \quad \text{--- (1)}$$

$$3x + 4y = 11 \quad \text{--- (2)}$$

There are several ways of solving the above equations. A simple method is to substitute for 'y' in Eqn (2) using Eqn (1)

$$y = \frac{(8 - 2x)}{3} \quad \text{--- (1a)}$$

Substituting in Eqn (2)

$$3x + \frac{4(8 - 2x)}{3} = 11 \quad \text{--- (x3)}$$

$$3 \times 3x + (4 \times (8 - 2x)) = 3 \times 11$$

Simplifying: $x = 1$

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Substituting in Eqn (1):

$$y = \frac{8-2x}{3} = \frac{8-2(1)}{3} = \underline{\underline{2}}$$

∴ We have $x=1$ & $y=2$

Now let us try to solve.

Ex. 2

$$2x + 3y = 8 \quad (1)$$

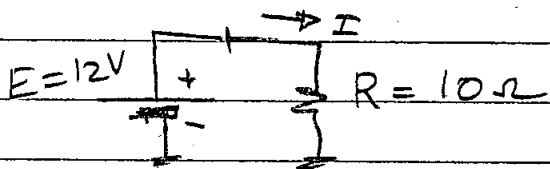
$$4x + 6y = 16 \quad (2)$$

Let us use an alternative method, to eliminate 'x' from Eqn (1) & (2)

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Let us now consider some practical example

Ex. 3 Calculate the current flow (I) in the resistor (R)



Using Ohm's law we have

$$E = IR$$

$$\text{or } I = \frac{E}{R} = \frac{12V}{10\Omega} = \underline{\underline{1.2A}}$$

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$$2x + 3y = 8 \quad (\times 4)$$

$$4x + 6y = 16 \quad (\times 2)$$

$$8x + 12y = 32 \quad (1)(a)$$

$$8x + 12y = 32 \quad (2)(b)$$

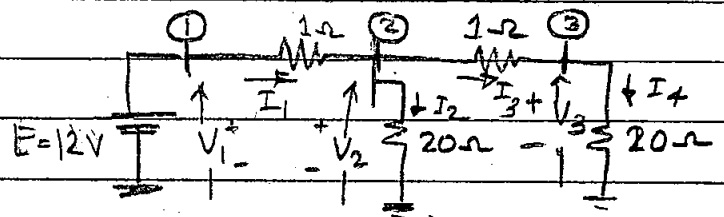
Subtracting, we get $0+0=0!$

[Check that this method works for the previous example!]

The problem with Ex. 2 is that the information content is the same in both equations! Hence, they are essentially identical equations!

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Ex. 4 Calculate the voltages at nodes (2) & (3)



We have $V_1 = E = 12V$ (no need to solve for V_1)

At each node, currents flowing "In" must be equal to currents flowing "Out" (Kirchoff's Current Law) (KCL)

Using KCL at Node (2)

$$\text{We have, } I_1 = I_3 + I_2$$

Using Ohm's law, we can write

$$\frac{(12 - V_2)}{1} = \frac{(V_2 - V_3)}{1} + \frac{V_2}{20}$$

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Simplifying, we get

$$41V_2 - 20V_3 = 240 \quad (1)$$

Using KCL at Node (3), we have

$$I_3 = I_4$$
$$\frac{(V_2 - V_3)}{1} = \frac{V_3}{20}$$

$\therefore$ we have $20V_2 - 21V_3 = 0 \quad (2)$

Using Eqn (2) $V_2 = \frac{21}{20} V_3$

Substituting in Eqn (1)

$$41 \left(\frac{21}{20} V_3 \right) - 20V_3 = 240$$

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Note that

$$V_2 = \frac{10.93}{12} \times 100 = \underline{\underline{91.08\%}}$$

of the rated voltage (of 12V)

$$V_3 = \frac{10.41}{12} \times 100 = \underline{\underline{86.75\%}}$$

of the rated voltage (of 12V)

In practice, V_2 may be acceptable for proper working of the load device, where as V_3 may be unacceptable!

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that is, $V_3 (23.05) = 240$

$$\therefore V_3 = \frac{240}{23.05} = \underline{\underline{10.41V}}$$

Substituting in Eqn (2)

$$V_2 = \frac{21}{20} \times 10.41 = \underline{\underline{10.93V}}$$

$\therefore$ we have,

$$V_1 = E = 12 \text{ Volts}$$

$$V_2 = 10.93 \text{ Volts}$$

$$V_3 = 10.41 \text{ Volts}$$

This is an important practical problem in Electrical Engineering.

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Home Work

• Check the voltage level by using cable resistance of 0.5 Ω instead of 1 Ω for both the cables.