Principles of Electrical Engineering I
Lect 1 9/5/23

- Susan Hughani
- office hours Tues 12:30-1:30

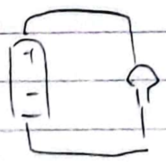
- Node-voltage methods } most important
- Mesh-current method }

Unit 11, 12, 13, 14 - Alternating currents

4 Workshops, 5 labs
4 workshops:
1. Simulation tools
2. Equipment training
3. Arduino
4. Oscilloscope training

- Can go to any recitation

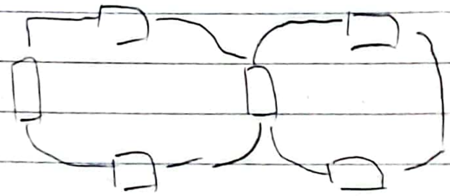
Circuit Variables
Section 1.1-1.8
- we are learning to <u>solve circuits</u>



- Energy - Power systems

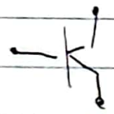
- Smart USB Charger
- Solve a circuit - find voltages and currents in all circuit elements
- Artificial intelligence - the brain is a very complex circuit

- Electric circuits - an interconnection of components, forming a closed path or many closed paths



- Most elements in this class have two terminals

- Elements have characteristics varying with the

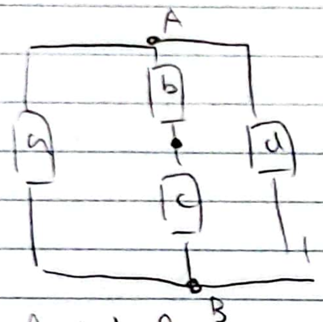


- transistor

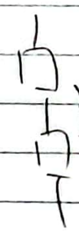
terminals

← component

Nodes: a point (junction) within a circuit where two or more elements join



- 3 nodes
- Essential node: a node where 3 or more elements meet



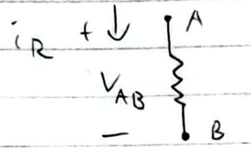
} anywhere here is a node

- A and B are essential nodes

- Models represent physical devices
- Some physical devices can be modeled by physical devices

Elements:

- Current: denoted by i or I, flowing through an element
- Voltage: denoted by v or V, drop across an element



q - charge

$i(t) = \frac{dq}{dt}$ - current

- In this class i doesn't often change with respect to time, but in reality it does

$1\,[\text{Amp}] = \frac{1\,[\text{Coulomb}]}{1\,[s]}$

$i(t) = \frac{dq(t)}{dt}$ $\quad q(t) = \int_{t_0}^{t} i(\tau)\,d\tau + q(t_0)$

$$\int_{t_0}^{t} dq(t) = \int_{t_0}^{t} i(t)\,dt$$

$$q(t) - q(t_0) = \int_{t_0}^{t} i(\tau)\,d\tau$$

$$q(t) = \int_{t_0}^{t} i(\tau)\,d\tau + q(t_0)$$

Ex 1.

$q(t) = 0\ C$ for $t < 0$

$q(t) = 4 - 3e^{-50t}\ C$ for $t > 0$

$$i(t) = \begin{cases} 0\ A & \text{for } t < 0 \\ 150e^{-50t}\ A & \text{for } t > 0 \end{cases}$$

Ex. 2

$q(t) = 0.01\sin(200t)\ C$

$i(t) = 2\cos(200t)\ A$

Ex. 3

Constant current of 2A, in 10 seconds:

20 Coulombs passes through the element

$$q(t) = \int_{t_0}^{t} i(\tau)\,d\tau$$

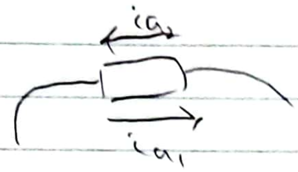
$$q(t) = \int_{0}^{10} 2\,d\tau = 20\ C$$

-Charge: multiple of number of electrons

$1\,[C] = -6.25 \times 10^{18}$ electrons

- Current: moving of negative or positive ions
  - convention: flow of positive charge
    (in reality it is the electrons that are moving)

- Use arrow to denote direction of current.



$i_{a_2} = -i_{a_1}$

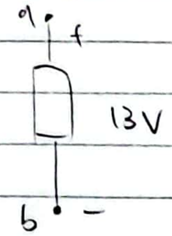
Voltage: v or V - energy per unit charge created by separation of positive/negative charge

$v(t) = \frac{dw(t)}{dq(t)}$ - it takes 1 V to use 1 J to take a coulomb across

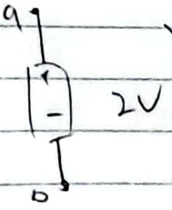
$V = \frac{dW}{dt}$ 40 J

Voltage polarity voltage: assume 2 voltage polarity

$v_{a_1} = -v_{a2}$



$v_a - v_b = 13$ V



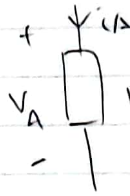
the voltage at the positive port is 2V higher than the negative port

- Power - rate of work with respect to the

$P = \frac{dw}{dt} = \underbrace{\frac{dw}{dq}}_{v} \underbrace{\frac{dq}{dt}}_{i} = Vi$ - Power for the component

$w(\tau) = \int_0^{\tau} p(x)\,dx$

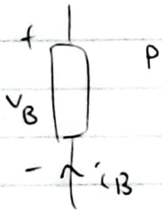
- Some circuit elements provide power, some take power
- Amount of power provided should be equal to the amount of power absorbed



$P = +i_A v_A$

- absorb power - positive power
- provide power - negative power

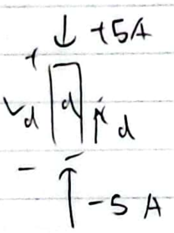
- If current enters at the positive port, the power is positive
- If current enters at the negative port, the power is negative



$P = -i_B v_B$

$p > 0$ - consuming/absorbing power

$p < 0$ - generating power



$i_d = -5A$

$v_d = 8V$

$P_d = -i_d v_d$

$= -(-5)(8) = 40$ watts