Introduction to Network Analysis

Comprehensive Course on Network Analysis

Ankit Goyal • Lesson 1 • May 18, 2022

Course Structure

1. 72 hours duration
2. Mon - Sat
   - 7am - 8:30am
   - 9am - 10:30 am
3. Every 4th session → Doubt clearing (Tue/Thu/Sat)
   - DPP discussion
   - doubts
4. DPP attached in every session
   - ↳ solve PYQs after every chapter
   - ↳ bit.ly/ankitese
   - ↳ GATE PYQs by AIR-1
   - ↳ Network Analysis (EE/EC)
5. Weekly Quiz
6. UA Lite test series (Part Test + Subject Test)

SYLLABUS

- BASIC OF NETWORK ANALYSIS — time consuming → Class XII Current Electricity
- DC NETWORK THEOREMS
- TRANSIENT ANALYSIS — most important
- STEADY STATE AC ANALYSIS — most important
- 2 - PORT NETWORK
- MAGNETICALLY COUPLED CIRCUITS — short topics
- GRAPH THEORY — not in ECE GATE
- THREE PHASE CIRCUITS — short topics, not for ECE

WEIGHTAGE

10 TO 12 MARKS

Resources

1. Standard books not required
   - Circuit Analysis: Sadiku
   - A. Chakraborathy (Ques)
2. Practice
   - → attached DPP
   - → practice with class ← UA practice section
   - → PYQs
3. Tests → Course Quizzes, UA Lite Test Series

Strategy

Step-1: Attend Live Class Daily

Step-2: Download class notes

Step-3: Revise class notes & create short notes (1 hr daily)

Step-4: Solve DPP & overlook UA study material

Step-5: attempt tests

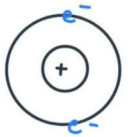
Step-6: Solve PYQ at end of each chapter

Introduction To Network Analysis

Basic Definitions

Charge

- property of a body due to loss or gain of electrons.
- atom:



protons: +ve charge

electrons: -ve charge

electrically neutral: +ve charge = -ve charge

- atom loses e^- ; +ve charge > -ve charge
  net positive charge
- atoms gains e^- ; net positive charge < net -ve charge
  ∴ overall -vely charge

**SN

- charge on e^- = 1.6×10^{-19} C
  SI unit: Coulomb (C)
- charge on a body = $q = \pm ne$
  n = +ve integer
- Charge is quantized [$q = ne$]
- Charge is associated with mass [$m_e = 9.1 \times 10^{-31}$ kg]

Law of Conservation of Charge

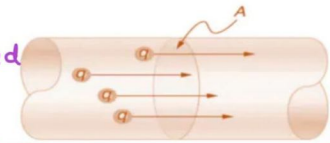
- Charge can neither be created nor destroyed but can only be transferred from one body to another.
  ↳ used in problems based on capacitors

Conservation of Charge

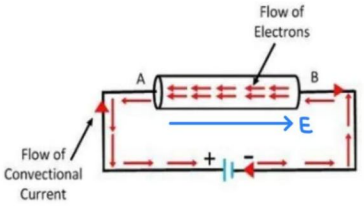
covered

Current

- When a battery is connected across a conductor then E-field is produced from +ve plate to -ve plate.



- force on charge due to electric field, $\vec{F} = q\vec{E}$
- In conducting material large no. of free e^- are present. [$q<0$, $\vec{F}$ opp. to $\vec{E}$]



- electrons experience a force & flow opp. to electric field. Their motion is called as Drift.

- the time rate flow of charge is called as current.

  Current, $i = dq/dt$ Ampere (A) **SN

Charge crossing a particular cross-section in time 'dt' $= dq$

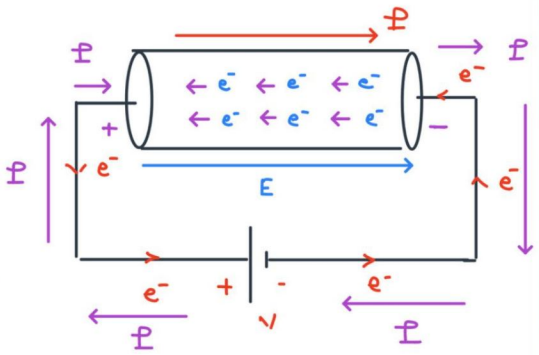
- conventional dir^n of current flow is in same dir^n as positive charge & opp. to -ve charge. **SN

Voltage

- also called as potential difference.
- from EMT, $V_A - V_B = -\int_B^A \vec{E}\cdot d\vec{l}$
- always E-field is directed from higher V to lower V
- $\vec{E} = -\nabla V$
- There is always a potential diff. b/w 2 terminals of a battery which causes E-field from +ve to -ve terminal which causes I-flow in same dir^n as E-field.

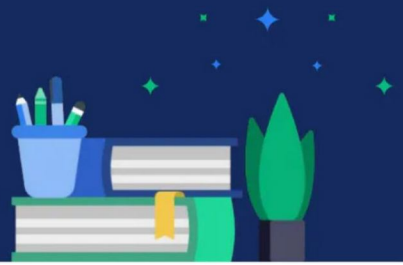
- current always leaves +ve terminal of battery & enters -ve terminal of battery.
- Current flows from higher V to lower V.

  pd → cause i → effect
- e^- flows from lower V to higher V



potential diff = work done in moving a charge from A to B per unit charge

$V_B - V_A = W_D/q$



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Network Test already uploaded

Unacademy Lite

Upcoming Test Details

Subject Name	Date & Time	Test Type	Duration
Electronic Devices Topic Test – 1	21st May 5:00 PM	Sectional Test	45 Min
Electronic Devices Topic Test – 2	22nd May 5:00 PM	Sectional Test	45 Min

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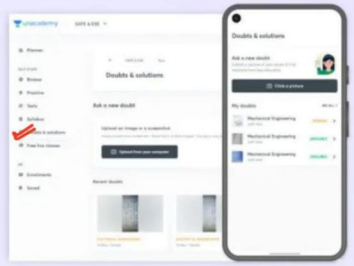

Simply **Click , Crop and Submit your doubts!**

ASK NOW

unacademy

▲ 3 • Asked by Shivam

Sir compus ke liye kaise preapere kare

Aptitude prep

Basics to Network Analysis

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Power

- rate of work done per unit time is called as power.
- $\Delta V = \frac{\text{Work done}}{q}$

$V_B - V_A = \frac{W_{A\to B}}{q}$

$W_{A\to B} = (V_B - V_A)q = qV$

where V = pd b/w A & B

$\text{power} = \frac{d}{dt}(WD)$

$= \frac{d}{dt}(qV) = V\frac{dq}{dt}$

$\boxed{\text{power} = Vi}$ ** IN

Instantaneous power : power at any time instant 't' is called Instantaneous Power. ** SN

$\boxed{p(t) = v(t) \cdot i(t)}$ ** SN

SI unit: Watt (W)

When voltage & current are periodic function of time then instantaneous power is also a periodic function of time.

$$\text{Average Power} = \frac{1}{T}\int_{<T>} p(t)\,dt = \frac{1}{T}\int_{<T>} v(t)\,i(t)\,dt$$ ** SN

Work Done

- Mechanical, $dW = \vec{F} \cdot \vec{ds}$

$\vec{F}$: force $\vec{ds}$: displacement

- work done on a charge by external agent = − work done by $\mathcal{E}$-field ** SN

- $dW = -(q\vec{E}) \cdot \vec{dl}$

$= q(-\vec{E} \cdot \vec{dl}) = q(dV)$

dV = potential difference

$\boxed{\text{Work done} = \text{charge} \times \text{potential difference}}$

Q The charge delivered by a 10V battery is given by $q(t) = (2 + t + 4t^2)$, t: sec. Find the work done by battery from 0 to 3 sec.

Ans $q(0) = 2 + 0 + 4(0)^2 = 2C$

$q(3) = 2 + 3 + 4(3)^2 = 41C$

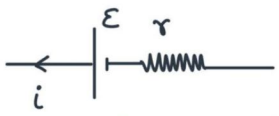
$\therefore$ charge delivered from $0 \to 3$ sec $= 41 - 2 = 39C$

$WD = 39 \times 10V = 390$ Joule

Q What is the difference b/w potential difference & emf? → (Electro motive force)

Ans: EMF is potential difference across the two terminals of a battery when no current is drawn.

each battery has a small resistance within it called as internal resistance.



$V = \varepsilon - ir$

- When a battery delivers current then pd across terminals is less than emf.

when $i = 0$ $V = \varepsilon$ = emf

↳ no term containing res

Sign convention for power calculation

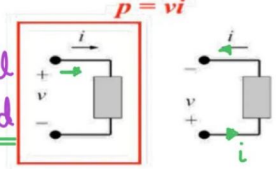
power absorbed

** SN

$p = vi$

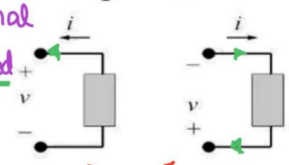
Step-1: form a hypothesis

- When current enters +ve terminal of an element power is absorbed by the element.



$p = -vi$

- When current leaves +ve terminal of an element power is delivered by the element.



power delivered

$p = vi$ delivered $p = -vi$ absorbed

Step-2: Compute the value of power

** SN

$p(t) = v(t) \cdot i(t)$

Step-3: if $p(t) > 0$, hypothesis is correct

$p(t) < 0$, hypothesis is wrong

i	P	p(t)	
• Current enters +ve terminal	absorb	> 0	absorb
		< 0	delivered
• Current leaves +ve terminal	delivered	> 0	delivered
		< 0	absorbed

Law of Conservation of Energy

- Energy can neither be created nor be destroyed but it can only be transformed from one form to other.

battery: chemical energy → electrical energy

resistance: electrical energy → heat energy

generator: mechanical energy → electrical energy

motor: electrical energy → mechanical energy

Energy

- the work done by an external agent on a body gets stored as energy in the body.

Change in energy ΔU = work done $= q\,\Delta V$ **SN

∴ work done by battery in a circuit = energy delivered by battery **SN

Question-01

A current of 0.5 A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit .

$q = \int i\,dt$

if i = const

$q = i\int dt = i \times \text{time}$ ~ only applied when i = const

$= 0.5 \times (10 \times 60) = 300\ C$

Question-02

A conductor has a constant current of 5 A. How many electrons pass a fixed point on the conductor in one minute?

$q = i \times \text{time} \quad (\because i = \text{const})$

$= 5 \times 60 = 300\ C$

$q = ne = \dfrac{300}{1.6 \times 10^{-19}}$

$= 1.875 \times 10^{21}$ electrons

Question-03

In an electric circuit an energy of 9.25 μJ is required to transport 0.5 μC from point a to point b. What electric potential difference exists between the two points?

energy = work done = $q \times$ potential diff

$9.25\,\mu J = 0.5\,\mu C \times V$

$V = 18.5$ volts