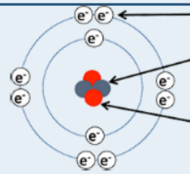
BASICS OF ELECTRICAL ENGINEERING

Basic Concepts

Atomic structure



- Charge on electron = -1.6×10^{-19} C
- Charge on Proton = $+ 1.6 \times 10^{-19}$ C

Electric Current (I)

- Rate of flow of charge $I = \frac{dq}{dt}$ Or

1 Ampere $= \frac{1 Coulomb}{1 Second}$

A → I → B, + ← q -

- 1 Ampere current: 1 coulomb of charges flows through a conductor in 1 second

Potential difference:

$$Voltage = \frac{Energy}{charge}$$

$$1 \text{ volt} = \frac{1 J}{1 C}$$

V_A ---R--- V_B

- Potential difference is $= V_A - V_B$
- Voltage drop across R is $= \frac{VA - VB}{R}$

Electric Power (P) :

- Work done per unit time $P = \frac{V \cdot Q}{t}$ (watt)
- P = V x I (watt)

Relation between various parameters:

A -: common area of plate in m²,

d -: Distance between two plates in m.

Energy Stored by Capacitor $E = \frac{1}{2}CV^2$ (unit : Joule)

Inductance (L)

$$L = \frac{\mu A N^2}{l}$$

Unit: henry

μ- permeability of core material (absolute)

A – cross-sectional area of former in m²

N- number of turns in a coil

l – the average length of the coil in m

$\mu = \mu_0 \mu_r$ relative permeability $\mu_r = 1$

μ_0 -absolute permeability

μ_r -relative permeability

Energy stored by the inductor is given by

$$E = \frac{1}{2} L I^2$$

E- energy stored in Joules

L- inductance value in Henry

I -current flows in ampere

Note: R, L, C are passive elements and V & I are Active elements.

2. DC CIRCUITS

Symbol	Parameter	Symbol	Parameter
—/\/\/—	Resistor	—||—	Capacitor
—∿—	Fuse	(LDR symbol)	LDR
—ɑɑɑ—	Inductor	⊗	Lamp
—||—	DC supply	(~)	Ac supply
—(A)—	Ammeter	(G)	Galvanometer
(↑)	Current source	⏚	Ground

4. THREE PHASE SYNCHRONOUS MACHINES

Voltage Regulation of Alternator or Synchronous Generator

Calculation of synchronous reactance

$$Z_s = \frac{\text{open circuit voltage per phase}}{\text{short circuit armature current}}$$

$$X_s = \sqrt{Z_s^2 - R_s^2}$$

$$\%\ Regulation = \frac{E_o - V}{V} \times 100$$

$$Per\ Unit\ Regulation = \frac{E_o - V}{V}$$

$$Z_s = \frac{\text{AB (in volts)}}{\text{AC (in amperes)}}$$

Eo = No-load induced emf

V = Rated terminal voltage

Zero Power Factor or Potier Triangle Method

$$X_L = \frac{Voltage\ drop/phase}{F.L.\ Armature\ current}$$

$$X_L = \frac{RS\ or\ BC}{(I_a)_{F.L}}\ \Omega$$

EMF induced in the alternator

$$E_{ph} = 4\ K_f\ K_c\ K_d\ f\ \Phi\ T\ \text{volt}$$

Equation for terminal voltage of an alternator

Where, $\frac{\ }{X_d}\sin\delta$ = Electromagnetic power

The reluctance power is given by,

$$P_{reluctance} = V_t^2\left(\frac{1}{X_q} - \frac{1}{X_d}\right)\sin 2\delta$$

Stepper Motor – Step Angle β

- As small as 0.78° to 90°
- Most commonly used – 1.8°, 2.5°, 7.5°, 15°

$$\beta = \frac{(N_s - N_r) \times 360°}{N_s.N_r} = \frac{360°}{mN_r}$$

N_s – No. of Stator poles (teeth)

N_r – No. of Rotor poles (teeth)

m - No. of stator phases

6. SINGLE PHASE TRANSFORMER

Self-induction $e = -L\frac{di}{dt}$

Mutual induction $e = -M\frac{di}{dt}$

E.M.F. Equation of A Transformer

Let N_1 = No. of turns in primary

N_2 = No. of turns in secondary

$\emptyset_m$ = Maximum flux in core in weber $= B_m X A$

f = Frequency of a.c. input in Hz

$$E_1 = 4.44\, fN_1\emptyset_m = 4.44\, fN_1B_mA \quad \ldots (i)$$

$$E_2 = 4.44\, fN_2\emptyset_m = 4.44\, fN_2B_mA \ldots (ii)$$

Voltage Transformation Ratio

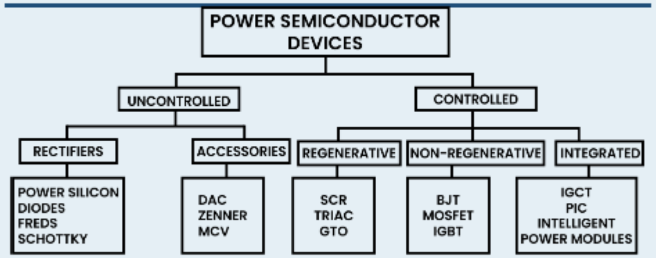
$$\frac{E_1}{E_2} = \frac{N_1}{N_2} = K$$

Other section headings on the sheet: 5. THREE PHASE SYNCHRONOUS MOTOR; POWER SYSTEM ANALYSIS; 1. ECONOMICS OF POWER SYSTEM; 2. TYPES OF POWER PLANTS; 3. OVERHEAD LINES & UNDERGROUND CABLES; 6. PERFORMANCE OF TRANSMISSION LINES.

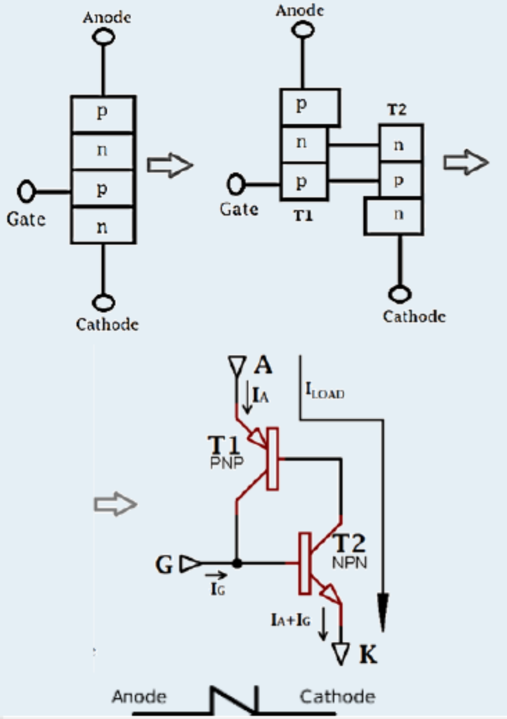
POWER ELECTRONICS

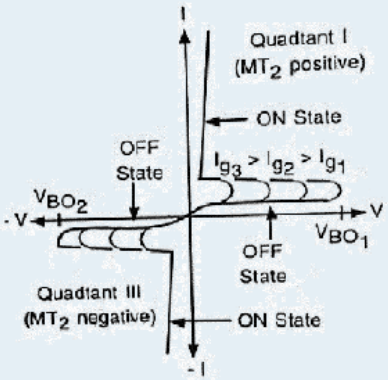
SILICON CONTROLLED RECTIFIER

Power Semiconductor Devices or Thyristor Family

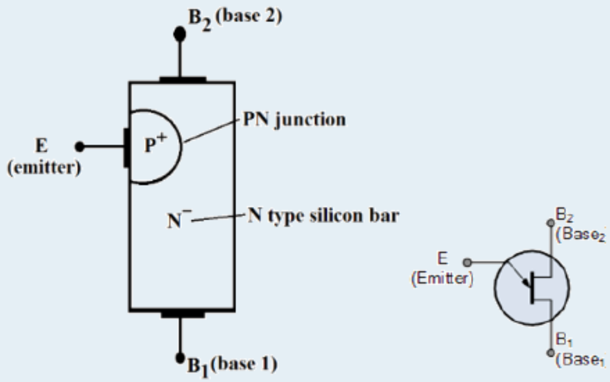


Silicon Controlled rectifier





UNI-JUNCTION TRANSISTOR (UJT)



Equivalent circuit of UJT

$R_{BB} = R_{B2}+R_{B1}$

Where

R_{B2} –resistance between terminal B2 and E (fix resistance)

R_{B1} – resistance between terminal E and B2 (variable resistance).

- **Intrinsic standoff ratio (η)** : It is the ratio of RB1 to the sum of RB1& RB2 It can be expressed as

  $\eta = (R_{B1}/ \; R_{B1} + R_{B2})$ or $\eta = (R_{B1}/ \; R_{BB})$

- The typical range of intrinsic standoff ratio is from 0.5 to 0.8.

SHEET : 6/6