Power Electronics

ESE

Prelims : 8 to 12 qns

Mains : 80 to 90 marks

GATE

1M : 1 or 2 = 1 to 2 marks

2M : 4 or 5 = 8 to 10 marks

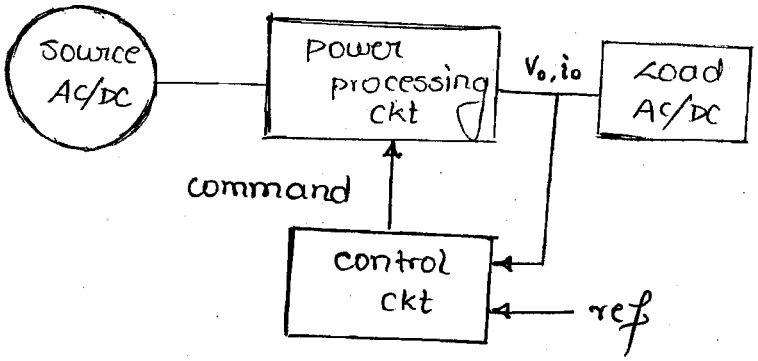
9M to 12M.

Books:

UG
i) Power Electronics by P.S. Bhimbra
ii) Power Electronics by MD singh / Kanchandhani
iii) Power Electronics by Rashid

PG
iv) Power Electronics converters. Design & Application } By Ned Mohan
v) Fundamentals of PE converters by Robert Ericsm
vi) Power Electronics Question Bank (PEQB)

www.electrical-mentor.blogopot.com
electrical.mentor@gmail.com



→ Power electronics is a technology associated with efficient conversion & control of electric power by using power semiconductor devices.

Semiconductor devices

Signal level	Power level
V: ±15 to ±30V	V: few V to kV
I: few μA to few A	I: few A to kA
P: few mW to few W	P: few W to MW
Sub:- EDC/AE/DE	Sub:- PE

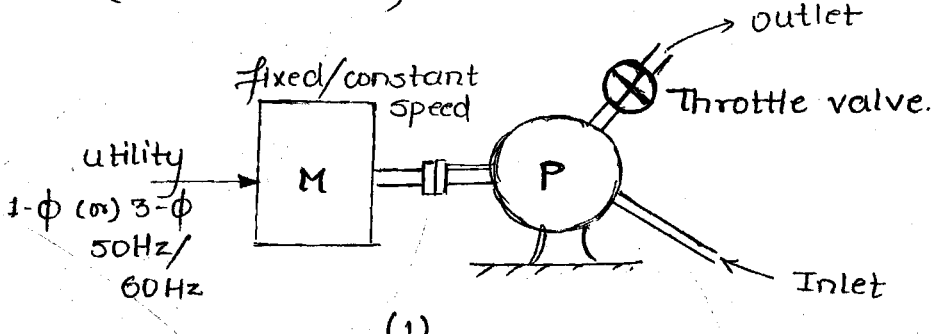
Material science
↓
Device char
↓
Applications
↓
Signal → AE, DE
Power → PE

→ In power semiconductor devices cross section lightly dopped material is inserted to withstand higher voltages because breakdown voltage is inversely proportional to doping density.

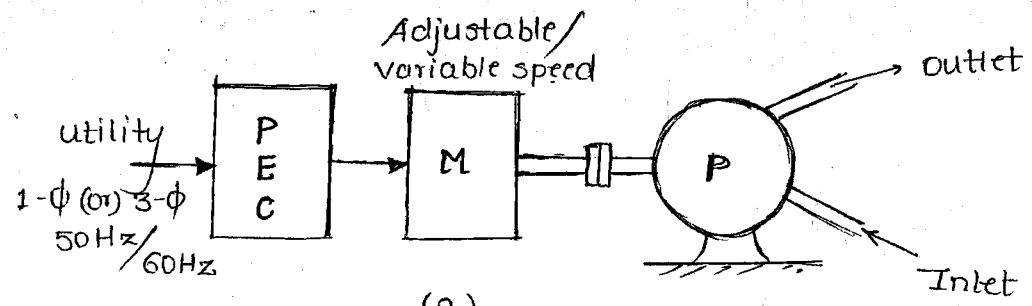
$$\left(\text{B.D. voltage} \propto \frac{1}{\text{doping density}}\right)$$

Applications of P.E. :-

i) Speed control of electric motors (DC & AC motors) [Medium Prange]
(electric drives) (Utilization)



(1)



(2)

→ In the application, light-fans pumps, compressors & blowers (where. $T_L \propto \omega^2$), the overall efficiency of the system can be increased or improved by operating the motor as adjustable or variable speed motors.

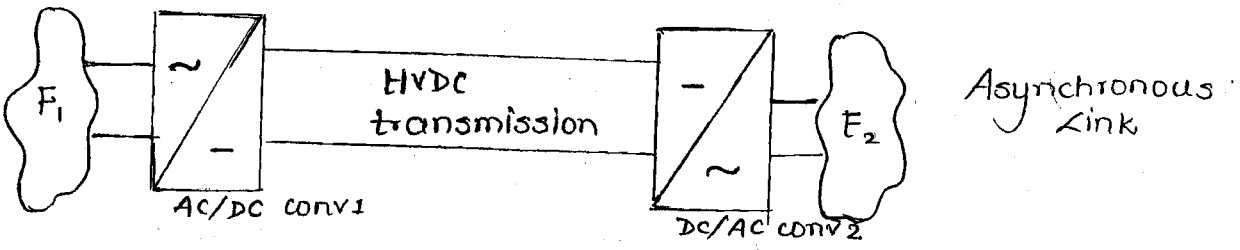
$$P \propto \omega^3 \quad (\because P = T \times \omega)$$

$$\frac{P_2}{P_1} = \left(\frac{\omega_2}{\omega_1}\right)^3 = \frac{1}{8} \qquad \left(\because \omega_2 = \frac{\omega_1}{2}\right)$$

$\left(P_2 = \frac{P_1}{8}\right)$ power consumption decreased by 8 times.

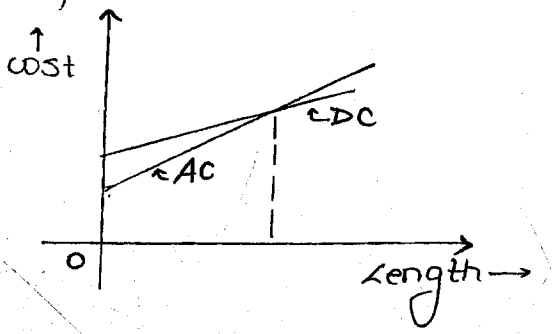
ii) In Power systems [High Power range] (T&D)

(FACTS)
a) Reactive power compensation
b) Active power control
c) to enhance the stability margin
d) Active filters.
e) HVDC transmission



Asynchronous Link

→ HVDC transmission is prefered to connect two ac s/s operating at different frequencies.



→ To transmit bulck power over long distances, HVDC transmission is more economical.

iii) Transportation :- [Medium Prange] (Utilization)

a) Rail : Electric traction.

→ in main line system : 1-ϕ, 25kV, 50Hz.

Motors : DC series motor

Induction Motor.

in Bullet trains (in Japan - 1960's)

→ Multilevel Inverter fed IM drives.

b) Air : UPS

c) Road : UPS

→ EVs / HEV.

iv) Domestic Applications [Low Prange] (Utilization)

→ Battery charging s/s

→ Fan regulators

→ Ac/ Refrigrators / Heaters

computers ⇒ UPS

v) Renewable Energy system [Medium Prange] (Generation)

→ solar

→ wind

Present contribution of power grid in India = 340 GW

In which renewable energy source has 70GW contribution.

Target - 175 GW upto 2022.

Advantages of PE

$$\eta = \frac{P_o}{P_o + P_{loss}}$$

$$\Rightarrow \eta \cdot P_o + \eta P_{loss} = P_o$$

$$\Rightarrow P_o = \left[\frac{\eta}{1-\eta}\right] P_{loss}$$

Ex:- $P_{loss} = 200W$

Conv. $\eta = 84\% \Rightarrow P_o = \frac{0.84}{1-0.84} \times 200 = 1050W$

Conv. $\eta = 94\% \Rightarrow P_o = \frac{0.94}{1-0.94} \times 200 = 3133W$

i) Power Electronic Ckts (PEC) will not have any rotating parts as in electric m/cs & hence there is no mechanical losses.

ii) In PEC the power semiconductor devices will operate as switches. Due to switch operation the losses are less and hence, conversion efficiencies will be higher due to this the power handling capacity per given unit volume (power density) will be high.

iii) Due to less losses the heat delivered ~~by the~~ will be less & hence external cooling requirement will be less.

iv) Due to less heat delivered the no of failure mode will be less & Hence PEC will have better reliability.

v) PEC can be controlled very effectively in closed loop operation.

Disadvantages of PE:

I) Harmonics

→ In PEC power semi-conductor devices will operate as switches.

Due to switching operation the waveforms will be of