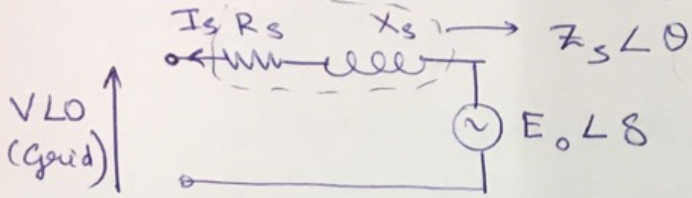
ISHANK JUNEJA | EE 222 | 16D070012

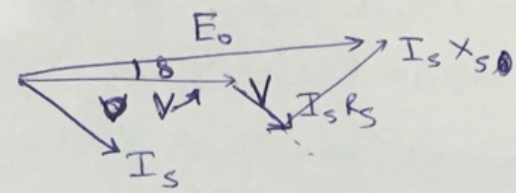
Assignment - 2

Q-1) Find Q supplied by Synchronous Machine when connected to the Grid.



$\delta > 0$ for Generator Action

~~$\bar{I}_s$ =~~



$$\bar{I}_s = \frac{E_0 \angle \delta - V \angle 0}{Z_s \angle \theta} = \frac{E_0 \angle(\delta - \theta)}{Z_s} - \frac{V \angle -\theta}{Z_s}$$

$$= \left[\frac{E_0}{Z_s}\cos(\delta-\theta) - \frac{V}{Z_s}\cos\theta\right] + j\left[\frac{E_0}{Z_s}\sin(\delta-\theta) + \frac{V}{Z_s}\sin\theta\right]$$

$$VA = VI_s = \frac{V}{Z_s}\left(\underbrace{\left[E_0\cos(\delta-\theta) - V\cos\theta\right]}_{\text{Power W}} + j\underbrace{\left[E_0\sin(\delta-\theta) + V\sin\theta\right]}_{\text{Reactive power } VA_r}\right)$$

$Z_s = (R_s + jX_s)$

$$\Rightarrow P = \cancel{\frac{V}{Z_s}} \frac{V}{(R_s + jX_s)}\left[E_0\cos(\delta-\theta) - V\cos\theta\right]$$

$\boxed{\text{if } X_s >> R_s \Rightarrow \theta = \pi/2}$: Approximation

$$P = \frac{V}{X_s}\left[E_0 \sin\delta\right] = \frac{E_0 V}{X_s}\sin\delta \text{ (per phase)}$$

total power $= 3P$ with Approximation

$$Q = \left[E_0\sin(\delta-\theta) + V\sin\theta\right]\frac{V}{(R_s + jX_s)}$$

OR -ve of this depending on convention

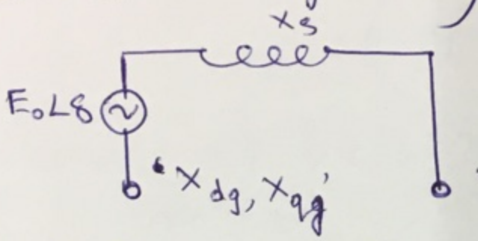
Again, per phase

$$\approx (-E_0\cos\delta + V) \times \frac{V}{X_s} = \boxed{\frac{V^2 - VE_0\cos\delta}{X_s}}$$

Q 2) Expression for power Generated by Salient Pole Machine (Different from power tranferred)

$X_{dg} \rightarrow$ Direct Axis

$X_{qg} \rightarrow$ Quadrature axis

→ 

$V_s\angle 0$ (load voltage)

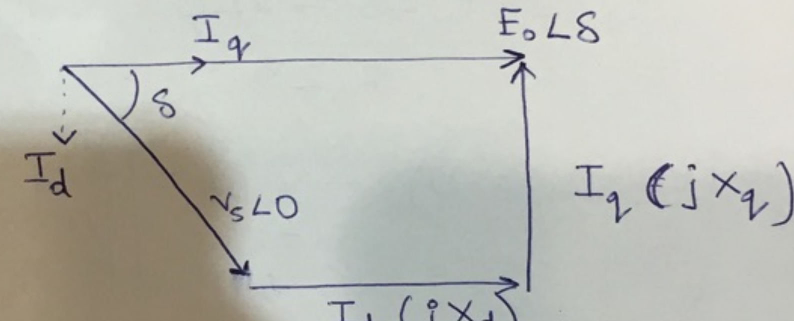
→ Total Reactance along direct axis $= X_d = X_{dg} + X_s$

→ Total Reactance along quadrature axis $= X_q = X_{qg} + X_s$

Neglect Armature Resistances.

Armature Current has both direct & quadrature components

Phasor Diagram :



$$I_d = \frac{E_0 - V_s\cos\delta}{X_d}$$

$$I_q = \frac{V_s\sin\delta}{X_q}$$

Total power delivered by E_0 to V_s

$$= (V_s\sin\delta) I_d + (V_s\cos\delta) I_q$$

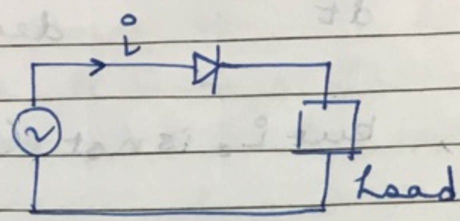
$$= (V_s\sin\delta)\left[\frac{E_0 - V_s\cos\delta}{X_d}\right] + V_s\cos\delta\left(\frac{V_s\sin\delta}{X_q}\right)$$

$$= \frac{E_0 V_s\sin\delta}{X_d} + V_s^2\cos\delta\sin\delta\left(\frac{X_d - X_q}{X_d X_q}\right)$$

$$= \frac{E_0 V_s\sin\delta}{X_d} + V_s^2\left(\frac{X_d - X_q}{2X_d X_q}\right)\sin 2\delta$$

4.3.18

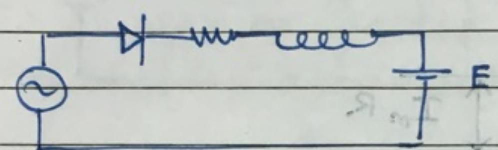
AC- DC Convertors

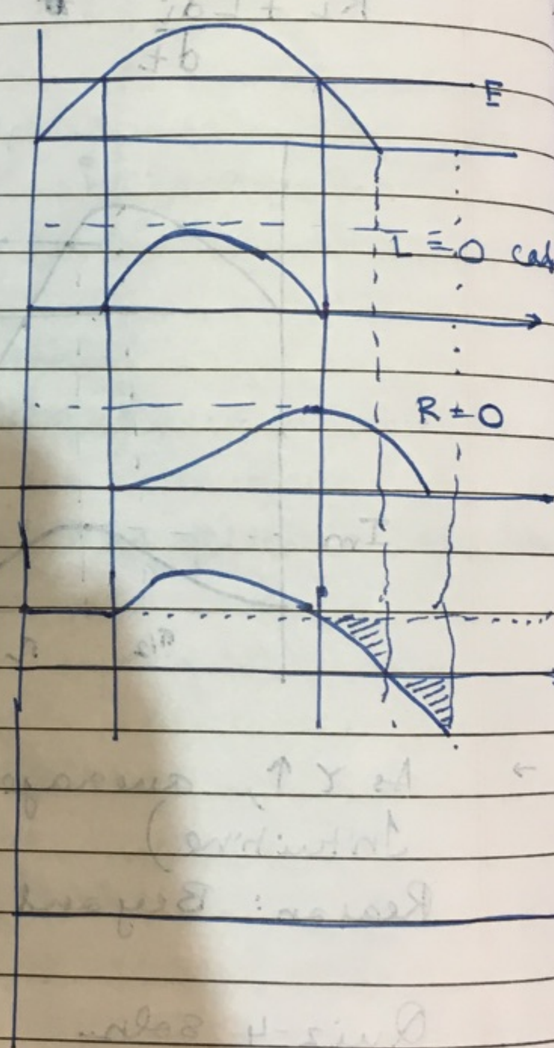


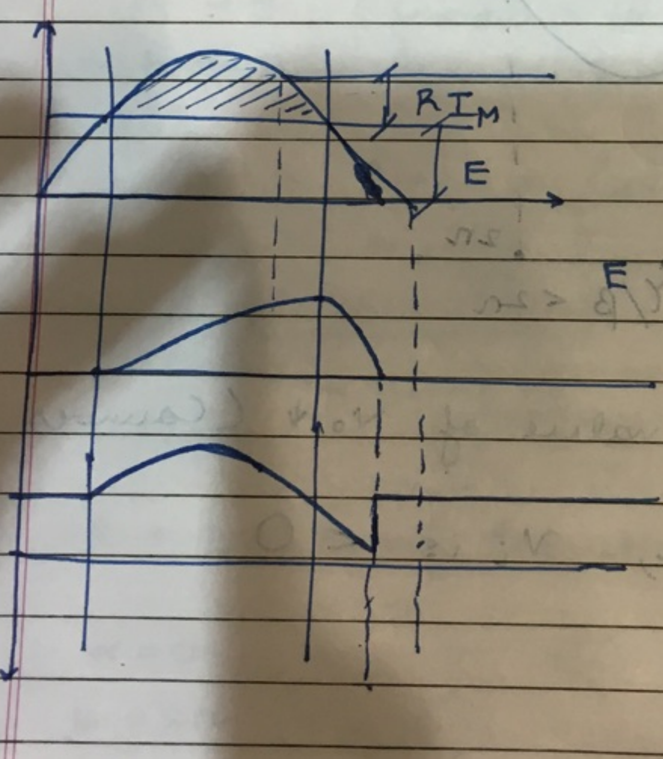
Half wave uncontr
rectification

→ HW uncontrolled rectification

RLC type load
↳ E in PE







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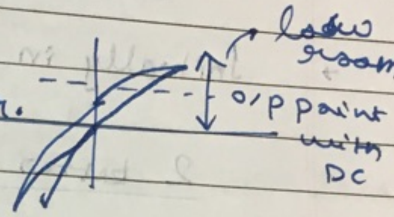
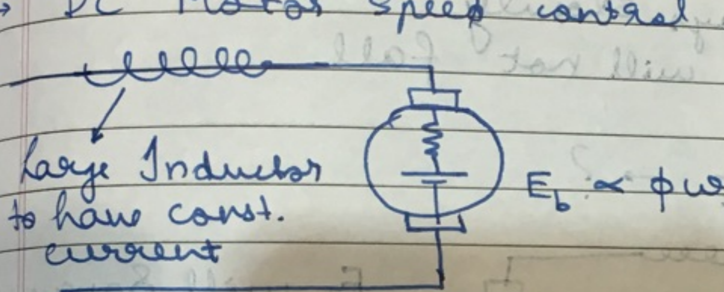
→ Problem with HW Rectification

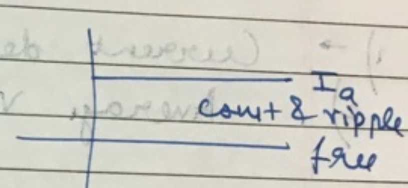
- Source I has a DC component, this will flow in transformer secondary, limits Magnetic headroom that transformer has.

→ Only works at low power.



→ DC Motor speed control





$$\frac{d\omega}{dt} = \frac{T_e - T_L}{J}$$

→ Cost of larger Inductor: Conduction period ↑
$\Rightarrow$ V_o ↓ (Average value last lecture)

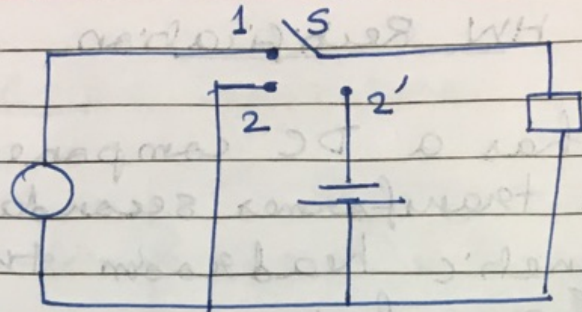
→ I_a - Should remain almost k

↓

Connect a large value of L

↓

As L ↑, V_a ↓

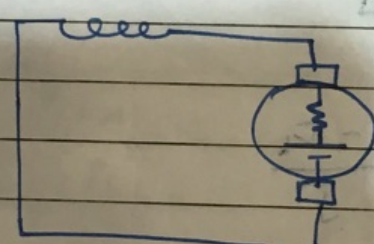


→ Initially in 1 → transfer to 2 or 2'

2 better than 2'

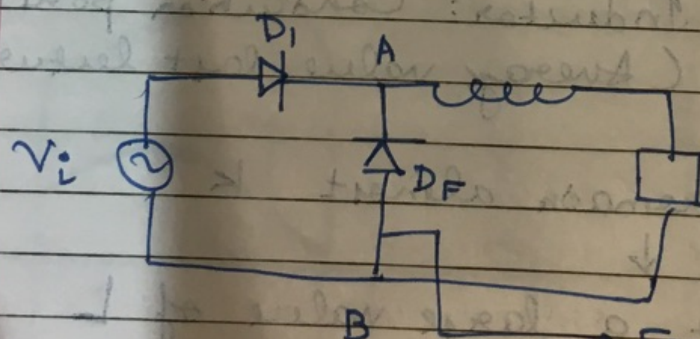
1) → Current decays slowly
2) Average V_o will not fall

Short DC M/c → ?



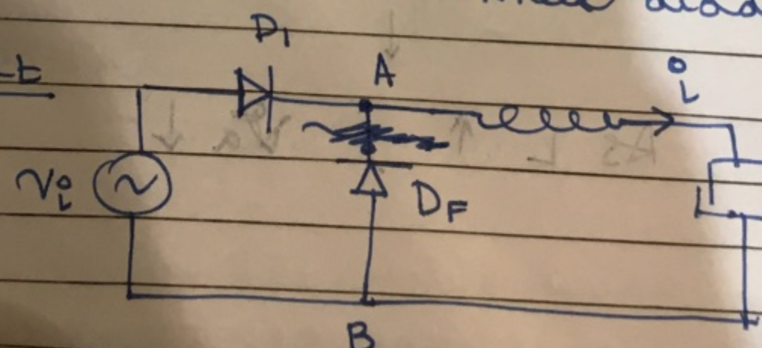
E_b will Source & current may Reverse

→ prevent this by ....



→ Free wheel diode

O/g Ckt



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→ Assume i_L is cont. (Somehow)

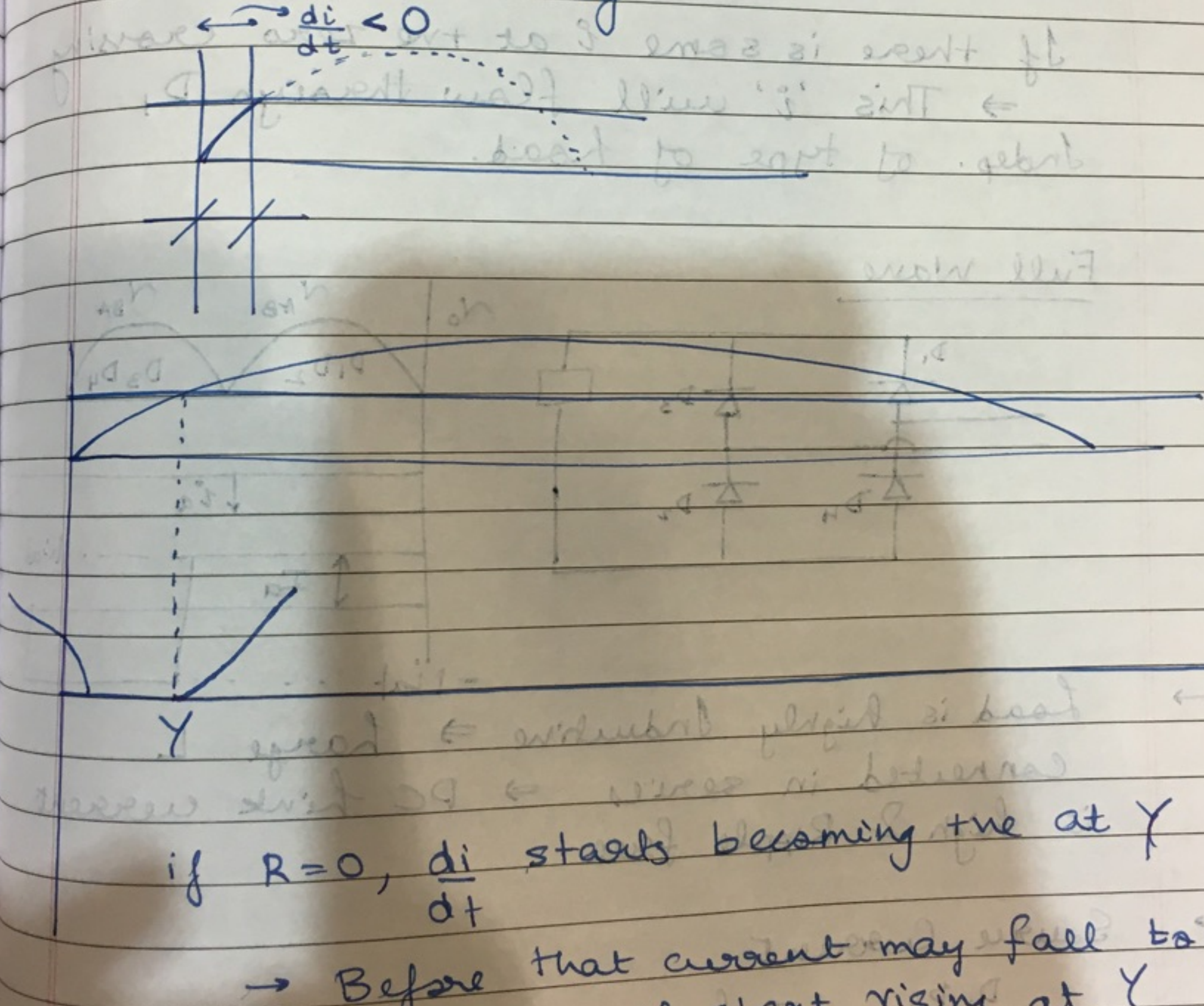
General Load → RLE

→ Diode D_1 starts to conduct at zero crossing independant of the type of Load.

→ $\frac{di}{dt}$ may be −ve (KVL)

→ D_F cannot conduct in the half (Since D_1 is F.B & inconsistency

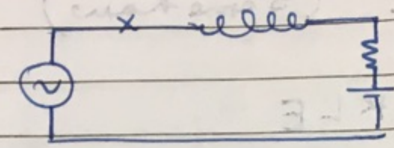
$\frac{di}{dt} < 0$



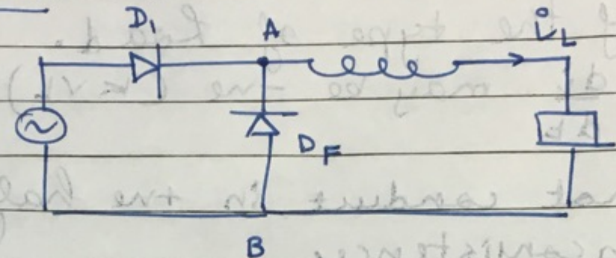
if $R = 0$, $\frac{di}{dt}$ starts becoming +ve at Y

→ Before that current may fall to 0

→ Current will start rising at Y

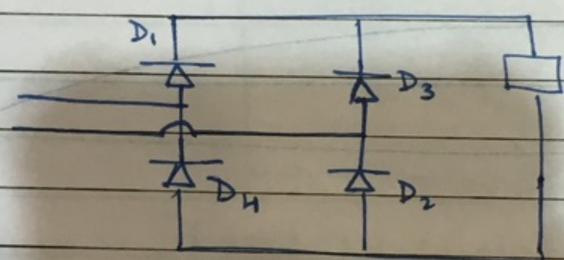


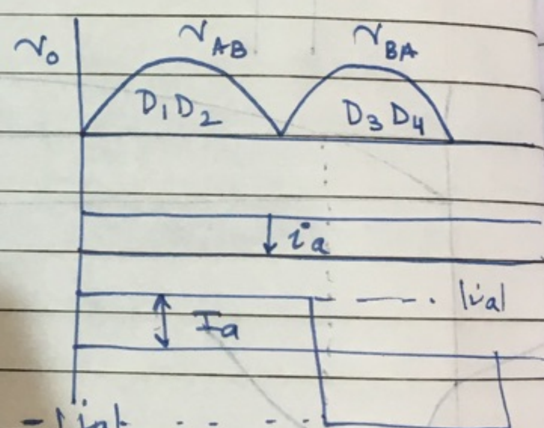
Condition



If there is some i at the zero crossing
⇒ This 'i' will flow through D_1
Indep. of type of Load.

Full Wave



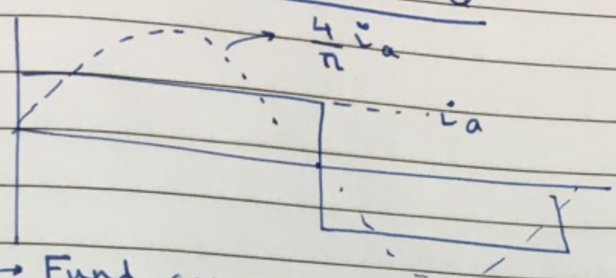


→ Load is highly Inductive ⇒ Large L connected in series ⇒ DC Link current is high & Ripple free

→ Source Current
$D_1 D_2$ → Load = Source

$D_3 D_4$ → Load = −ve of Source

Power supplied by source



$I_1 \rightarrow$ Fund. component in square wave

$\angle^{I_1}_{V_i} = 0 = \phi_1$ Displacement Angle

$\cos\phi_1$ " Factor

→ New power factor Definition.

- Any power term with 0 avg → Reactive power

$\Rightarrow \sin\omega t \sin 3\omega t + \dots$ etc term

$\sin\omega t \sin 5\omega t \dots$

$$= \frac{\text{Power}}{VA} = \frac{V_{RMS}\, \overset{RMS}{I_1}\, \cancel{\cos\phi_1}^{\,1}}{V_{RMS}\, I_a}$$

$$= \frac{I_1}{I_a} = \boxed{\frac{4}{\pi\sqrt{2}}}$$