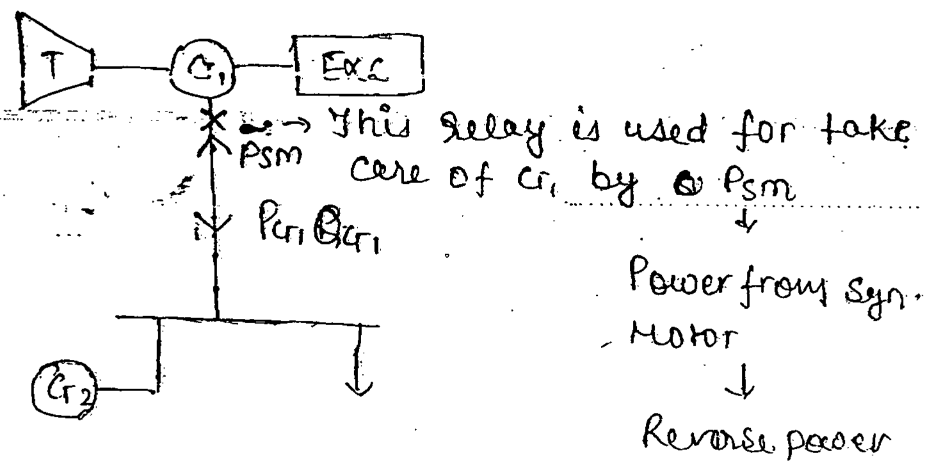
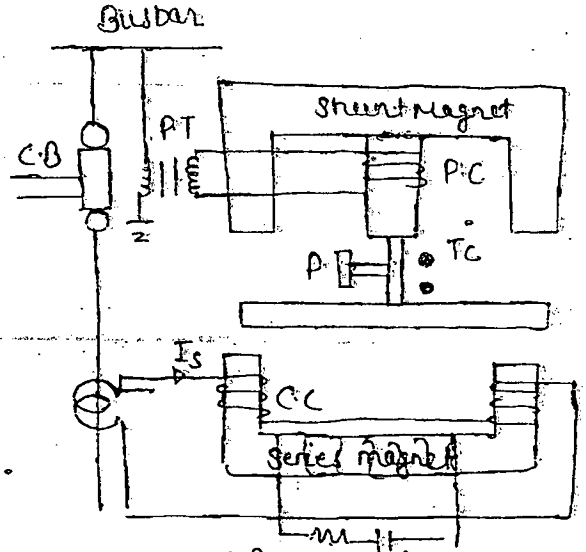
Directional or Reverse power Relay:
(Wattmetric Relays).

Protection of Genrator from the failure of prime mover (Turbine). The normal operation Syn. gen. delivers both Active and reactive power If excitation is present and prime mover is fail. then the synchronous genrator working as a Syn. motor. drawing the active power from other ll genrator (gen.). This causes temp. increment in the turbine due to churning effect which damages the turbine blades. for driving the turbine, the motor draws huge amount of current, which damages the wdg of genr. working as motor. for potection gen from this abnormalities relay reverse power wattmetric relay is used. It must have instantaneous charc. so that within short time it isolate the gen. hence it is normally made induction cup structure which has higher torque and this structure works as induction motor.





Directional Relay.

Non directional Relay

$$T_d \propto \phi_{m1} \phi_{m2} \sin\theta$$

Directional Relay

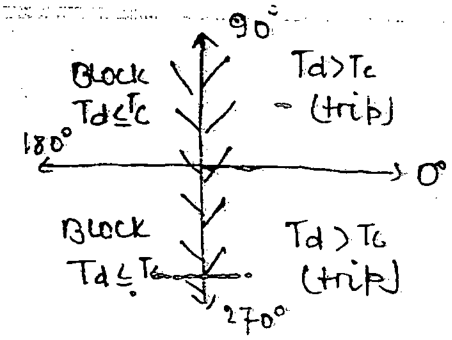
$$\phi_{m2} \propto I_s, \quad \phi_{m1} \propto V$$

Angle b/w ϕ_{m1} & $\phi_{m2} \Rightarrow (90^\circ - \theta)$

$$T_d \propto VI \sin(90^\circ - \theta)$$

$$\boxed{T_d \propto VI\cos\theta \propto P}$$

Ideal characteristics

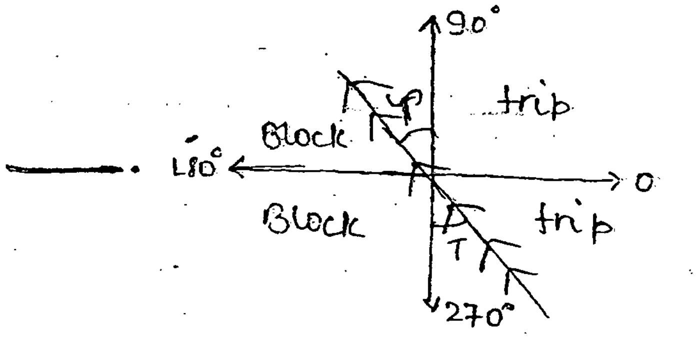


Physical

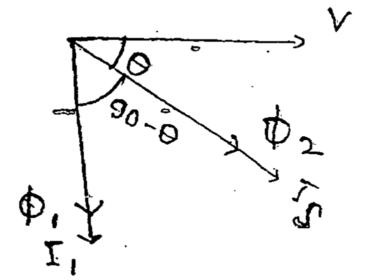
$T_d \propto VI \cos(\theta - \tau)$ * $\boxed{30° < \tau < 45°}$ *

τ = max^m torque Adjusment Angle using RC circuit

Practical char.



P.C (high inductive preffered) so produces flux ϕ_1. and C.C produces ϕ_2.



Intially turbine are in healthy condn. Gr acts as synchronous genrator. relay is in blocking state. but there is fault occur Generator and works as motor. Relay θ is shifted by 180° from block state to Trip state.

If θ = 0° T_d = max^m $T_d = VI$ it means C.C is purely resistive. that why C.C donot produce ϕ_2. hence we use RC circuit in C.C.

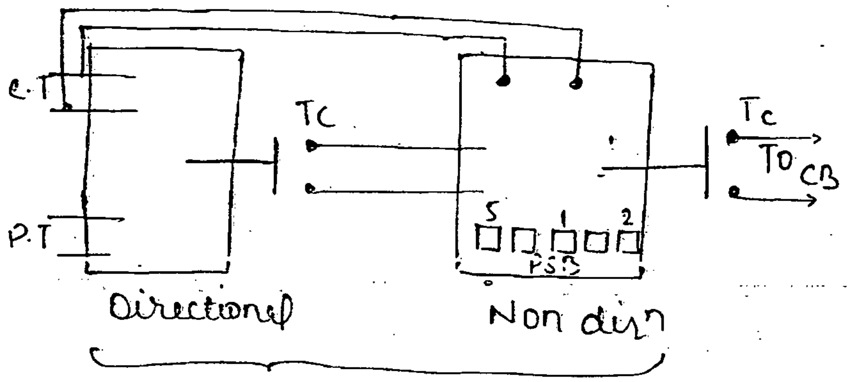
if $\varphi \geq 45°$ it work as non-direction.

Directional overcurrent Relay:-

DOC consisting of two sub relays. One is a directional and other one is non-directional O/C relay. Which connected in cascade.

Initially Directional relay checks the dirn of current and power. If the power dirn is reverse produces trip signal, which initiates non dirn O/C relays. This relay checks the reverse current magnitude and if this magnitude is more than PSB setting produces trip S/g which opens the C.B.

- DOC relays are used at load end and O/C / non direction relays are used at source end. The combination of O/C and D.O/C are used for protection of 11 feeders and ring trans. and distribution system.

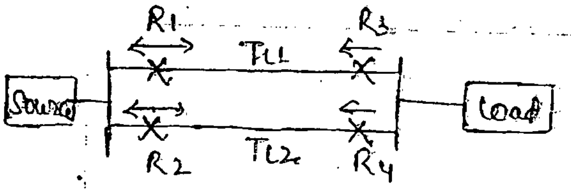


Directional O/C (DOC

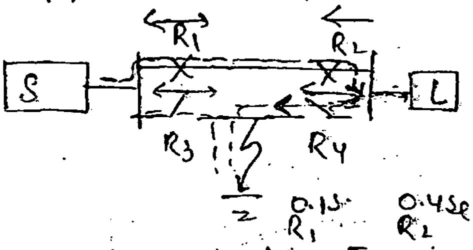
Symbol:

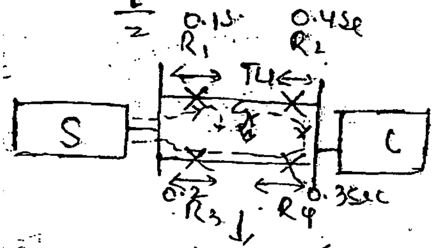
Application of O/C and DOC :-

(1) Protection of || feeders:

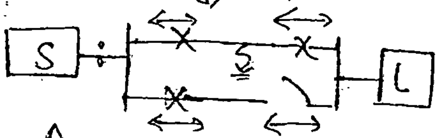


• If the fault occur in the TL2. then R4 ~~and~~ trip first and R2 also. if R4 fail then R1 operate.





~~failure~~



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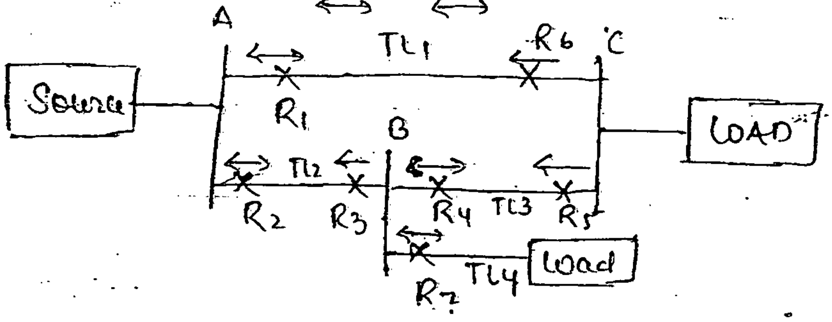
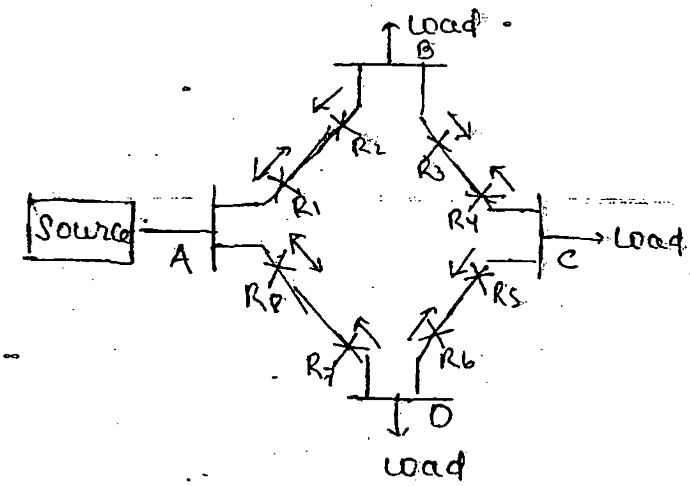


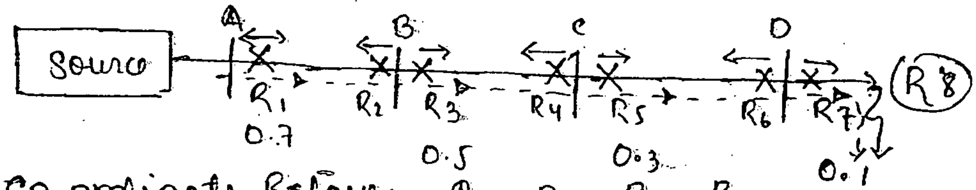
* Protection of || feeder O/C relays are used at source end and DOC are used at load end. under healthy condn both the lines are feeding the power to the load if any fault is occur in one of the line causes crossponding O/C & DOC produces S/G and open crossponding CB. So that 50% of the power can be transmitted to the load from the

remaining healthy line:

② Protection of Ring System.

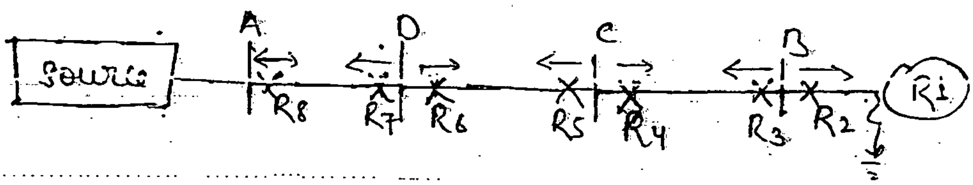


Open R_8

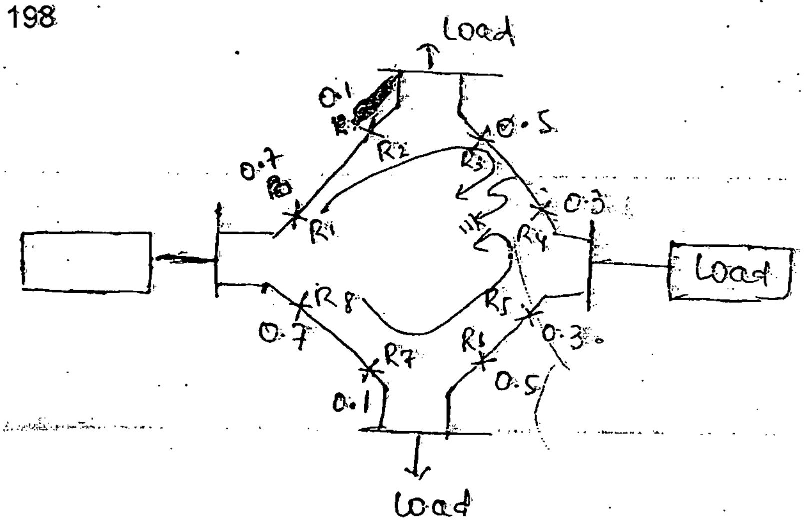


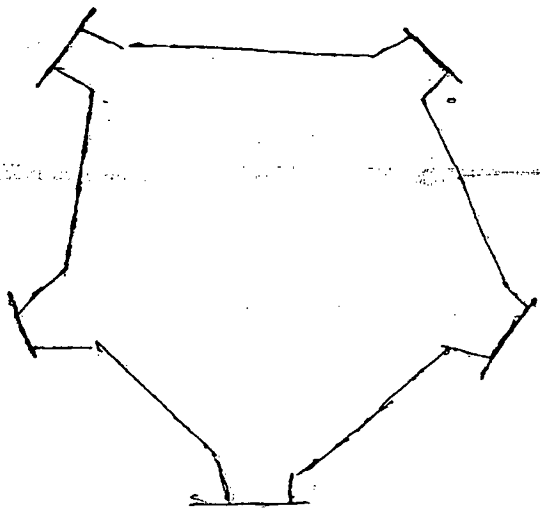
Co-ordinate Relays: R_7, R_5, R_3 R_1
0.7 0.5 0.3 0.1

Open R_1

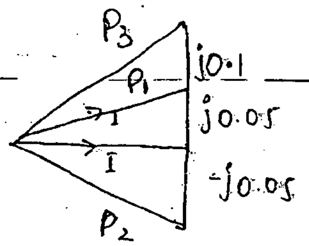


Co-ordinate Relays: R_2 R_4 R_6 R_8
0.1 0.3 0.5 0.7


Load
0.1
R2
0.5
R3
0.7
R1
0.3
R4
Load
R8
R5
0.7
R7
R6
0.3
0.1
0.5
Load



Qg. T99' (c)



Q17 Soln:

$$Q_c = P_1(\tan\phi_1 - \tan\phi_2)$$

$\phi_1 = ?$ $\cos\phi_1 = 0.8$ lag.

18 Soln:

$$\frac{Q_2}{100} = \left(\frac{V_2}{V_1}\right)^2 \cdot \left(\frac{f_1}{f_2}\right)$$

19 Soln:

Δ Cap bank

$$C_{ph} = \frac{P_1(\tan\phi_1 - \tan\phi_2)}{3(2\pi f V_{ph}^2)}$$

20 Soln:

$Z = 8 + j6$

$\phi_1 = \tan^{-1}(6/8)$

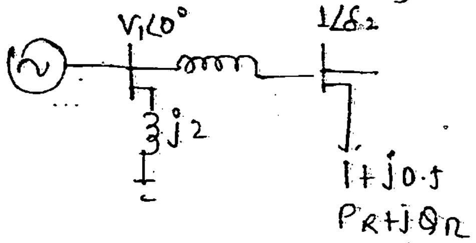
~~$P_1 = \frac{3V_L^2}{Z}$~~ $V_L = 400$

Δ Load $\therefore P_1 = \frac{3V_L^2}{Z}\cos\phi_1$

$\cos\phi_2 = 0.9$

$Q_c = P_1(\tan\phi_1 - \tan\phi_2)$

35 Soln:



$$P_R = \frac{V_1 \times 1}{0.1}\sin(0 - \delta_2) = 1$$

$$\therefore V_1 \sin\delta = -0.1 \quad \text{— (i)}$$

$$Q_R = \frac{V_1 \times V}{0.1}\cos(0 - \delta_2) - \frac{1^2}{0.1} = 0.5$$

$$V_1 \cos\delta_2 = - - - \quad \text{— (ii)}$$

4100... 2000LL = $V_s^2\sqrt{\frac{C}{L}}$

$V_S = 800KV$
$C = 11.68\times10^{-9}$
$L = 1.1\times10^{-3}$

$SIL = 2085 MV$

4.2 soln $(SIL)_c = \frac{SIL}{\sqrt{1-K_{fe}}}$

$\frac{\cdot}{X_L} = 100KVA$
$V_R = 475 \rightarrow 500K$ $X_L = ?$

$Q_R = \frac{V_S V_R}{X_L} - \frac{V_R^2}{X_L}$

$T_4 = 20.17$

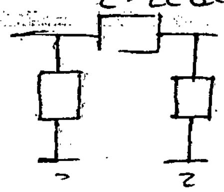
$P_2 = \frac{1\times1}{0.05}\sin 15° \Rightarrow 5.17$

$P_T = 15+5.17 = 20.17$

Chapter 2:

Q29. $l = 400km$
$z = j0.5\ /km$
$y = j\,5\mu/km$

$Z = Z_c \sinh(\gamma L)$



$Z_c = \sqrt{z/y} = \sqrt{\frac{0.5}{5\times10^{-6}}} = 316.2\Omega$

$l\gamma = \sqrt{zy}$
$= j\sqrt{0.5\times5\times10^{-6}}\times400 = j0.632\ rad. = j36.23°$

$\sin\gamma l \Rightarrow \sinh(\alpha l + j\beta l)$
$= \sinh(\alpha l)\cos\beta l + j\cosh\alpha l\ \sin\beta l$
$= 0 + j\cosh(0)\sin(36.23°) = 0.6$

$Z = Z_c\sinh(\gamma l)$
$= 316.2\times0.6 = 187\ \Omega$

0 41.201