Protective Relays

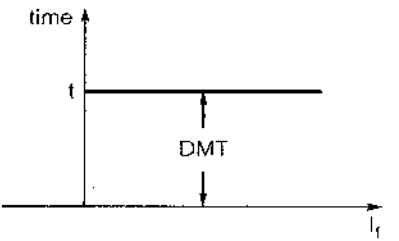
Relays are sensing device, which detect abnormal conditions in electric circuit like faults and send signal to operate circuit breaker to isolate faulty equipment from the system as quickly as possible.

Types of Relay

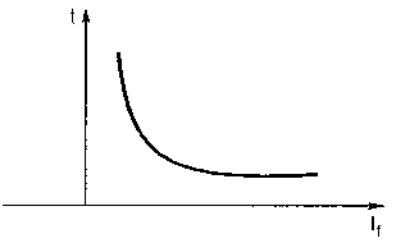
1. Based on Time of Operation

(i) *Instantaneous relay:* Operating time ≤ 0.1 sec.

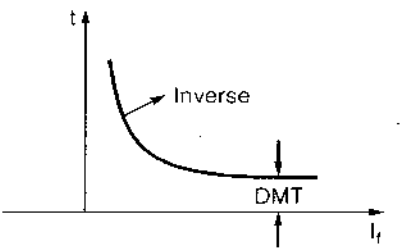
(ii) *Definite minimum time (DMT) Relay:*



(iii) *Inverse relay:*



(iv) *Inverse definite minimum time (IDMT) relay:*



2. Based on Construction

(i) *Electromagnetic attraction type:*
  (a) Balanced beam type.
  (b) Moving plunger type.
  (c) Attracted armature type.

(ii) *Electromagnetic induction type:*
  (a) Shaded pole type.
  (b) Induction cup type.
  (c) Wattmeter type.

(iii) *Gas operated relay:* Buchholz relay.

(iv) *Thermal relay:* For over load protection.

(v) *Static/microprocessor based relay.*

Pickup Value

It is minimum value of operating quantity at which relay is at the verge of operation.

Reset Value

It is maximum value of operating quantity at which relay is at the verge of non-operation.

Note:

- For Well-design relay the ratio of reset to pickup value is unity.
- For induction type relay the ratio of reset to pickup value is 0.98.

Time Multiplier Setting (TMS)

By setting different value of TMS, for the same operating current, we get different time of operation.

$$TMS_{(required)} = \frac{t_{required}}{t_{(TMS=1)}}$$

where, $t_{required}$ = Required time of operation

$t_{(TMS=1)}$ = Time of operation when TMS = 1

$$\frac{TMS_2}{TMS_1} = \frac{t_2}{t_1}$$

Plug Setting Multiplier (PSM)

PSM gives additional feature to the same relay, so that it can operate for different pickup current

$$PSM = \frac{\text{Fault current}}{\text{Current setting} \times \left(\frac{\text{C.T. secondary}}{\text{rated current}}\right) \times \text{C.T. ratio}}$$

Torque Equation

Universal Relay Torque Equation

$$T = K_1 I^2 + K_2 V^2 + K_3 VI\cos(\theta - \tau) + K$$

where, I = RMS value of current in current coil

V = RMS value of voltage fed to the voltage coil circuit

θ = Angle between I and V

τ = The maximum torque angle

K = Restraining torque including spring and friction.

K_1, K_2, K_3 = Relay constant

Torque Equation for Different Type of Relays

1. Over current relay

$$T_{oc\,relay} = K_1 I^2 - K$$

2. Directional relay

$$T = K_3 VI\cos(\theta - \tau) - K$$

3. Impedance relay

$$T = K_1 I^2 - K_2 V^2$$

For relay to operate, $Z = \frac{V}{I} < \sqrt{\frac{K_1}{K_2}}$

4. Reactance relay

$$\boxed{T = K_1 I^2 - K_3 VI \sin\theta} \quad \tau = 90°$$

For relay to operate, $\boxed{\frac{V}{I}\sin\theta = X < \frac{K_1}{K_3}}$

5. Mho relay

$$\boxed{T = K_3 VI \cos(\theta - \tau) - K_2 V^2}$$

For relay to operate, $\boxed{\frac{V}{I} = Z < \frac{K_3}{K_2}\cos(\theta - \tau)}$

Note:

- Relay used for phase fault on
  - (a) Short line : Reactance relay.
  - (b) Medium line : Impedance relay.
  - (c) Long line : Mho relay
- For earth fault generally reactance relay are used.

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