OVERCURRENT & EARTH FAULT RELAYS

Objective:

To study the protection of equipment and system by relays in conjunction with switchgear.

Theory:

The function of a relay is to detect abnormal conditions in the system and to initiate through appropriate circuit breakers the disconnection of faulty circuits so that interference with the general supply is minimised. Relays are of many types. Some depend on the operation of an armature by some form of electromagnet. A very large number of relays operate on the induction principle. When a relay operates it closes contacts in the trip circuit which is normally connected across 110 V D.C. supply from a battery. The passage of current in the coil of the trip circuit actuates the plunger, which causes operation of the circuit breaker, disconnecting the faulty system.

In the laboratory, a 3-phase contactor simulates the operation of the circuit breaker. The closure of the relay contacts short-circuits the 'no-volt ' coil of the contactor, which, in turn, disconnects the faulty system.

The protective relaying which responds to a rise in current flowing through the protected element over a pre-determined value is called 'overcurrent protection' and the relays used for this purpose are known as overcurrent relays. Earth fault protection can be provided with normal overcurrent relays, if the minimum earth fault current is sufficient in magnitude. The design of a comprehensive protection scheme in a power system requires the detailed study of time-current characteristics of the various relays used in the scheme. Thus it is necessary to obtain the time-current characteristics of these relays.

The overcurrent relay works on the induction principle. The moving system consists of an aluminium disc fixed on a vertical shaft and rotating on two jewelled bearings between the poles of an electromagnet and a damping magnet. The winding of the electromagnet is provided with seven taps (generally0, which are brought on the front panel, and the required tap is selected by a push-in -type plug. The pick-up current setting can thus be varied by the use of such plug multiplier setting. The pick-up current values of earth fault relays are normally quite low.

The operating time of all overcurrent relays tends to become asymptotic to a definite minimum value with increase in the value of current. This is an inherent property of he electromagnetic relays due to saturation of the magnetic circuit. By varying the point of saturation, different characteristics can be obtained and these are

1. Definite time
2. Inverse Definite Minimum Time (IDMT)
3. Very Inverse
4. Extremely Inverse

The torque of these relays is proportional to $\phi1\phi2$ Sinα, where $\phi1$ and $\phi2$ are the two fluxes and α is the angle between them. Where both the fluxes are produced by the same quantity (single quantity relays) as in the case of current or voltage operated, the torque T is proportional to I2, or $T = K I^2$, for coil current below saturation. If the core is made to saturate at very early stages such that with increase of I, K decreases so that the time of operation remains the same over the working range. The time -current characteristic obtained is known as <u>definite -time characteristic.</u>

If the core is made to saturate at a later stage, the characteristic obtained is known as <u>IDMT</u>. The time-current characteristic is inverse over some range and then after saturation assumes the definite time form. In order to ensure selectivity, it is essential that the time of operation of the relays should be dependent on the severity of the fault in such a way that more severe the fault, the less is the time to operate, this being called the inverse-time characteristic. This will also ensure that a relay shall not operate under normal overload conditions of short duration.

It is essential also that there shall be a definite minimum time of operation, which can be adjusted to suit the requirements of the particular installation. At low values of operating current the shape of the curve is determined by the effect of the restraining force of the control spring, while at high values the effect of saturation predominates. Different time settings can be obtained by moving a knurled clamping screw along a calibrated scale graduated from 0.1 to 1.0 in steps of 0.05. This arrangement is called Time Multiplier Setting and will vary the travel of the disc required to close the contacts. This will shift the time-current characteristic of the relay parallel to itself.

By delaying the saturation to a further point, the <u>Very Inverse</u> and <u>Extremely Very Inverse</u> time current characteristics can be obtained.

<u>Pre-experimental quiz</u>

1. What do you understand by
- Primary relay
- Secondary relay
- Auxiliary relay?

2. What do you understand by
- Single quantity relay
- Double or multiple quantity relay?

3. What is the purpose of shaded pole structure?

4. Can both a.c and d.c actuate the overcurrent & earth fault relays?

5. What is meant by
- Pick-up current
- Drop-out current
- Dropout ratio?

6. In systems with low ground fault current is there a necessity to provide an earth fault relay?

7. Where do you connect overcurrent & earth fault relays in a power system?

8. What do sensitivity & selectivity of a relay mean?

Material & equipment

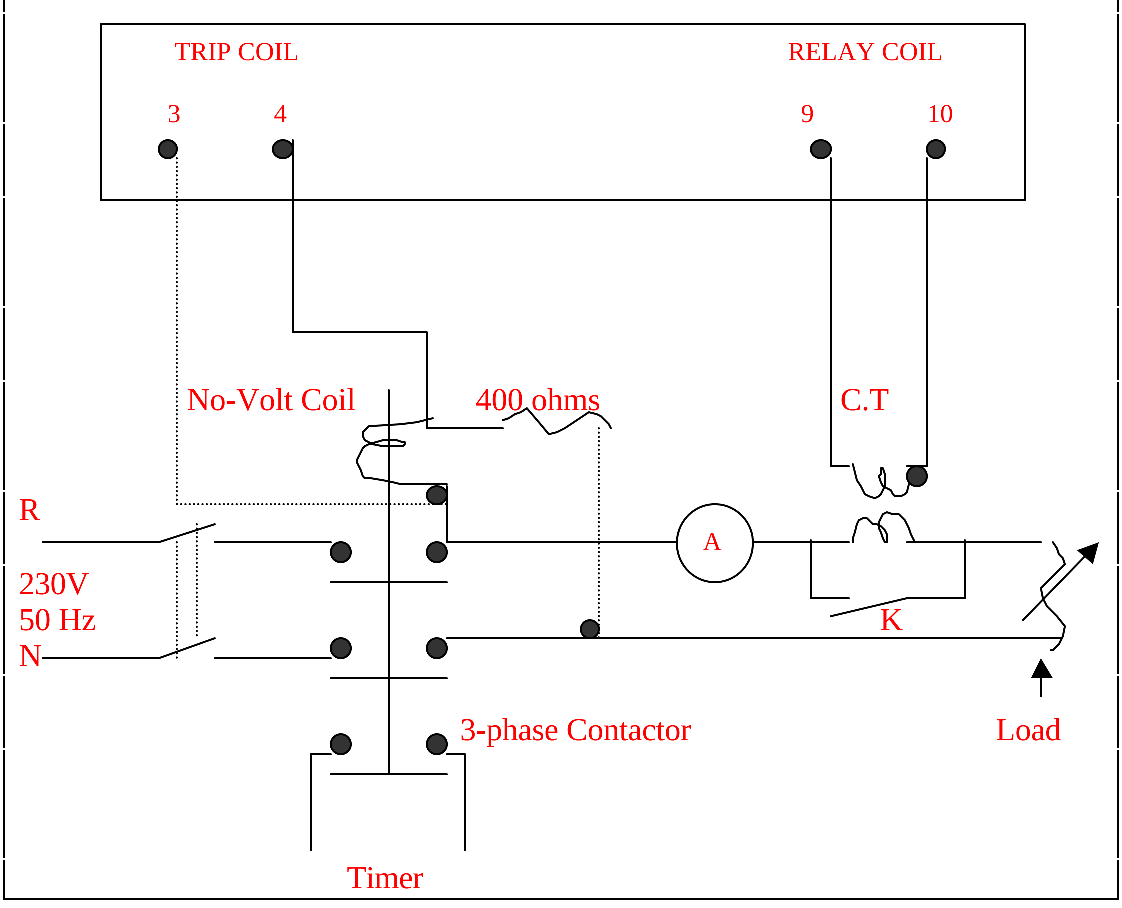
Overcurrent relay, Earth fault relay, Current transformer, 3-phase contactor, 1-phase load, Ammeter, Digital timer.

Procedure:

Overcurrent Relay:

1. Study the construction of the relay and identify the various parts.
2. Connect as in FIG.1

FIG.1 Overcurent or Earth -fault Relay



3. Set the pick-up value of the current marked 1 A(100 % f. l current) by inserting the plug in the groove.
4. Set the Time Multiplier Setting (TMS) initially at 1.0.
5. Adjust the load current to about 1.3 times the f.l current by shorting the switch K. Open the switch K to permit this adjusted current to flow through the relay and record the time taken for this overload condition.
6. Vary the value of the load current in steps and record the time taken for the operation of the relay in each case with the help of the timer.
7. Repeat steps 5 and 6 for TMS values of 0.2, 0.4,0.6 and 0.8.
8. Repeat the above experiment with different pick up current values using the plug setting bridge.

Earth-fault Relay

1. Replace the overcurrent relay by the earth fault relay.
2. Set the pick-up value of the current to full load current using the plug setting bridge.
3. Set the TMS to 1.0
4. Vary the load current in different steps and record the operating current value and the time of operation in each case.
5. Repeat step 4 for different TMS values as in the overcurrent relay case.
6. Repeat with different pick-up current values , using the plug-setting bridge

Data Sheet:

Type of Relay:

Pick-up current (plug setting multiplier) = ----- Amps

S.No	Current, A	Current(A) times the plug setting multiplier	Operating time in sec. for TMS of				
			0.2	0.4	0.6	0.8	1.0

Data Processing & analysis:

1. Plot operating time versus the multiples of plug setting values for different TMS on the same graph for overcurrent relay.
2. Plot on a log -log sheet operating time versus the multiples of the plug setting value for different time multiplier settings on the same graph sheet for the overcurrent relay.
3. Plot the curves for earth fault relay as in steps 1 and 2 respectively.
4. Observe the Inverse nature of the characteristics as well as the definite time required for the operation of the relay in either case.

Post experimental Quiz:

1. When is it necessary to add a direction feature for overcurrent protection?

2. Can the overcurrent and earth fault relays be made to operate instantaneously and how?
3. What are the equations of IDMT, very Inverse and Extremely Inverse overcurrent relays?