For Academic Session 2013

(EE-455)

Electrical Power System Protection

Lab Procedures

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LAB. # 01

To apply a relay for detection of phase detection, phase failure and load unbalancing (% asymmetry)

Procedure:-

Part (a)

- Switch “ON” KESC supply (1 Φ 220V, 50Hz);
- Move sector switch from “0” to “1” position. The indication marked as “Line” on GCB-1/EV control board will turn “ON”.
- Move the button of motor drive from “Stand by” to “Run”.
- Adjust the excitation voltage of three phase generator from control board so that the terminal voltage of three phase generator becomes 400V.
- Adjust the speed of DC motor Drive for 50Hz frequency.
- Connect three jumper sets of presence asymmetry & sequence failure phase relay on GCB 1/EV. Protection relay’s indication on GCB 1/EV will turn “ON” (% asymmetry LED & delay time LED will turn “ON”).
- Set the % asymmetry 10% & delay time as “minimum”.
- Now connect balanced load at the output of three phase generator marked as L1, L2 & L3. The voltage drop is almost same in all phases (Symmetry will be around ±10%), so relay will not operate.
- Now connect three phase balanced load at output terminals of generator in such a manner that % asymmetry of voltage drop in any two phases is greater than 10%.
- The moment when % asymmetry exceeds that set value of 10% the asymmetry relay will interrupt that load; after the fixed time delay. Now relay LED will be “OFF” and relay N/C contact will show “OPEN”.
- When the parameters return back to the normal limits; relay will be switched OFF automatically.

Part (b):-

- Remove the load.
- Phase sequence of generated voltage is changed.(i.e. change the position of any of two phases)
- As the phase sequence is changed again the asymmetry relay will operate after the set time delay, so relay LED will be “OFF” and the N/C contact will show “OPEN”.
LAB. # 02

Three Phase Max and Min Voltage Relay

Procedure:-

(01) Switch “ON” KESC supply (1Φ, 220 V, 50Hz)

(02) Move the selector switch from “0” to “1” position. The indication marked as line on GCB-1/EV control board will turn “ON”.

(03) Move the button of motor drive from “Stand by” to “Run”.

(04) Adjust the excitation voltage of three generator from control board so that the terminal voltage of generator (L-L voltage) become 400V.

(05) Adjust the speed of DC motor drive from control board for 50 Hz frequency.

(06) Connect jumpers of 3 Φ of minimum & maximum voltage relay on control board.

(07) Adjust the Max: voltage relay setting as 105% and a relay time of 5 sec of rated voltage.

(08) Adjust the Min: voltage relay setting as 90% of rated voltage (i.e. 400 V L-L) and delay time of 5 sec.

(09) Set multi meter as ohmmeter and connect it to the normally close contact of Max: voltage & Min: voltage relay output & check the contacts accordingly.

(10) Increase the voltage supplied by synchronous by generator to 430V by increasing its excitation voltage. The 430 V is obviously more than 105% of rated voltage.

The 5% rise in rated 400 V is actually 420V.

The moment we across the limit the Maximum voltage relay will operate. It will disconnect the circuit (i.e. disconnect load from generator)

- There will be time delay of as per set time delay.
- Contacts positions will change accordingly. (N/O to N/C and N/C to N/O vice versa)
- Now decrease the voltage of synchronous generator by 90% of rated voltage (i.e. 360V or less). After the set time delay, contact positions will change accordingly.
- Take back the voltage to 400V rated; again the supply to load will be restored.
LAB. # 03

Three Phase Maximum & Minimum Frequency Relay

Producer:-

(01) Switch “ON” KESC supply (1Φ, 220 V, 50Hz)
(02) Move the selector switch from “0” to “1” position. The indication marked as line on GCB-1/EV control board will turn ON.
(03) Move the button of motor drive from “Stand by” to “Run”.
(04) Adjust the excitation voltage of three generator from control board so that the terminal voltage of generator (L-L voltage) becomes 400V.
(05) Adjust the speed of DC motor drive from control board for 50Hz frequency.
(05) Connect the Jumpers of Max/ Min Frequency relay.
(06) Adjust Max Frequency threshold to 50+2Hz with minimum time delay time.
(07) Adjust minimum frequency threshold to 50-2 Hz with minimum time delay.
(08) Connect the multi meter to normally close (N/C) contacts of Max / Min frequency relay output and check the contacts accordingly.
(09) In case the frequency increases to 53 Hz. The Max frequency relay will operate after the set time delay.
(10) The contacts will show change in position accordingly.
(11) Bring frequency back to 50 Hz; the max frequency relay operation will be back to its normal state.
(12) Bring frequency to 47 Hz. In this case minimum frequency relay will operate after the set time delay (Signal by interruption in continuity of multi meter).
LAB. # 04

Over Current Relay

Procedure:-

(01) Switch “ON” KESC supply (1Φ, 220 V, 50Hz)

(02) Move the selector switch from “0” to “1” position. The indication marked as line on GCB-1/EV control board will turn ON.

(03) Move the button of motor drive from “Stand by” to “Run”.

(04) Adjust the excitation voltage of three phase generator from control board so that the terminal voltages of generator (L-L voltage) become 400V.

(05) Adjust the speed of DC motor drive from control board for 50Hz frequency.

(06) Adjust the over load threshold to 1A with minimum time delay setting.

(07) Adjust the short circuit threshold to 5 A.

(08) Connect the RL load to the output of synchronous generator.

(09) Adjust the load current to approximately near about 0.6A, either by adjusting the three generator output voltage or by changing the load resistance values. Over current relay will not operate as the current is within overload threshold.

(10) Now in case the load current increases to about 1.2A; either by increasing supply voltage or changing load. The overload relay will operate after the set time delay (which can be verified by the operation of relay contacts).
LAB. # 05

Timer Relay

Procedure:

(01) Switch ON variable three phase AC/DC power supply.

(02) Adjust three phase variable AC/DC power supply for AC voltage (L₁-N or L₂-N & L₃-N)

(03) Make the connection of phase of power supply with point A₁ of timer relay
     (i.e. L₁-A₁ or L₂-A₁ & L₃-A₁)

(04) Make the connection of neutral of power supply with A₂ terminal of timer relay (i.e. N-A₂)

(05) Connect the multimeter to common point and normally open point of timer relay.

(06) Configure the timer as follows for ON delay operative mode.

     SW-3---Off
     SW-4---Off
     SW-6,7---Off
     SW-5, SW-8---ON

(07) Set the time range of sec.

(08) Increase the voltage (L-N) from supply and adjust it to 230 V.

(09) Check the state of timer output relay after designated time delay. The relay will be operated.

     Configure timer as follows: (Off delay timer)

(10) SW-4, 5, 7—OFF

(11) SW-4, 5, 7—ON

(12) Select range of 3 sec.

(13) Now connect the phase of regulated AC power supply to A₄ terminal of timer relay
     (i.e. L₁-A₄ or L₂-A₄ & L₃-A₄)

(14) Connect the neutral of regulated AC supply with A₂ terminal of timer relay (N-A₂)

(15) Increase the voltage from zero to 24V.

(16) At 24V the timer will operate after designated time delay.
LAB. # 06

Alarm Relay

Procedure:-

(01) Switch “ON” three phase AC/DC power supply.
(02) Adjust the selector switch of three phase regulated AC/DC power supply for DC voltage output.
(03) Connect power source (DC supply) in parallel with 24V alarm relay.
(04) Make sure to connect the positive terminal of supply with positive terminal of alarm relay (i.e. with bulb & buzzer).
(05) Connect the negative terminal of supply to negative terminal of the alarm relay (i.e. normally close contacts of two switches)
(06) Connect two jumper between N/O contacts of two switches (with which –ve side of supply is connected) with buzzer & bulb respectively.
(07) Increase supply voltage and observe the indication of alarm & bulb.
LAB. # 07

Current Transformer Relay

Procedure:

(01) Switch ON the variable three phase AC/DC power supply.
(02) Adjust the operation of three phase variable AC/DC power supply for AC voltage (select the selector to (L₁-N- or L₂-N & L₃-N).
(03) Connect the phase of regulated AC power supply to C.T primary via a multimeter (i.e. connected in series).

Connect the neutral of AC power supply to second terminal of C.T.
(04) Connect Rheostat (R₁) in series with the primary of the C.T.
(05) Connect a Rheostat (R₂) in series with secondary side of C.T. Also connect an ammeter in series with secondary to measure current.
(06) The rating of C.T is 10/5.
(07) Adjust the Rheostat (R₁) of primary at mid value & Rheostat of secondary to max: allowable impedance.
(08) Adjust the voltage from AC regulated power supply such that ammeter at primary gives 1 ampere current reading.
(09) Now measuring the current flowing into secondary with different burdens, calculate percentage error.
LAB. # 08

Voltage Transformer

Procedure:-

(01) Switch “ON” variable three phase AC/DC power supply.
(02) Adjust the operating of three phase variable AC/DC power supply (select the selector to (L₁-N- or L₂-N & L₃-N).
(03) The rating of V.T is 500/100 V connect single phase supply with the primary of V.T (i.e. L₁-N-, L₂-N & L₃-N)
(04) Connect a voltmeter at V.T input (i.e. primary side)
(05) Connect the secondary terminal of V.T transformer to “load Rheostat”.
(06) Connect a voltmeter at V.T secondary and also connect a multimeter in series with V.T secondary winding to measure current.
(07) Apply 80% of nominal voltage to V.T primary from regulated A.C power supply & adjust Rheostat at secondary at maximum value.
(08) Record value of primary & secondary voltage of V.T
(09) Apply formula for calculation of % ratio error.