



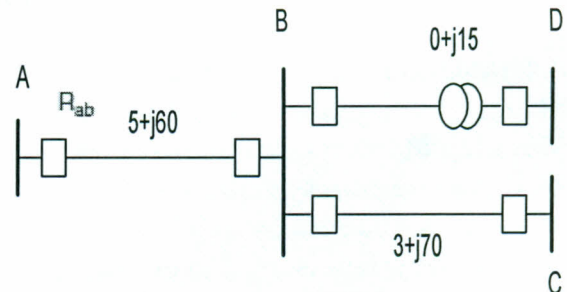
Answer the Following Questions

Question # 1 (18 Marks):

- (A) A current transformer has the following data; 20 VA, class 10 P 20, 1 amp. Evaluate an equivalent ANSI/IEEE standard current transformer to this current transformer. (8 Marks)
- (B) What is the difference between the CT and the VT for the protection devices? (5 Marks)
- (C) State the methods used for the estimation of CT performance. (5 Marks)

Question # 2 (20 Marks):

- (A) Explain how to define the IEC and ANSI knee point for the protection CT. (5 Marks)
- (B) i- Determine the relay side three zone settings in ohms for the Mho relay R_{ab} in the system shown in the Figure. The system nominal voltage is 220 kV, and the positive sequence impedances for the various elements are given in the figure. The transformer impedance is given in ohms as viewed from the 220 kV side. The angle of maximum torque is 80° . Assume that the maximum load at the relay site is 300 MVA. (15 Marks)
- ii- Determine a CT and a PT ratios for this relay .
- iii- Draw the relay characteristics considering a 10% offset in zone 3 .
- iv- Determine the loadability limit for this relay assuming a 0.85 power factor lag.



Question # 3 (17 Marks):

- A three-phase Yd1 transformer is rated at 110/22 kV, 100 MVA. It has an overload capability of 120%. The 110 kV side has a tap changer with $(5/8)\%$ step size, and with a range of 99 to 121 kV. Assume a maximum CT error of 5% in either of the two CTs.
- i- Determine CT ratios for a percentage differential relay to protect this transformer.
- ii- What is the minimum slope of the percentage differential characteristic of the relay?
Assume that both the relay windings are provided with taps for 3.0, 4.0, 4.8, 5.0, 5.2, 6.0 A,
- iii- Determine the appropriate taps which will minimize the required slope of the relay characteristic.
- iv- Draw the relay characteristic and what pickup current setting for the relay would you recommend?

Question # 4 (18 Marks):

Write only the sign of true or false for the following sentences and correct the wrong one:

- 1- The purpose of protective relays is to operate the fast circuit breakers.
- 2- High reliability of protection system should not be pursued as an end in itself regardless of cost.
- 3- The protection of the network consists of more than one overlapping zones.
- 4- Pilot protection uses communication media such as power cables and optical fiber.
- 5- Multi-relay is the relay which designed that actuates several contacts simultaneously.
- 6- Most of distribution transformers are pole mounted.
- 7- The CL fuse consists of one or more ribbon elements suspended in an envelope filled with sand.
- 8- The continuous load characteristic of the fuse is the maximum current that is expected for three hours the fuse will not be damaged.
- 9- The VI OC relay operating characteristic is much steeper and therefore the operation decreases for the same reduction in current compared with SI OC relay characteristic.
- 10- According to IEC standards the grading margin for the digital relay to relay is 0.4 seconds.
- 11- For grading inverse time relays with fuses the best relay characteristic is the SI characteristic.
- 12- Directional relays require two inputs; the operating current and the pilot.
- 13- On R-X plane of the distance relay characteristic, the corresponding impedance of the lagging real power flow into the line lies in the second quarter of the plane.
- 14- The uncertainty of reach at remote point of a distance relay is about 15% of the setting.
- 15- The unbalanced current in the generator neutral can be as much as 10 % of the rated current.
- 16- A star earthed/broken delta PT is used to detect faults in ungrounded machines.
- 17- A toroidal CT allows only negative sequence currents to be appears in the relay.
- 18- Stalling is condition lead to drawing heavy currents in motor.
- 19- Motoring of the synchronous generator can be done when fuel stopped.
- 20- TCR is a resisting system to limit the fault current.
- 21- SCL limits a current by quickly inserting a series inductance in the fault path.
- 22- Protection system is used to eliminate the consequences of a fault.
- 23- The supply of the tripping system must be storage battery with a battery charger.
- 24- Electromagnetic relays are not still in use today.
- 25- Solid-state relays may be turned on using LED light source.
- 26- The bimetal relay is a form of thermal relays.
- 27- URD transformers are usually pole-mounted.
- 28- The relay that operates for a fault beyond the intended zone of protection is said to overreach.
- 29- The grading margin depends on the overshoot time of the relay.
- 30- The satisfactory two fuses grading is achieved if the current rating ratio is less than two.
- 31- The heat loss in CL fuse limits the current to a small value known as dropout.
- 32- The Mho relay characteristic is defined by a circular shape attaches the coordinates.
- 33- In the distance relay's R-X diagram, the impedance is plotted as a point.
- 34- The instantaneous OC relay is used when motor neutral is grounded with high impedance.
- 35- The transformer inrush current magnitude is affected by the size of the power system.
- 36- DVR is used for protecting sensitive loads.

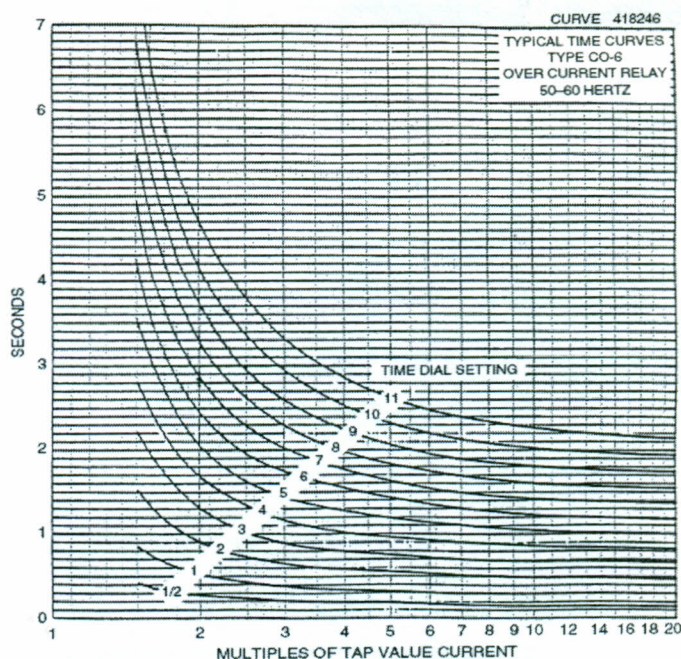
Question # 5 (20 Marks):

- (A) You are responsible for a three-phase generator, 150 MVA, 11kV, star earthed connected. Suggest and explain briefly for this generator the main protection system and two backup protection systems. Illustrate your answer with the help of the required diagrams. **(10 Marks)**
- (B) Compare between the IEC 60255 standards characteristics for IDMT relays. **(3 Marks)**
- (C) Discuss the advantages of using the toroidal CT. Draw the required schematic diagram for illustration. **(3 Marks)**
- (D) Draw a sketch for the plunger type electromagnetic relay and derive the dropout to pickup ratio. **(4 Marks)**

Question # 6 (17 Marks):

- (A) State the possible faults encountered in the oil-immersed type reactor. **(3 Marks)**
- (B) Compare between the sectionalizer and the recloser. Give a simple example to illustrate your answer. **(3 Marks)**
- (C) Explain the high-impedance bus protection scheme. **(3 Marks)**

- (D) A 300 hp motor connected to a 0.4 kV bus. Assume the following bus and motor parameters:
phase-to-phase bus fault =15000 A
three-phase bus fault =25000 A
minimum ground fault = 1500 A
motor full-load current =25 A
motor locked rotor current =150 A
motor starting time =1.5 seconds.
Select and set the phase and ground relays using the time-current characteristic of the three relays shown. **(8 Marks)**



With Our Best Wishes

Prof. Dr. Gabr M. Abdulsalam

Dr. Ebrahim A. Badran