



COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electrical & Control Engineering

Lecturer : Prof. Amany Hanafy

Course : Power System Protection (1)

Course Code: EE442

Date : 19 / 1 / 2016

Marks: 40

Time: 2 hours

Final Examination Paper

Answer the following questions:

- 1] a) What are the basic objectives of a protection system. (A4) (5 marks)
- b) Explain with neat sketches the theory of operation of a shaded-pole structure electromagnetic relay. (A8) (5 marks)
- 2] a) Is it possible to obtain the zero-sequence current by using a single current transformer? Explain. (B3) (5 marks)
- b) What is the advantage of using an HRC Fuse with a tripping device? (A8) (5 marks)
- 3] a) On an R-X diagram, show if the relay will detect a fault on a transmission line AB having an impedance $Z_{AB}=1.5+j5 \Omega$ if an arcing short circuit with impedance $1+j1.5 \Omega$ occurred at 60% of the line while a 90% of the line is protected by:
- an impedance relay.
 - an MHO relay whose center of characteristics lies on the line impedance vector.
 - a reactance relay. (C5) (5 marks)
- b) For the system shown in Fig.(1), calculate the settings of both TDOC relay and instantaneous relay. Use the relay characteristics attached. (B17) (5 marks)

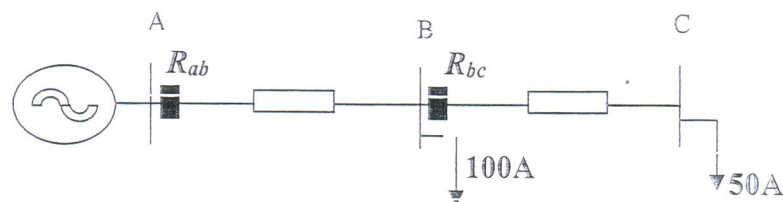


Fig.(1)

Min. fault current	2000A	1500A	500A
Max. fault current	4000A	2000A	1000A

Members of course Examination Committee:	Signature	Date:
Lecturer: Prof. Amany Hanafy	<i>[Signature]</i>	5/1/2016
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4] a) A single phase, 50 MVA, 66 kV / 220 kV transformer is protected via a percentage differential relay whose available secondary taps are: (3, 4.5, 4.8, 4.9, 5, 5.1, 5.2, 5.3). The available differential slopes are: (10%, 20% & 40%). The relay's minimum trip operating current is 0.25 A. If the ULTC introduces error of $\pm 5\%$ and CTs are 10C800, find:

- CT sizing
- Differential slope
- Pick-up current in both primary and secondary sides.

(A4-B3)(5 marks)

b) A 300 hp motor connected to a 4 kV bus has the following bus and motor parameters:




motor full-load current = 65 A

motor locked rotor current = 350 A

motor starting time = 1.5 s.

Select and set the phase overcurrent relay (51) using the time-current characteristic of the relay characteristics attached. The overcurrent relay is set to 125% of motor full load current while the motor service factor is set to 115%.

(A4-B3)(5 marks)

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