



Mansoura University
Faculty of Engineering
Electrical Engineering Dept.

B.Sc. of Electrical Engineering
Three Hours Time allowed
Cutting & Protection Instruments
Saturday 5/1/2013
Part II

Answer the Following Questions

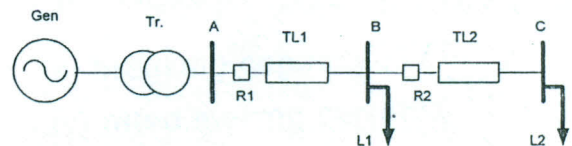
Please Answer This Part from the Left Side of Your Answer Paper

Question # 1 (25 Marks):

- (A) Draw and discuss the operating characteristic of different types of distance relay. (6 Marks)
- (B) Derive the current-time relation for the plunger type electromagnetic relay using the first principles. (6 Marks)
- (C) Draw a possible circuit configuration for a solid-state over-current relay. Sketch the waveforms at each node in the proposed circuit. (5 Marks)
- (D) There is many properties must be considered for power system protection. State three important items and define each of them. (3 Marks)
- (E) Draw a schematic diagram to represent the circulating current AC wire-pilot relaying and state the function of each part of the diagram. (5 Marks)

Question # 2 (30 Marks):

- (A) Derive the torque equation of an induction type two input signals relay, if one flux is generated by $v = 110 \sin(\omega t)$ through N_v turns which has an impedance of $2+j60$ ohms. The other relay signal is generated by a current $i = 100 \sin(\omega t + 30)$ through N_i turns. (6 Marks)
- (B) Explain the basic operation principles of the two-element current-balance relay. Use a schematic diagram as you can. (5 Marks)
- (C) Explain using sketch diagrams the basic principles of differential protection. (5 Marks)
- (D) Consider the power system shown in Fig. The important data are given as follows: Generator (Gen): 1000 MVA, 20 kV, $X_s=100\%$, $X''_d=X_1=10\%$, L1: 200 MW, 20 kV, 0.8 lag PF, L2: 150 MW, 20 kV, 0.9 lag PF. TL1: $X_1=15\%$, - TL2: $X_1=10\%$, on base of 1500 MVA, 500kV. Transformer (Tr): 1000 MVA, 500Y/20D kV, $X=17\%$. Assume the relay R1 is set to pickup for a three-phase fault at bus C. If the pickup setting is equal to one-third of the fault current, what is the pickup setting of this relay? (8 Marks)



- (E) Explain the basic principles of digital relay and state its advantages. (6 Marks)

With My Best Wishes
Dr. Ebrahim A. Badran



UNIVERSITY OF EL-MANSOURA
FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL POWER AND MACHINE ENGINEERING

Bs.c Final EXAMINATION

January 2013

SUBJECT: Switchgear and Protection Devices

TIME:1.5 Hours

Part (1) Switchgear

Question # 1 (15 Marks):

1- Discuss briefly the following:

- a- Current limiting feature of the air break circuit breaker.
- b- Multiple reignition phenomena in Vacuum circuit breaker.
- c- The arc extinction techniques .
- d- The comparison between **Vacuum,SF6 and Air Break Circuit Breaker.**
- e- Substation bus configurations.

Question # 2 (20 Marks):

2-a) Prove that the critical damping switching resistance is equal to = $\frac{1}{2}\sqrt{\frac{L}{C}}$

b) In a short circuit test on a 3 poles 220 KV. circuit breaker the power factor was 0.2, the recovery voltage was 0.96 times the peak value. The frequency oscillations of restriking voltage was 30 KHz. Assuming a symmetrical breaking current, and estimate the rate of restriking voltage for the following cases;

- i- The neutral is grounded and the fault involves ground;
- ii- The neutral is grounded and the fault does not involve ground;

c) With the help of neat sketches Describe arc quenching process in the **SF₆ Thermal Blast Chamber type circuit-breaker.**

Question # 3 (20 Marks):

3- A circuit breaker is rated as 1500 A , 1000 MVA , 33 KV , 3- seconds , three-phase SF6 circuit breaker . Find;

- | | |
|---|-----------------------------|
| i) the rated normal current . | ii) breaking capacity , |
| iii) rated symmetrical breaking current , | iv) rated making current , |
| v) short time rating , | vi) rated service voltage . |

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