UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

Department of Electrical and Electronic Engineering

MAIN EXAMINATION 2015

Title of the Paper:

Power Systems--EE452

Instructions:

1. The answer has to be written in the space provided in the question book. Consider only the material in the answer space be the answer. If need more space, the previous page is the best option. Use the answer book as a scratch pad. Both books must be marked with the student identity
2. There are 8 questions in the question book. Pick 5 as instructed above the question.
3. Time Allowed: Three Hours.
4. This paper has 8 pages, including this page.

DO NOT OPEN THE PAPER UNTIL
PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR.

Q1, 20pts: compulsory

Draw, on one line diagram, an electrical power service system of an overhead primary loop distribution, which must include and mark the equipments: breakers, step-down transformers, bus, transmission lines, and proper protection instruments.

Q2, 20pts: compulsory

A Δ-Y connected 3-Φ transformer is loaded with an unbalanced 3-Φ resistive load, R_A=381, R_B=76.5, R_C=190.5 Ω. Both center of Y and load are grounded. The transformer is ideal, 1 to 1 ratio, and the primary of it receives a balanced ideal power source, 220V. The circuit of the power system is shown in Fig. Q2-1. Find the primary currents and the power flowing into the load side of each phase.

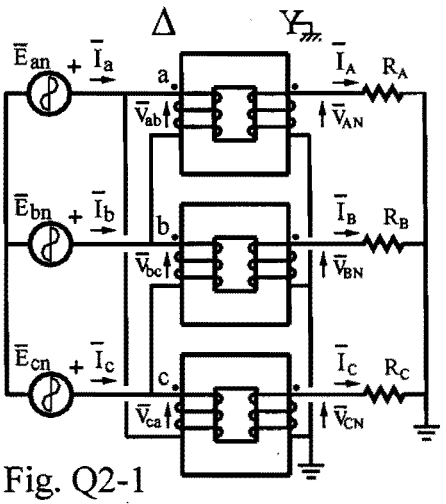


Fig. Q2-1

Optional to choose one of Q3 and Q4

Q3, 20pts: A power service system shown in the Fig. Q3-1. The specs of its equipments are given below:

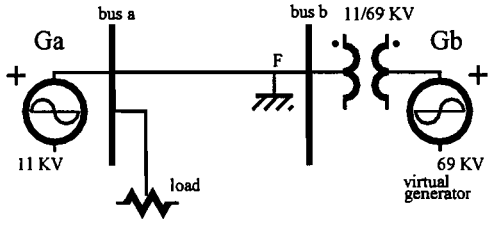


Fig. Q3-1

Generator A: 11 KV, 100 MVA, x_A"=0.12 pu

Generator B: Thevenin's equivalent to 69 KV, 20 MVA, x_B"=0.08 pu

Transformer: 11/69 KV, 75 MVA x_T=0.1 pu

Feeder Transmission line: 11 KV, 0.5 Ω

Fault at "F" spot, calculate the steady short circuit current.

Q4, 20pts: Find the steady fault current Φa and the 3-Φ voltages due to an La-G fault at a point F at the end of the transmission line of the power system shown in Fig. Q4-1. The reactances in pu of the equipments are marked on the diagram.

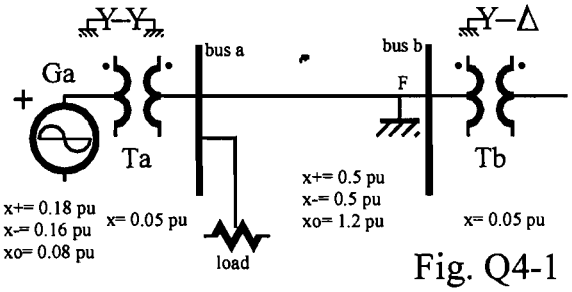


Fig. Q4-1

Optional to choose one of Q5 and Q6

Q5, 20pts: (i). Compute the inductance and the capacitance per phase per KM of a transposed 3-Φ line which has a bundling arrangement of 2 sub-conductors per phase as shown in Fig. Q5-1. Assume that the two sub-conductors in each phase carry equal current.

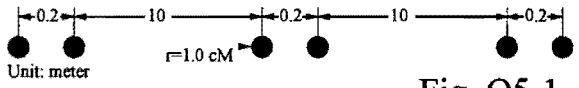


Fig. Q5-1

Q6, 20pts: From the transmission line constants, l/m and c/m, find (i). the line constants, γ and Z_c, (ii). accurate (long line) π-equivalent circuit constants (all in symbolic answer) and draw the equivalent circuit of the line.

Optional to choose one of Q7 and Q8

Q7, 20pts: Fig. Q7-1 shows an 11 KV (line-neu), 50Hz, radial system, together with its circuit constants. Assume using a CO-7 relay, with its characteristics given in Fig. Q7-2. Select relay settings to protect the system.

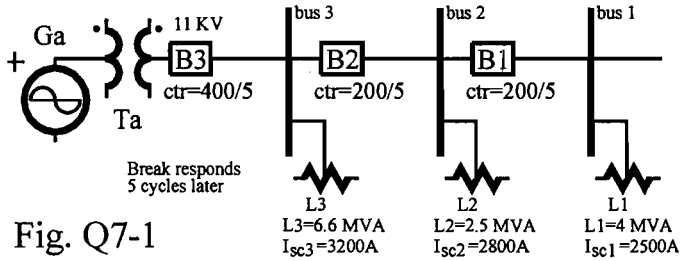


Fig. Q7-1

Q8, 20pts: A simplified power protection system, 34.5 KV, 40 MVA load shown in Fig. Q8-1 consists of a recloser and fuses. These equipments are to manage short time and long time faults and to minimize power service interruption time. (i). Describe the recloser operating process, general action and delay time must be cited, (ii). With the given power fuse time characteristics in Fig. Q8-2, draw on the figure the recloser time characteristics to reach the objectives in the second sentence. Recloser action time and fuse time must be coordinated in scale proportion for a fault current 500-1000 A.

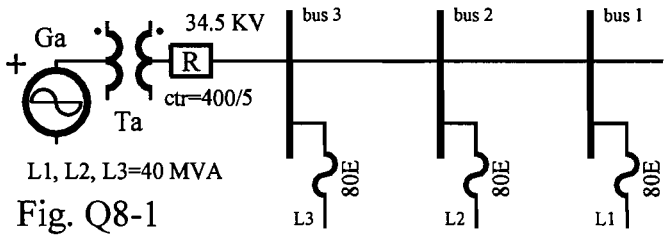
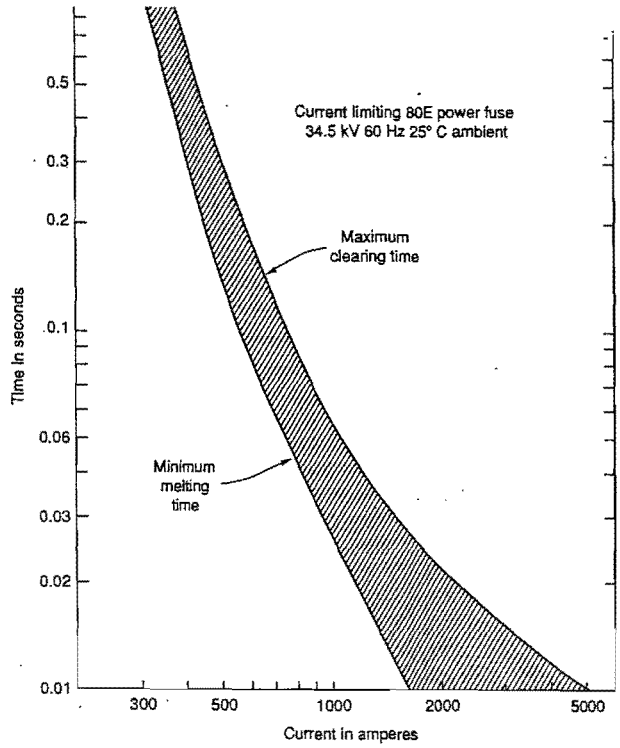
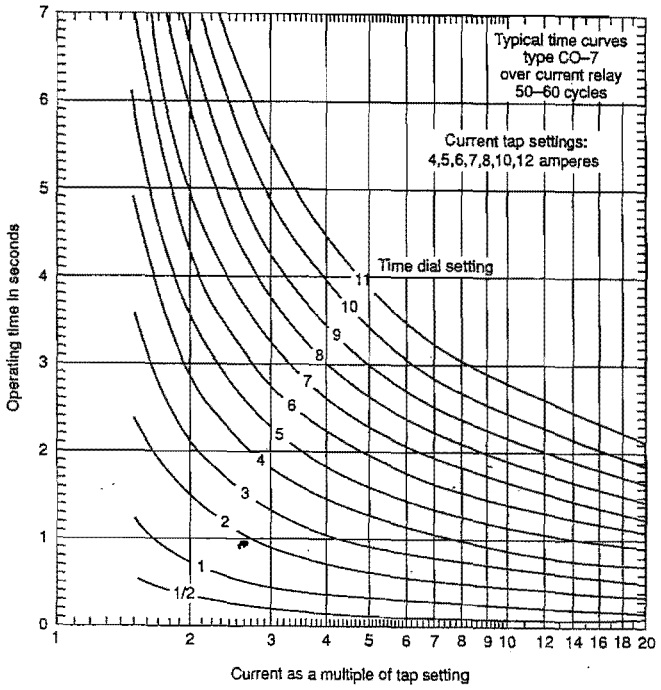


Fig. Q8-1


Current limiting 80E power fuse
34.5 kV 60 Hz 25° C ambient
Maximum clearing time
Minimum melting time
Time in seconds
0.5
0.3
0.2
0.1
0.06
0.03
0.02
0.01
300
500
1000
2000
5000
Current in amperes


Typical time curves
type CO–7
over current relay
50–60 cycles
Current tap settings:
4,5,6,7,8,10,12 amperes
Time dial setting
11
10
9
8
7
6
5
4
3
2
1
1/2
Operating time in seconds
0
1
2
3
4
5
6
7
1
2
3
4
5
6
7
8
9
10
12
14
16
18
20
Current as a multiple of tap setting