Power system Protection Lab

Complex Engineering Problem

Problem Statement:

A seven-bus system in Texas is shown in figure below, as different faults occur in this area a appropriate protection system designing is major concern. As a design engineer the main task is to select appropriate relays and breakers for this area that avoid the system to complete shutdown and maintain the proper power flow in some area when fault occurs.

1. For a single line diagram shown below, the generation, transformation, transmission and utilization data is given. Simulate the entire system on MATLAB/Simulink in steady state. Represent the values for phase voltages and line currents for each line in tabular form. Calculate the Real Power flowing in each line using Simulink Libraries and represent them in tabular form.

2. Design the protection scheme for the entire system using Definite Time Over Current Relays, Definite Time Over/Under Voltage Relays and Differential Protection Relays, where applicable, for the circuit breakers shown in the diagram. Represent the pick-up values for each DTOC, DTOV/DTUV, Distance relay based on the results obtained in Part 1. All the relays must wait for 4 cycles before tripping a circuit breaker to ignore the transients due to frequent load switching. Also represent primary and secondary protection schemes for same lines and delay for secondary lines.

3. Simulate a Single Line to Ground fault on L3 at 0.2 second. Which relay has to operate first? Identify the breakers for primary and secondary protection. Submit the current waveforms for L3 for 1 complete second. Represent the Real Power flows for the entire system after 1 second in tabular form.

4. Simulate an overvoltage three phase fault on L4 at 0.3 second. Which relay has to operate? Identify the breakers for primary and secondary protection. Submit the voltage waveforms for L4 for 1 complete second. Represent the Real Power flows for the entire system after 1 second in tabular form.

5. Simulate a Single Line to Ground fault on L3 at 0.2 second. Which relay has to operate first? Identify the breakers for primary and secondary protection. Submit the current waveforms for L3 for 1 complete second. Represent the Real Power flows for the entire system after 1 second in tabular form and distance relay used for this line by primary and secondary protection.

WP1 Depth of knowledge (WK3 - Engineering Fundamentals, WK5 - Engineering Design, WK6-Engineering Practice, WK8 - Research Literature)

The selection and designing of relays relate to knowledge of all different types of relays working, basic principles, implementation in MATLAB and suitability to which bus it should be implemented.

WP3 Depth of Analysis:

Based on analysis of 7 bus system and different parameters (voltage, current, active and reactive power) the set point and delays time in different relays (Primary and secondary) must be appropriates.
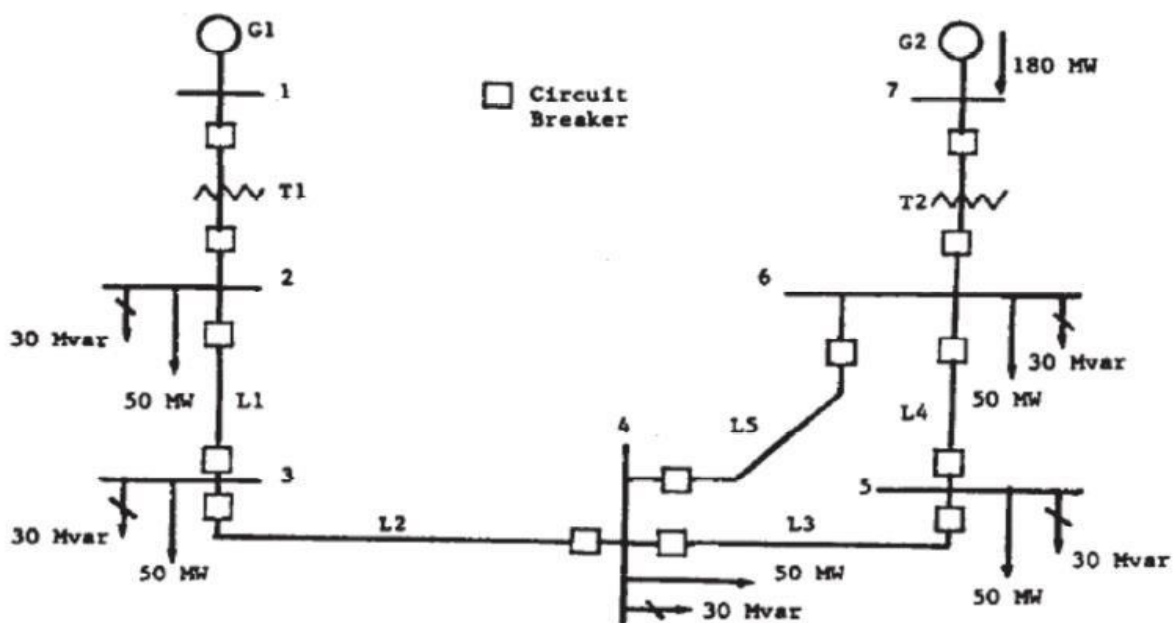
Generation Data:

G1: 100 MVA, 13.8 kV
G2: 200 MVA, 15.0 kV

The generator neutrals are solidly grounded

Transformation Data:

T1: 100 MVA, 13.8 kV/230 kV delta/star, x = 0.1 per unit T2:
200 MVA, 15 kV/230 kV delta/star, x = 0.1 per unit

The transformer neutrals are solidly grounded.

Transmission Data:

All Lines: 230 kV, z = 0.08 + j0.5 ohms/km

Maximum MVA = 400
Line Lengths: L1 = 15 km, L2 = 30 km, L3 = 40 km, L4 = 15 km, L5 = 50 km

Utilization Data:

Real and Reactive Loads are mentioned on single line diagram

CLO4	Demonstrate the operation and coordination of relaying schemes by using modern simulation tools	**Psychomotor**	**Level 3 Precision**	PLO5 Modern Tool Usage

Rubrics of CEP

Performance	Meets Expectations (0.9-1.0)	Average (0.5-0.8)	Does not meet Expectations (0.0-0.4)	Marks
Simulation of techniques [4] CLO2	Selects relevant tools in simulation to solve the problem, appropriate selection of relays set points and accurate delays values.	Selects relevant tools in simulation to solve the problem, appropriate selection of relays up to some extent with with minor error.	Have no idea about appropriate tools for solving problem and no idea of relays settings.	
Report of CEP [3] CLO2	Submit the CEP Report (Including Literature Review, procedure, and observations/graphs) on due time	Submit the CEP report (Including Literature Review, procedure, and observations/graphs) manual less accurate and not having information.	Submit the CEP report (Including Literature Review, procedure, and observations/graphs) manual less accurate and after due date.	
Selection of Relay Types [3] CLO2	Selects the appropriate Relay for protection of lines and equipment.	Selects the Relay for protection of lines and equipment that is suitable upto some extent.	Selects the Relay for protection of lines and equipment that is not suitable for such system.	
[10]				Total= [10]