Sample: Topics in Power Electronics and Distributed Generation – Test 1 **Points 20**

Open book test. Make reasonable assumptions where necessary. No clarifications to questions will be provided during the test. Spend some time thinking about the questions before you start answering. Write the answers clearly and legibly so that they can be graded.

A *TT* secondary distribution network is shown in the Fig. 1. The $11kV/415V$ step down transformer is rated at $100kVA$ and has leakage reactance of 4%. Loads L_1 and L_2 are rated $10kW$ each and have independent grounding terminals. A $20kVA$ DG is connected at L_2 and its neutral is solidly connected to ground. The DG has a leakage reactance of 10%. All earthing electrodes have a ground resistance of 5Ω.

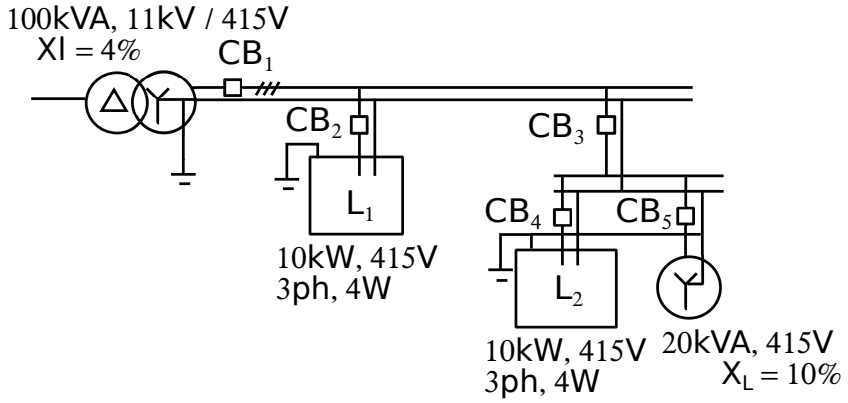

Figure 1: TT Secondary distribution network.

1. What is the rated and fault current levels for CB_1 and CB_2. *(2 points)*

2. What is the i^2t protection requirement for load L_1 if its wiring uses $2.5mm$ diameter copper. Copper and wire data are as follows: resistivity = $1.68 \times 10^{-8}\Omega m$, density = $8.96g/cm^3$, specific heat capacity = $0.386J/gmK$. The operating temperature of the wire is at 45^oC and the maximum temperature before wire damage is 225^oC. *(2 points)*

3. What are the fault currents due to a single line to ground (SLG) fault at L_1 with and without the DG? *(2 points)*

4. The parameters for CB_2 are: $I_{pickup} = 20A$, $B = 60ms$, $p = 2$ and the desired I^2t protection level is $0.75MA^2s$. What can be the maximum value of A if the maximum expected fault current through CB_2 is $3.5kA$? *(1 point)*

5. If the value of A in CB_2 is $35s$ with the remaining CB_2 parameters as in (4) above, what are the trip times of the breaker for SLG faults with and without the DG. *(2 points)*

6. If there is a SLG fault at L_1 with the DG energized, what are the touch potentials at loads L_1 and L_2? *(2 points)*

7. If CB_1 opens after the solid SLG fault in L_1 and with the DG energized, what are the line to ground voltage magnitude seen on the three phases? *(3 points)*

8. The number of secondary turns is 24 in the $Delta - Wye$ step down transformer in Fig. 11. What is the required number of primary turns? *(1 point)*

9. For the $Delta - Wye$ step down transformer shown in Fig. 1, what are the currents in the three high voltage primary $Delta$ windings, when there is an SLG fault with no DG on the secondary distribution network? *(2 points)*

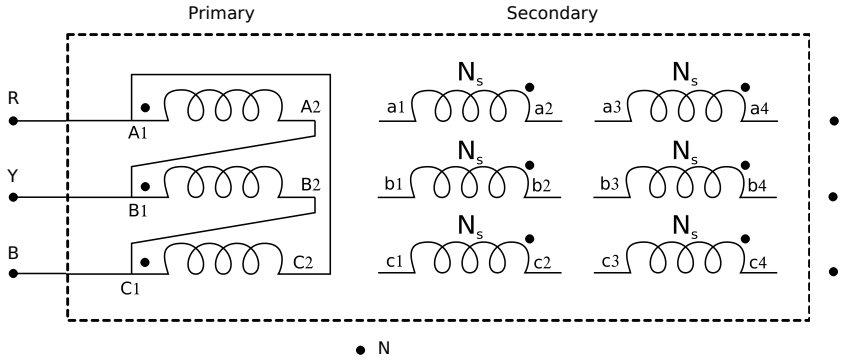

Figure 2: Delta zig-zag distribution transformer.

10. The $Delta - Wye$ transformer is replaced by a $Deltazig - zag$ transformer as shown in Fig. 2. What is the minimum required turns for the secondary keeping the primary turns the same as in (8) above. Sketch the necessary winding connections required on the secondary side so that it can be used in place of the transformer in Fig. 1. *(3 points)*
