

## EE.EES.440 DISTRIBUTION AUTOMATION

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An electronic calculator may be used provided that it does not have a facility for either textual storage or display, or for graphical display.

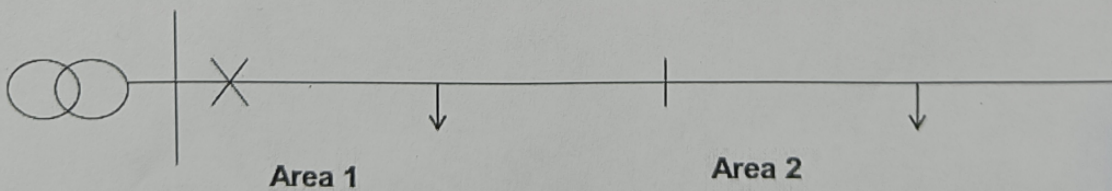
Q1 Provide a brief explanation for the following questions:

- State what does the protection zone mean? What means the overlapping of the protection zones? How the backup protection relates to protection zones?
- State what does the selectivity of the feeder protection mean? What methods can be used for confirming the selectivity in the case when we have radially fed MV feeder and three protection zones downwards from the primary transformer (110/20 kV)?
- List the essential functionalities and communications of modern feeder terminal (IED).
- You should determine the settings for earth fault protection relay of the medium voltage feeder. Express briefly, what factors determine the settings for fault current and time delay and where these factors come from?
- Describe shortly a principal functioning principle of distance relay and measurements needed for it.
- How is an earth fault current compensation normally implemented in large rural cable or mixed medium voltage network?

Q2 Describe a typical substation automation system used for medium voltage network monitoring. Typical means how these systems are implemented today in practice. Include for the description measurement devices, communication protocols and devices, and IT systems.

Q3 One of the most important functionality in Distribution Management System (DMS) is the fault management. Describe the different functionalities of DMS related to the fault management, e.g. which information they need and where the information in question is coming from, and how these functionalities benefit the process of fault management. Focus on overall view instead of details.

Q4 Calculate SAIDI of following case (see attached figure). Fault rate is 2 faults/100 km, a. Switching time of a switch is 1 h and repair time is 3 h. The length of Area 1 is 10 km and Area 2 is 20 km. The number of customers are 3000 (Area 1) and 1000 (Area 2).



Q5 Reactive power management of medium voltage cable networks is becoming important design and control aspect of rural distribution networks. Explain why cable networks differ from overhead networks traditionally used in rural areas? Describe and explain possible reactive power compensation methods to be used for reactive power management.

Q6 Describe how Distribution Management System (DMS) maintains the real-time model of distribution network. Explain where the necessary information is coming from and why the updated and accurate information is important for network management.