Ex/PG/EE/T/1210D/2024

M. E. POWER ENGINEERING EXAMINATION, 2024

(1st Year, 2nd Semester)

CONDITION MONITORING OF HIGH VOLTAGE EQUIPMENT

Time: Three Hours | Full Marks: 100

Answer ***any six*** questions

Four Marks *are reserved for neat and well organized answers*

1. a) Why is condition monitoring of high voltage equipment necessary? 4

   b) How can condition monitoring improve asset reliability and productivity? 4

   c) What are the benefits of condition monitoring? 5

   d) Explain why adopting a modern condition monitoring system in a station can take a long time. 3

2. a) Describe surface resistivity of an insulating material with an experimental setup. 4

   b) Define dielectric dissipation factor (DDF). Show the series and parallel equivalent circuit of a lossy dielectric and derive the DDF vs. frequency curves. Explain why the curve differs from real-life dielectrics. 12

3. a) A package containing a 100-meter reel of high-voltage single-core cable is available for sale. The supplier provides a sample length of 5 meters for quality testing. For the sample, the experimental results in the laboratory show that the overall insulation resistance is 7 GΩ at 25°C. The dielectric of the cable exhibits a characteristic such that a temperature increase of 10°C is needed to halve its insulation resistance from the value at 25°C. On the other hand, the overall insulation resistance of the packaged cable is found to be 67.5 MΩ at 45°C. Analyze the quality of the high-voltage cable reel based on the given experimental data. 12

   b) Discuss the temperature limits for different insulating materials in high-voltage equipment. 4

4. a) What are the objectives of performing DGA in a transformer? 4

   b) Justify or correct: "Duval's Triangle is an excellent technique for diagnosing internal faults in power transformers." 12

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5. a) Explain the concept of polarization and depolarization current (PDC) measurement in oil-paper insulation. 5

   b) Describe how PDC measurement is performed on oil-filled transformers with drawings. 6

   c) How is insulation aging reflected in PDC measurements? 5

6. a) Explain the basic theory of Frequency Domain Spectroscopy (FDS). 5

   b) Describe the setup for FDS measurement with a drawing. 5

   c) How are the effects of (i) moisture and (ii) insulation aging reflected in FDS measurements? 6

7. a) Introduce condition monitoring of high voltage equipment, emphasizing benefits, testing, and diagnostics. 4

   b) Provide examples of condition monitoring for switchgears, cables, and transformers. 8

   c) What are the primary causes of failure in distribution equipment? How can this information be beneficial? 4

8. a) Explain (i) electronic, (ii) ionic, (iii) dipolar, and (iv) interfacial polarization in dielectrics. 12

   b) Show the variation of polarization with frequency for a material exhibiting all types of polarization mechanisms. 4

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