

Time: 3 hrs

Marks:80

**Instructions:**

- Question No: 1 is compulsory.
- Answer any three from the remaining six questions.
- Figures to the right indicate full marks.
- Answers to questions should be grouped and written together.

- Solve any four
- Q1** a) What are the impacts of low power factor in an HVDC system? **05**  
 b) What are the causes of overlap in a converter and evaluate the angle at which inversion starts for a converter with overlap angle less than  $60^\circ$ ? **05**  
 c) Prove that ratio of DC power to AC power in DC and AC transmission respectively is 1.5 if power factor of AC is 0.945 **05**  
 d) What are the causes and effect of arc back **05**  
 e) What are the features of HVDC Transmission for Offshore Wind Farms? **05**
- Q2** a) Illustrate with neat diagram the classification of HVDC links. And give one application for each links. **10**  
 b) Illustrate with neat diagram the major components of HVDC system. **10**
- Q3** a) Develop the equivalent circuit of HVDC rectifier and draw the output voltage waveform. **10**  
 b) "Converter consumes reactive power" Justify the statement. Draw all supporting voltage and current waveforms and phasor diagrams. **05**  
 c) A three phase rectifier fed from a transformer with nominal voltage rating of 220 kV/110 kV. If the primary voltage is 230 kV and effective turns ratio T is 0.48, estimate the effective commutating reactance, power factor and reactive power at the primary side of the transformer. Direct current is 2000 A, ignition delay angle  $\alpha$  is  $20^\circ$  and commutation overlap angle  $\mu$  is  $18^\circ$  **05**
- Q4** a) Develop the control characteristics of HVDC system under normal and abnormal conditions. **10**  
 b) Develop the control characteristics of HVDC system for power reversal. **10**
- Q5** a) Illustrate the equidistant pulse generation schemes used in HVDC system. What are the advantages and disadvantages? **06**  
 b) Justify with appropriate reason why there is a minimum and maximum current limit in HVDC control scheme. **04**  
 c) Illustrate with neat voltage and current waveforms the single commutation failure. **10**
- Q5** a) Which device is being used to isolate the rectifier in an HVDC system affected by a valve fault? Show with neat waveform how the current transfer occurs from faulty rectifier to the device and inverter to the device **10**  
 b) What are the causes of over currents in HVDC and illustrate how the system is protected? **10**
- Q6** a) Illustrate the causes and effect of harmonics in HVDC system **10**  
 b) Illustrate various methods adopted in AC side and DC side to reduce harmonics in HVDC system **10**

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