Time: 3 Hours **Marks: 80**

Instructions:

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

Q1	**a)**	Illustrate with neat diagram the mono polar and bipolar links of HVDC system. What are the main features of these links?	**20**
	b)	Illustrate the causes of over voltages in HVDC system and over voltage protection method used in HVDC system?	
	c)	Show that the expression for the power factor of an HVDC converter with grid control and overlap angle less than 60° is $\frac{1}{2}(cos \propto + \cos(\propto + \mu))$	
	d)	Illustrate with block diagram the operation of HVDC Transmission for Offshore Wind Farms?	
Q2	**a)**	Illustrate the relative merits of AC and DC mode of transmission based on economics of transmission and power flow through a conductor	**10**
	b)	Derive the equivalent circuit of three phase rectifier with grid control and overlap angle less than 60°.	**10**
Q3	**a)**	Illustrate the control characteristics of HVDC and explain how power reversal is possible in HVDC.	**10**
	b)	Illustrate with neat diagram the equidistant pulse generation schemes used in HVDC system control method and mention its advantages and disadvantages?	**10**
Q4	**a)**	What are the causes and effects of harmonics in HVDC system? How harmonics is classified?	**10**
	b)	Explain the transfer of current to bypass valve in rectifier operation.	**10**
Q5	**a)**	Describe with neat diagrams single commutation failure of converters.	**10**
	b)	Calculate the secondary line voltage, active power, power factor and reactive power of the transformer for a three phase bridge rectifier to provide a DC voltage of 120 kV. Assume α= 30°, μ =15°. What is the effective reactance XL, if the rectifier gives 800 A of DC output current	**10**
Q6	**a)**	What are the features of ground return used in HVDC systems?	**10**
	b)	With neat diagram explain components of HVDC system.	**10**

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