GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2022
HVDC TRANSMISSION SYSTEM
EE704C

TIME ALLOTTED: 3Hours **FULL MARKS:70**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP – A
(Multiple Choice Type Questions)

Answer any *ten* from the following, choosing the correct alternative of each question: **10×1=10**

		Marks	CO No
1. (i)	Which type of HVDC scheme uses only one conductor? a. Monopolar b. Homopolar c. Bipolar d. Back to Back link	1	CO1
(ii)	Which of the following HVDC scheme is much better as far as the cost of cable is the concern? a. Bipolar b. Monopolar c. Homopolar d. Back to Back link	1	CO1
(iii)	The relation between V_{do} and peak value of phase voltage on the secondary side of AC system is, V_{do}= a. a) $\frac{3}{\pi}V_m$ b. $\frac{3\sqrt{3}}{\pi}V_m$ c. $\frac{\pi}{3}V_m$ d. $\frac{\pi}{3\sqrt{3}}V_m$	1	CO1
(iv)	Fault on a two terminal DC link is removed by a. Breakers on DC side b. Breakers on AC side c. Current control of converters d. None of the above	1	CO1
(v)	In HVDC system what would be sequence of the parameter conversion from sending end side to receiving end side? a. dc-dc-ac-dc b. ac-dc-dc-ac c. ac-ac-dc-ac d. dc-ac-dc-ac	1	CO1

(vi)	HVDC Systems are mainly used with large power rating for a. interconnection of two systems with different frequencies b. Bulk power transmission over long distances c. Underwater or submarine cable transmission d. For connecting the non-conventional power sources like wind power etc to the grid.	1	CO2
(vii)	An HVDC link consists of rectifier, inverter transmission line and other equipment's. Which one of the following is true for this link? a. The transmission line produces/supplies reactive power b. The rectifier consumes reactive power and the inverter supplies reactive power from/to the respective connected consumers c. Rectifier supplies reactor power and the inverter consumes reactive power to/from the respective connected AC System d. Both the converters (Inverter and rectifier) consume reactive power from the respective connected AC System	1	CO5
(viii)	Which is the lowest order harmonic present in the source current of 12 pulse converter? a. 5^{th} order b. 7^{th} order c. 11^{th} order d. 13^{th} order	1	CO3
(ix)	When continuous ground currents are inevitable then ____________ system is preferable. a. Monopolar b. Homopolar c. Bipolar d. Back to back	1	CO4
(x)	Fault on a two terminal DC link is removed by a. Breakers on DC side b. Breakers on AC side c. Current control of converters d. None of the above	1	CO2
	The main objective of the smoothing reactor a. To reduce the risk of commutation failure b. Prevent the resonance in the DC circuit c. To smooth the ripple current in DC d. All of these	1	CO2
(xii)	An HVDC link consists of rectifier, inverter transmission line and other equipment's. Which one of the following is true for this link? a. The transmission line produces/supplies reactive power b. The rectifier consumes reactive power and the inverter supplies reactive power from/to the respective connected consumers c. Rectifier supplies reactor power and the inverter consumes reactive power to/from the respective connected AC System d. Both the converters (Inverter and rectifier) consume reactive power from the respective connected AC System	1	CO2

GROUP – B
(Short Answer Type Questions)

(Answer any *three* of the following) **3 x 5 = 15**

		Marks	CO No
2. a)	Prove that less amount of copper is required in HVDC system for transmission of same amount of power as in 3ph ac system at unity power factor.	3	CO1
b)	"There is no stability problem in HVDC system". Explain.	2	CO1
3.	A transformer secondary line voltage to a three phase bridge rectifier is 345 kV. Calculate the dc voltage output with μ=15° when α= (a) 0° and (b) 15°	5	CO2
4.	Discuss the various faults exist in converter station? Explain	5	CO1
5.	Explain in detail, the concept of reactive power requirement in HVDC converters.	5	CO3
6.	How to reduce the harmonics by using an AC filter?	5	CO4

GROUP – C
(Long Answer Type Questions)

(Answer any *three* of the following) **3 x 15 = 45**

		Marks	CO No
7.	Give a comparison between HVDC and EHVAC system based on economics, technical performance and reliability when bulk power is transmitted over a long distance.	15	CO2
8. a)	Explain the Graetz bridge circuit. Derive the expression for average DC output voltage of converter without overlap.	7	CO2
b)	Derive expression for average direct voltage of a six pulse converter with a delay angle of 'α' and overlap angle of less than 60°.	8	CO3
9. a)	Discuss the list of dominant harmonics present in the various types of HVDC converters.	7	CO3
b)	Discuss series-parallel multi-terminal HVDC system and its control.	8	CO1
10. a)	Calculate the necessary secondary line voltage of the transformer of a 3phase bridge rectifier to provide a DC voltage of 120 kV. Assume α= 30°, μ= 15°. Calculate the effective resistance Rc and the effective reactance Xc if the rectifier is delivering a DC current of 800 A.	8	CO2
b)	Develop the complete equivalent circuit of an HVDC link and obtain an expression for the currents in DC link as $I_d = \dfrac{(A_r E_r / T_r)\cos\alpha_r - (A_i E_i / T_i)\cos\gamma_i}{R_{cr} + R_d - R_{ci}}$ Symbols carry the usual meaning.	7	CO2
11. a	For a 3 phase, 6 pulse, full wave, full controlled converter bridge explain the operation of the converter. Hence, with necessary circuit diagram and graphs deduce the following: i) Average no-load direct voltage with & without ignition delay α.	5	CO4
b.	RMS value of the fundamental frequency component of the alternating line current.	5	CO4
c.	Mention and define the criteria for designing an AC filter.	5	CO4