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Question Paper Code: BPSB03



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER

M.Tech I Semester End Examinations, January - 2020

(Regulations: R18)

HVDC TRANSMISSION

(ELECTRICAL POWER SYSTEMS)

Time: 3 hours

Max. Marks: 70

Answer ONE Question from each

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

UNIT– I

1. a) With the help of a neat schematic diagram of a typical HVDC converter station explain the functions of various components available. [7M]
 b) What are the different applications of dc transmission system? Explain them in detail? [7M]
2. a) Explain in detail the principle of DC Link control. With a neat sketch explain different types of DC link control [7M]
 b) It is required to eliminate harmonics of order 10 and below 10 others than fundamental in a 12-pulse converter. Suggest a suitable transformer configuration and derive an equation for primary current of transformer. [7M]

UNIT – II

3. a) Derive the expression for input power, output power and power factor of 12-pulse bridge converter with delay angle α . Assume there is no overlap. [7M]
 b) Show the rating of the valve used in gratez circuit is $2.094P_d$ where P_d is dc power transmitted. [7M]
4. a) Derive V-I characteristics of an inverter operating with constant advance angle. Show these characteristics in VI plane [7M]
 b) Discuss analysis of 3-phase (six-pulse)-converter with grid control overlap angle, $u < 60^\circ$. [7M]

UNIT – III

5. a) From fundamentals, deduce the basic equation of control. Also draw the equivalent circuit diagram of HVDC converter used for analyzing control concept [7M]
 b) What are the basic characteristics of converter control? with the aid of V-I characteristics explain the power flow control. [7M]
6. a) Discuss about conventional control strategies for Reactive power control in HVDC link. Enumerate the relative merits and demerits of constant current control and constant voltage control of HVDC link. [7M]
 b) Why the delay angle and extinction angles are to be maintained to minimum value [7M]

UNIT – IV

7. a) Mention different types of converter faults, briefly explain with waveforms about commutation failure. [7M]
b) Compute the maximum dip at the converter bus that will not result in a commutation failure. Assume that the voltage dip occurs at the instant immediately after firing the incoming valve. Consider symmetrical three phase voltage dip. [7M]
8. a) Discuss corona loss in HVDC-link. Also explain V-I characteristics of HVDC-system. [7M]
b) Explain for what reasons as a system planner, you consider the applications of HVDC in India? Explain the protection scheme for over currents in converters. [7M]

UNIT – V

9. a) Explain extended variable method of DC power flow. Explain the sequential method of DC power flow. Draw the necessary flow chart. [7M]
b) Explain unified method of DC power flow. Compare sequential and unified methods of DC power flow. [7M]
10. a) Mention the various sources of harmonic generation in HVDC systems and suggest methods to eliminate them. [7M]
b) What are the filter configurations that are employed for HVDC Converter station? Give design aspect of one such filter. [7M]



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COURSE OBJECTIVES:

The course should enable the students to:

I	Understand state of the art HVDC technology
II	Learn the methods to carry out modeling and analysis of HVDC system frontier- area power flow regulation

COURSE OUTCOMES (COs):

CO 1	Classify AC and DC transmission and understand control characteristics of HVDC system.
CO 2	Explain the working of HVDC converter in rectifier and inverter modes of operation.
CO 3	Understand different control schemes used in HVDC converters
CO 4	Understand the nature of faults happening on both the AC and DC sides of the converters and formulate protection schemes for the same.
CO 5	Develop harmonic models and use the knowledge of circuit theory to develop filters and assess the requirement and type of protection for the filters.

COURSE LEARNING OUTCOMES (CLOs):

BPSB03.01	Illustrate the layout of HVDC converter stations.
BPSB03.02	Understand the difference between HVDC and HVAC transmission.
BPSB03.03	Describe the converter control characteristics of HVDC systems.
BPSB03.04	Analyze single phase and three phase converters and understand its properties.
BPSB03.05	Demonstrate the rectifier configurations of 12 pulse HVDC converter.
BPSB03.06	Understand the working of inverter configuration of HVDC converter.
BPSB03.07	Understand different modes of operation of converters.
BPSB03.08	Analyze the output waveforms for rectifier and inverter circuits.
BPSB03.09	Examine the control schemes for HVDC transmission systems.
BPSB03.10	Analyze the characteristics of HVDC converter with respect to Constant current and Constant voltage.
BPSB03.11	Understand actual and desired characteristics of a converter
BPSB03.12	Understand the concept of power reversal in HVDC converters
BPSB03.13	Illustrate the starting and stopping of converter bridge
BPSB03.14	Analyze various aspects responsible for commutation failure
BPSB03.15	Analyze the adverse effects of HVDC converter on equipment
BPSB03.16	Understand different methods used in protection of HVDC converter
BPSB03.17	Understand controllers for controlling the power flow through a dc link
BPSB03.18	Analyze the Harmonics and use of filters to minimize the harmonics.

BPSB03.19	Understand the importance of smoothening reactors in HVDC converters
BPSB03.20	Analyze the harmonics and basis of protection for HVDC System.

MAPPING OF SEMESTER END EXAMINATION TO COURSE OUTCOMES

SEE Question No		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	BPSB03.01	Illustrate the layout of HVDC converter stations.	CO 1	Remember
	b	BPSB03.02	Understand the difference between HVDC and HVAC transmission	CO 1	Understand
2	a	BPSB03.03	Describe the converter control characteristics of HVDC systems.	CO 1	Remember
	b	BPSB03.03	Describe the converter control characteristics of HVDC systems.	CO 1	Understand
3	a	BPSB03.05	Demonstrate the rectifier configurations of 12 pulse HVDC converter	CO 2	Understand
	b	BPSB03.05	Demonstrate the rectifier configurations of 12 pulse HVDC converter	CO 2	Understand
4	a	BPSB03.08	Analyze the output waveforms for rectifier and inverter circuits	CO 2	Understand
	b	BPSB03.05	Demonstrate the rectifier configurations of 12 pulse HVDC converter	CO 2	Understand
5	a	BPSB03.05	Demonstrate the rectifier configurations of 12 pulse HVDC converter	CO 3	Understand
	b	BPSB03.09	Examine the control schemes for HVDC transmission systems.	CO 3	Understand
6	a	BPSB03.09	Examine the control schemes for HVDC transmission systems.	CO 3	Understand
	b	BPSB03.10	Analyze the characteristics of HVDC converter with respect to Constant current and Constant voltage	CO 3	Understand
7	a	BPSB03.14	Analyze various aspects responsible for commutation failure	CO 4	Understand
	b	BPSB03.15	Analyze the adverse effects of HVDC converter on equipment	CO 4	Understand
8	a	BPSB03.17	Understand controllers for controlling the power flow through a dc link	CO 4	Understand
	b	BPSB03.17	Understand controllers for controlling the power flow through a dc link	CO 4	Understand
9	a	BPSB03.20	Analyze the harmonics and basis of protection for HVDC System.	CO 5	Understand
	b	BPSB03.18	Analyze the Harmonics and use of filters to minimize the harmonics.	CO 5	Remember
10	a	BPSB03.20	Analyze the harmonics and basis of protection for HVDC System.	CO 5	Understand
	b	BPSB03.18	Analyze the Harmonics and use of filters to minimize the harmonics.	CO 5	Understand

Signature of Course Coordinator

HOD, EEE