SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203.

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

VIII SEMESTER

1905808 –High Voltage Direct Current Transmission

Regulation–2019

Academic Year: 2024–25 EVEN

Prepared by

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SUBJECT: 1905808–High Voltage Direct Current Transmission

SEM / YEAR: VIII / IV

UNIT I - INTRODUCTION				
DC Power transmission technology-Comparison of AC and DC transmission system-Application of DC Transmission- Description of DC Transmission-Planning of HVDC transmission-Modern trends in HVDC technology-DC breakers-Operation problems-HVDC based on VSC-Types and applications of MTDC systems.				
PART - A				
Q.No.	**Questions**	**BT Level**	**Competence**	**Course Outcome**
1.	List the different types of power devices for the HVDC Transmission System.	1	**Remember**	**CO1**
2.	List the components of HVDC Transmission system.	1	**Remember**	**CO1**
3.	Summarize the difference between AC and DC Transmission System.	2	**Understand**	**CO1**
4.	Classify the types power losses occurs on thyristor.	3	**Apply**	**CO1**
5.	Compare series and parallel MTDC system.	4	**Analyze**	**CO1**
6.	Point out the any 4-HVDC projects in India.	4	**Analyze**	**CO1**
7.	Define the terms (i) Reliability (ii) Availability of HVDC Transmission System.	1	**Remember**	**CO1**
8.	Sketch the diagram and Discuss about Bipolar DC Link.	2	**Understand**	**CO1**
9.	Define the terms Economic of power transmission for AC and DC.	1	**Remember**	**CO1**
10.	Develop and sketch the diagram for series MTDC System.	6	**Create**	**CO1**
11.	Illustrated how to improve the reliability and performance can be improved or HVDC Transmission System.	3	**Apply**	**CO1**
12.	Draw and explain the block diagram of HVDC Transmission Systems,	5	**Evaluate**	**CO1**
13.	Define the terms stability limit of DC and AC Transmission with suitable sketch.	1	**Remember**	**CO1**
14.	List the applications of MTDC Systems.	1	**Remember**	**CO1**
15.	List out the two merits of AC and DC Transmission.	2	**Understand**	**CO1**
16.	What are the operating problems on HVDC Transmission System?	1	**Remember**	**CO1**
17.	List any two applications of DC Transmission.	2	**Understand**	**CO1**
18.	Distinguish between AC and DC Transmission.	2	**Understand**	**CO1**
19.	Classify the different types of DC Links.	3	**Evaluate**	**CO1**
20.	Justify the applications and need of DC Transmission.	6	**Create**	**CO1**

21.	Define Voltage Source Converter (VSC) in HVDC systems.	1	**Remember**	**CO1**
22.	List the different types of DC links used in HVDC transmission.	1	**Remember**	**CO1**
23.	Tell the purpose of DC breakers in HVDC transmission systems.	2	**Understand**	**CO1**
24.	Summarize the modern trends in HVDC technology.	2	**Understand**	**CO1**
	PART – B			
1.	Explain the comparison of AC and DC Transmission System with suitable tabulation. (13)	4	**Analyze**	**CO1**
2.	Describe the applications of DC Transmission System. (13)	1	**Remember**	**CO1**
3.	Analyze the components of HVDC Transmission System. (13)	4	**Analyze**	**CO1**
4.	Examine the choice of voltage level for the planning of HVDC Transmission. (13)	6	**Create**	**CO1**
5.	Analyze the modern trends in HVDC Technology. (13)	4	**Analyze**	**CO1**
6.	Describe the following terms (i) Filters (ii) Circuit Breakers (iii) Reactive Power Source (iv) Smoothing Reactors. (13)	2	**Understand**	**CO1**
7.	With a neat diagram explain the HVDC Transmission based on Voltage Source Converters. (13)	1	**Remember**	**CO1**
8.	Discuss the advantages and disadvantages of HVDC transmission. (13)	1	**Remember**	**CO1**
9.	Discuss the following types of MTDC Systems (i) Series MTDC Systems (ii) Parallel MTDC Systems. (13)	3	**Apply**	**CO1**
10.	Explain the different types and applications of MTDC systems. (13)	2	**Understand**	**CO1**
11.	Describe the following operational problems in HVDC Transmission Systems (i) Converter Transformer (ii) Flashover performance of HVDC Converter Stations Insulators (iii) Valve Hall Fires (iv) Problems of Ground Return. (13)	1	**Remember**	**CO1**
12.	Mention the applications of High Voltage DC Transmission and also mention the advantages and disadvantages of it. (13)	2	**Understand**	**CO1**
13.	Discuss in the following the following terms (i) Power semiconductors and valves (ii) Converter Control (iii) Dc Circuit Breakers (iv) Active DC Filter (v) Capacitor Commutated Converters (vi) Ultra High Voltage DC Transmission. (13)	3	**Apply**	**CO1**
14.	How the High Voltage AC Transmission system is distinguished with High Voltage DC Transmission system. (13)	5	**Evaluate**	**CO1**
15.	Illustrate the layout of an MTDC system and explain how it can interconnect multiple grids. (13)	3	**Apply**	**CO1**
16.	Analyze the operational challenges faced by HVDC systems in harsh environmental conditions. (13)	4	**Analyze**	**CO1**
17.	Differentiate between Capacitor Commutated Converters (CCC) and Voltage Source Converters (VSC) in HVDC technology and assess their applications. (13)	4	**Analyze**	**CO1**
	PART – C			

1.	Explain the following types of HVDC Transmission (i) Monopolar links (ii) Bipolar Links (iii) Homopolar Links (iv) Back to Back Links (v) Multi terminal Links. (15)	**2**	**Understand**	**CO1**
2.	With a neat diagram explain the components of HVDC Converter station. (15)	**3**	**Apply**	**CO1**
3.	Analyse the performance of AC and DC Transmission which depends on the (i) Economic of Power Transmission (ii) Technical performance-Stability and voltage control. (15)	**4**	**Analyze**	**CO1**
4.	Explain the following types of High Voltage Transmission System (i) AC Transmission System (ii) DC Transmission System. (15)	**2**	**Understand**	**CO1**
5.	Assess the role of modern trends in HVDC technology in improving grid stability and interconnection between asynchronous power systems. (15)	**5**	**Evaluate**	**CO1**

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UNIT II-ANALYSIS OF HVDC CONVERTERS

Line commutated converter-Analysis of Graetz circuit with and without overlap-Pulse number-Choice of converter configuration-Converter bridge characteristics-Analysis of a 12 pulse converters-Analysis of VSC topologies and firing schemes.

PART – A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	Express the terms (i) Firing angle (ii) Pulse number of Counters.	2	**Understand**	**CO2**
2.	Illustrate the symbolic representation of HVDC Converters.	3	**Apply**	**CO2**
3.	Define the terms overlap and overlap angle in converters for HVDC Transmission.	1	**Understand**	**CO2**
4.	Mention some converters used in HVDC Systems.	1	**Remember**	**CO2**
5.	Mention the various mode of operation of rectifier characteristics.	1	**Remember**	**CO2**
6.	Differentiate the terms (i) Rectifier (ii) Inverter in converter characteristic of HVDC System in their mode and range.	2	**Understand**	**CO2**
7.	Draw the thyristor voltage wave form for inversion for 6-pulse converter.	2	**Understand**	**CO2**
8.	Analyze the concept of (i) Peak Inverse Voltage (ii) Utilization factor of HVDC Converters.	4	**Analyze**	**CO2**
9.	Mention the merits of 12 or multibridge converters.	1	**Remember**	**CO2**
10.	Define the need of snubber circuits in HVDC Transmission systems.	1	**Remember**	**CO2**
11.	Difference the terms (i) HVDC Converters (ii)Line Commutated Converters	2	**Understand**	**CO2**
12.	Justify for which applications series and parallel operations of thyristors are used in HVDC Transmission.	6	**Create**	**CO2**
13.	Explain the term valve rating in converters.	5	**Evaluate**	**CO2**
14.	Draw and Compare the Graetz circuit analysis by with and without overlap.	4	**Analyze**	**CO2**
15.	Illustrate the equivalent circuit of rectifier for HVDC System.	3	**Apply**	**CO2**
16.	Mention the assumption need to consider for the analysis of 6-pulse converter.	2	**Understand**	**CO2**
17.	Define and Draw the circuit for Two and Three valve conduction.	1	**Remember**	**CO2**
18.	Illustrate the circuit diagram for 12-Pulse Converter for HVDC System.	3	**Apply**	**CO2**
19.	Illustrate the star/delta transformer for AC Current Harmonic circuits and equation for 12-pulse converter.	3	**Apply**	**CO2**
20.	Justify the formulae for average direct voltage expression for Graetz circuits.	6	**Create**	**CO2**
21.	Define a Line Commutated Converter (LCC).	1	**Remember**	**CO2**

22.	What is the significance of the pulse number in a converter?	1	**Remember**	**CO2**
23.	How does a Line Commutated Converter (LCC) work?	2	**Understand**	**CO2**
24.	What happens when there is overlap in a Graetz circuit?	2	**Understand**	**CO2**
	PART – B			
1.	Illustrate the schematic diagram of 3-phase bridge rectifier and explain its principle of operation without overlap. (13)	3	**Apply**	**CO2**
2.	What are the three models of six pulse Graetz converter ? Explain the complete analysis of model operation of converter for overlap angle less than 60 degree. (13)	1	**Remember**	**CO2**
3.	Discuss the combine characteristics for the Rectifier and Inverter. (13)	2	**Understand**	**CO2**
4.	Describe the six pulse converter bridge characteristics as rectifier and explain the different mode of operation of a 12-pulse converter for rectification. (13)	2	**Understand**	**CO2**
5.	Elaborate the 3 and 4-valve mode of conduction using the Graez circuit. (13)	1	**Remember**	**CO2**
6.	Explain the analysis of 2 & 3 valve conduction mode using Graez circuit. (13)	1	**Remember**	**CO2**
7.	Explain the various modes of operation of rectifier characteristics. (13)	**4**	**Analyze**	**CO2**
8.	Explain the analysis of 12-pulse converter for the Bridge type Rectifier. (13)	4	**Analyze**	**CO2**
9.	Explain the analysis of the 12-pulse converter with Bridge rectifier. (13)	1	**Remember**	**CO2**
10.	Illustrate the equivalent circuit of a rectifier ? (13)	3	**Apply**	**CO2**
11.	Explain the method for obtaining steady state solution of equations for six pulsed converter bridge with filters. (13)	**2**	**Understand**	**CO2**
12.	Explain the choice of converter configuration for any pulse number. (13)	**2**	**Understand**	**CO2**
13.	Draw the schematic circuit diagram of a 3-phase Bridge Rectifier and explain its principle of operation without overlap. (13)	**6**	**Create**	**CO2**
14.	With neat sketch describe the individual characteristics of converter bridge when operating as (i) Rectifier (ii) Inverter.(13)	1	**Remember**	**CO2**
15.	Apply the principles of the Graetz circuit in the analysis of Line Commutated Converters, and explain how the overlap impacts the performance of the converter. (13)	3	**Apply**	**CO2**
16.	Analyze the advantages and limitations of Voltage Source Converter (VSC)-based HVDC systems compared to Line Commutated Converters (LCC) for renewable energy integration. (13)	3	**Apply**	**CO2**
17.	Illustrate the operation of a 12-pulse converter in a HVDC system, and explain how it reduces harmonics compared to a 6-pulse converter. (13)	3	**Apply**	**CO2**

PART – C				
1.	(a)Explain the following types of converter bridge circuit characteristics (i) Rectifier (ii) Inverter. (15)	**2**	**Understand**	**CO2**
2.	(a) Illustrate the circuit diagram analysis of a 12-pulse converter. And also calculate (i) Average DC output voltage (ii) Current harmonics with suitable expression and wave forms. (15)	**3**	**Apply**	**CO2**
3.	Explain the analysis of a Voltage Source Converter(VSC) Topologies with suitable firing scheme and also obtain the expression. (15)	**1**	**Remember**	**CO2**
4.	For a 12 pulse converter with q=4, s=3, r=1, calculate the maximum DC power and transformer rating (Valve winding) if PIV rating of the valve is v and rms current rating is 1. Rework the problem if r=3, s=4, r=1. (15)	**3**	**Apply**	**CO2**
5.	Evaluate the impact of converter configurations and firing schemes on the performance of HVDC transmission systems, focusing on efficiency and reliability. (15)	**4**	**Analyze**	**CO2**

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QUESTION BANK

UNIT III - CONVERTERS AND HVDC SYSTEM CONTROL				
Principles of DC link control-Converter control characteristics-system control hierarchy-firing angle control- current and extinction angle control-Starting and stopping of DC Link-Power Control-Higher level controllers-Control of VSC based HVDC Link				
PART – A				
Q.No	**Questions**	**BT Level**	**Competence**	**Course Outcome**
1.	Mention the function of Higher level controllers.	1	**Remember**	**CO3**
2.	Discuss about the modes of Converter Control Characteristics.	2	**Understand**	**CO3**
3.	Illustrate the block diagram of Pulse Frequency Control (PFC) System.	3	**Apply**	**CO3**
4.	Define the terms (i) Start up long pulse firing (ii) Start up with short pulse firings.	5	**Evaluate**	**CO3**
5.	Illustrate the steady state equivalent circuit of a 2-terminal DC link.	3	**Apply**	**CO3**
6.	Mention the types 2-types of Firing Schemes.	1	**Remember**	**CO3**
7.	What is meant by high level converters?	1	**Remember**	**CO3**
8.	Draw and evaluate the starting and stopping of DC link voltage waveform Deenergization, Energization of rectifier and inverter.	5	**Evaluate**	**CO3**
9.	Mention the different converter control characteristics?	1	**Remember**	**CO3**
10.	Define the Individual Phase Control type of Individual Phase Control.	1	**Remember**	**CO3**
11.	Illustrate the block diagram system control of Hierarchy.	3	**Apply**	**CO3**
12.	Define Equidistant Pulse Control and also explain the types of EPC.	1	**Remember**	**CO3**
13.	Analyze the steady state current equation of DC Link.	4	**Analyze**	**CO3**
14.	What are the draw backs of Equidistant Pulse Control (EPL)?	2	**Understand**	**CO3**
15.	Summarize the draw backs of Constant Extinction Angle, Negative resistance characteristics of converter.	5	**Evaluate**	**CO3**
16.	What are the conditions VSC based HVDC Link?	2	**Understand**	**CO3**
17.	Analyse and draw the diagram for Current and Extinction	4	**Analyze**	**CO3**

	Angle control.			
18.	Discriminate through the System Control Scheme what are the functions to be performed.	6	**Create**	**CO3**
19.	Justify the purpose of Constant Extinction Angle.	6	**Create**	**CO3**
20.	Illustrate the expression of transfer function of generic model of VDCOL.	3	**Apply**	**CO3**
21.	What is the purpose of firing angle control in HVDC systems?	1	**Remember**	**CO3**
22.	Define extinction angle control in the context of DC link control.	1	**Remember**	**CO3**
23.	Give the principle of power control in an HVDC system.	2	**Understand**	**CO3**
24.	How does the control hierarchy in an HVDC system ensure stable operation?	2	**Understand**	**CO3**
	PART – B			
1.	Illustrate the principles of DC Link Control (i) Equivalent and Schematic Diagram (ii) Constant Extinction Angle (iii) Current Margin. (13)	3	**Apply**	**CO3**
2.	Describe the following Converter Control Characteristics (i) Basics and Modified Control Characteristics. (13)	2	**Understand**	**CO3**
3.	Explain the diagram of system control hierarchical structure of HVDC Link. (13)	2	**Understand**	**CO3**
4.	Generalize the block diagram of Firing Angle Control (FAC) scheme. (13)	**5**	**Evaluate**	**CO3**
5.	Describe the following types of Firing Angle Control (FAC) scheme (i) Individual Phase Control (IPC) (ii) Equidistant Pulse Control. (13)	**2**	**Understand**	**CO3**
6.	In the Individual Phase Control (IPC) Scheme explain the following schemes (i) Constant alpha control (ii) Inverse Cosine Control. (13)	**1**	**Remember**	**CO3**
7.	Illustrate the block diagram of Power Control Scheme (i) Generic Model of VDCOL (ii) Converter Station (iii) Power Order (iv) Auxiliary Controller . (13)	**3**	**Apply**	**CO3**
8.	Create the following types of High Level Controllers (i) Frequency and Power Control (ii) Emergency Control (iii) Reactive Power Control. (13)	**6**	**Create**	**CO3**
9.	Draw the block diagram of VSC Controller. Explain the control of VSC Based HVDC Link and obtain the mathematical expression. (13)	**2**	**Understand**	**CO3**
10.	In control of VSC based HVDC Link and Explain the following (i) Design of Current Controller (ii) Control Hierarchy and System Control. (13)	**1**	**Remember**	**CO3**
11.	Draw and explain the three level of control of the VSC based HVDC. (13)	**1**	**Remember**	**CO3**

12.	Analyze the following terms (i) Current Controller (ii) DC Link Controller. (13)	**4**	**Analyze**	**CO3**
13.	Design the diagram of (i) System Control Hierarchy (ii) High Level Controller. (13)	**6**	**Create**	**CO3**
14.	Create the diagram of HVDC Hierarchical and System Control (i) Three Level control of VSC Based HVDC Link (ii) Control Characteristics of terminal. (13)	**6**	**Create**	**CO3**
15.	Apply the principles of DC link control to analyze how firing angle and current control work together to regulate power flow in HVDC systems. (13)	**3**	**Apply**	**CO3**
16.	Illustrate the starting and stopping procedures of a DC link with suitable diagrams and explain their importance in system stability. (13)	**3**	**Apply**	**CO3**
17.	Analyze the role of higher-level controllers in the control hierarchy of HVDC systems and evaluate their impact on system performance. (13)	**4**	**Analyze**	**CO3**
	PART – C			
1.	Illustrate the following type of Firing angle control scheme and explain (i) Individual Phase Control (IPC) (ii) Equidistant Pulse Control (EPC). (15)	**3**	**Apply**	**CO3**
2.	Analyze the following types of starting and stopping of DC Link (i) Energization and De energization of a Bridge (ii) Voltage wave form of Rectifier and Inverter (iii) Start up with long and short pulse. (15)	4	**Analyze**	**CO3**
3.	Draw the block diagram and explain the control of VSC based HVDC Links and also explain (i) Design of Current Controller (ii) Control Hierarchy and System Control. (15)	**2**	**Understand**	**CO3**
4.	With a neat diagram, explain the following Converter Control Characteristics (i) Basic Characteristics (ii) Control Characteristics of Negative Margin (iii) Modification control characteristics (iii) Voltage Dependent Current Limit. (15)	**6**	**Create**	**CO3**
5.	Compare the control mechanisms of VSC-based HVDC systems with Line Commutated Converters (LCC) and discuss their relative advantages and limitations. (15)	4	**Analyze**	**CO3**

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UNIT IV - REACTIVE POWER AND HARMONICS CONTROL				
Reactive power requirements in steady state-Sources of reactive power-SVC and STATCOM-Generation of Harmonics-Design of DC and AC Filters-Active Filters				
PART – A				
Q.No.	**Questions**	**BT Level**	**Competence**	**Course Outcome**
1.	What is meant by Conventional Control Strategies?	1	**Remember**	**CO4**
2.	Mention the region bounded by Alternate Control Strategies.	1	**Remember**	**CO4**
3.	Define the term Force commutation for HVDC System.	1	**Remember**	**CO4**
4.	Point out the advantages of sources of Reactive Power.	4	**Analyse**	**CO4**
5.	Mention the sources of Reactive Power requirements of the Converter.	1	**Remember**	**CO4**
6.	Express the disadvantages of Source Reactive Power.	2	**Understand**	**CO4**
7.	Compare the difference between SVC and STATCOM.	4	**Analyse**	**CO4**
8.	Express the control characteristics of STATCOM and SVC.	5	**Evaluate**	**CO4**
9.	Compare and differentiate the characteristics and non-characteristics of harmonics.	4	**Analyse**	**CO4**
10.	Illustrate the diagram of the variation of Q_d and P_d	3	**Apply**	**CO4**
11.	List the sources of harmonics and also effect of trouble caused by harmonics.	1	**Remember**	**CO4**
12.	Mention the criteria for the selection of Filters.	2	**Understand**	**CO4**
13.	Explain the causes of non-characteristics of harmonics.	2	**Understand**	**CO4**
14.	Mention the different types of filters.	1	**Remember**	**CO4**
15.	Explain the terms (i) Total Harmonic Distortion (ii) Reduced Harmonics (iii) Short Circuit Ratio (SCR).	2	**Understand**	**CO4**
16.	Illustrate the diagram for the control system of TCR.	3	**Apply**	**CO4**
17.	What is meant by radio interference?	1	**Remember**	**CO4**
18.	List the performance characteristics for the selection of Filter.	1	**Remember**	**CO4**
19.	Discuss the criteria for the selection of filter.	2	**Understand**	**CO4**
20.	State the ill effects of harmonics injected into AC line?	1	**Remember**	**CO4**
21.	What are the sources of reactive power in an HVDC system?	1	**Remember**	**CO4**

22.	Define the role of AC filters in HVDC systems.	1	**Remember**	**CO4**
23.	Tell how a Static Var Compensator (SVC) supports reactive power management.	2	**Understand**	**CO4**
24.	How does harmonic generation affect the performance of HVDC systems?	2	**Understand**	**CO4**
	PART – B			
1.	Explain the terms SVC and STATCOM with suitable circuit. (13)	1	**Remember**	**CO4**
2.	Discuss different sources of Reactive Power and explain it. (13)	2	**Understand**	**CO4**
3.	Criteria to create the generation of Harmonics distortion in HVDC System. (13)	6	**Create**	**CO4**
4.	Analyze the following terms :Harmonic Distortion (ii) TIF (iii) THFF (iv) IT (v) KIT (13)	4	**Analyze**	**CO4**
5.	Explain Reactive Power Requirements in steady state HVDC Systems. (13)	2	**Understand**	**CO4**
6.	Discuss about the Harmonics characteristics calculation procedure with suitable expression. (13)	2	**Understand**	**CO4**
7.	Explain the characteristics and non-characteristics harmonics in HVDC System. (13)	4	**Analyze**	**CO4**
8.	Evaluate the criteria for the design of DC Filter. (13)	3	**Apply**	**CO4**
9.	Explain the detail about STATCOM with suitable circuit and represent different characteristics of it. (13)	4	**Analyze**	**CO4**
10.	Explain the detail about Static Var Compensator(SVC) with suitable circuit and represent different characteristics of it. (13)	2	**Understand**	**CO4**
11.	Explain the criteria for the design of AC Filter. Also mention different circuit configuration and impendence characteristics. (13)	5	**Evaluate**	**CO4**
12.	Write short notes and explain the terms (i) Harmonic Distortion (ii) Non-Harmonic Distortion (13)	2	**Understand**	**CO4**
13.	What are the types of AC Filter? And also explain the criteria for the selection of filter. (13)	1	**Remember**	**CO4**
14.	Illustrate the following terms of (i) Single tuned Filter (8) (ii) Double tuned Filter (5)	3	**Apply**	**CO4**
15.	Illustrate the working of STATCOM and analyze how it provides reactive power support during steady-state and dynamic conditions. (13)	3	Apply	CO4
16	Apply the principles of harmonic mitigation to design an AC filter for an HVDC system and explain its operation. (13)	3	Apply	CO4
17.	Analyze the reactive power requirements in steady-state conditions for HVDC systems and evaluate the use of SVC and STATCOM for fulfilling these requirements. (13)	4	Analyze	CO4
	PART – C			

1.	Explain the reactive power requirement in steady state (i) Conventional Control Strategies (ii) Alternative Control. (15)	2	**Understand**	**CO4**
2.	Explain the circuit and terminology of in HVDC System : (i) Static Var Compensator(SVC) (5) (ii) STATCOM (5) (iii) Compare SVC with STATCOM (5)	1	**Remember**	**CO4**
3.	What is meant by Harmonic? Explain (i) Characteristics of Harmonics (ii) Non-Characteristics Harmonics. (15)	1	**Remember**	**CO4**
4.	In the Filter explain the following terms (i) Design of AC Filter (ii) Single Tuned Filter (ii) Double Tuned Filter. (15)	6	**Create**	**CO4**
5.	Examine the effects of harmonics generated in HVDC systems and evaluate the role of active filters in improving power quality. (15)	4	**Analyze**	**CO4**

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QUESTION BANK

UNIT V - POWER FLOW ANALYSIS IN AC/DC SYSTEMS				
Per unit system for DC Quantity-DC System Models-Inclusion of constraints-Power flow analysis-Case Study.				
PART – A				
Q.No.	**Questions**	**BT Level**	**Competence**	**Course Outcome**
1.	Define the basic model of converter.	1	**Remember**	**CO5**
2.	Create the converter average DC Voltage Equation.	6	**Create**	**CO5**
3.	Draw and discuss the Norton's Equivalent circuit for a converter and also write the equation.	1	**Remember**	**CO5**
4.	Draw and show the equivalent basic circuit model of converter.	3	**Apply**	**CO5**
5.	Evaluate the power factor j^{th} terminal per unit system.	5	**Evaluate**	**CO5**
6.	Evaluate the rms AC current phase equation.	3	**Apply**	**CO5**
7.	Evaluate the active and reactive power equation of converter terminal.	3	**Apply**	**CO5**
8.	Evaluate the per unit voltage equation for a HVDC Converter for Single phase and Three phase.	5	**Evaluate**	**CO5**
9.	How to removal of tap violation of HVDC System?	1	**Understand**	**CO5**
10.	Discuss the assumption are made in the deviation of the equation representing AC/DC Converter in HVDC System.	2	**Understand**	**CO5**
11.	Points out the characteristics for the variation of V with(a'v).	4	**Analyse**	**CO5**
12.	Evaluate rms AC current phase equation.	3	**Apply**	**CO5**
13.	Evaluate per unit DC-AC Current at the terminal j^{th} equation.	3	**Apply**	**CO5**
14.	Mention the use of inclusion constraints in HVDC System.	1	**Remember**	**CO5**
15.	Create a diagram of 5-terminal MTDC System.	6	**Create**	**CO5**
16.	Analyze the characteristics of Ɵ-with a'.	4	**Analyse**	**CO5**
17.	What is the value of Ɵ–values for inverter and rectifier and also write down the minimum and maximum value.	1	**Remember**	**CO5**
18.	Mention the different methods for power flow analysis.	1	**Remember**	**CO5**
19.	Recommend the purpose of inclusion of constraints?	6	**Create**	**CO5**
20.	Evaluate the active and reactive power equation of converter terminals.	3	**Apply**	**CO5**
21.	Define the per-unit system for DC quantities.	1	**Remember**	**CO5**

22.	What are the key components of a DC system model?	1	**Remember**	**CO5**
23.	Explain the significance of constraints in DC system modeling.	2	**Understand**	**CO5**
24.	How is power flow analysis used in DC systems?	2	**Understand**	**CO5**
	PART – B			
1.	Derive and Explain per unit system for DC quantity. (13)	5	**Evaluate**	**CO5**
2.	Create the Basic Model of the Converter. (13)	3	**Apply**	**CO5**
3.	Analyze the DC System Model with a suitable example. (13)	4	**Analyze**	**CO5**
4.	Explain the case study of description of the system. (13)	6	**Create**	**CO5**
5.	Examine any two cases of Power Flow Analysis. (13)	4	**Analyze**	**CO5**
6.	Explain the Inclusion Constraints of HVDC Systems. (13)	3	**Apply**	**CO5**
7.	With a neat diagram flowchart and examine the solution methodology for AC-DC Power Flow. (13)	3	**Apply**	**CO5**
8.	Design the DC Control Equations of HVDC System. (13)	6	**Create**	**CO5**
9.	Create the mathematical modeling of HVDC Links for Power Flow Analysis. (13)	6	**Create**	**CO5**
10.	Explain the DC Network Equation for HVDC System. (13)	1	**Remember**	**CO5**
11.	With sketch explain the DC Model for HVDC System. (13)	2	**Understand**	**CO5**
12.	Analyze the DC System Model terms (i) Basic Model of Converter (ii) Converter Equation (iii) Basic Converter Model. (13)	4	**Analyze**	**CO5**
13.	Create the mathematical model for a DC Network Converter and its controllers in the Power flow Analysis. (13)	6	**Create**	**CO5**
14.	Examine the per unit system for HVDC Systems for DC Power transmission. (13)	6	**Create**	**CO5**
15.	Apply the per-unit system to a DC power system and demonstrate its use in simplifying calculations with a suitable example.	3	**Apply**	**CO5**
16.	Develop a power flow analysis for a DC system, including relevant equations and the incorporation of system constraints.	3	**Apply**	**CO5**
17.	Analyze the inclusion of operational constraints in DC system models and evaluate their impact on system performance.	4	**Analyze**	**CO5**
	PART – C			
1.	With an example explain per unit system for DC quantities. (15)	6	**Create**	**CO5**

2.	Explain the following DC System Model (i) Basic model of Converter (ii) Converter Equation (iii) A flexible per unit system. (15)	2	**Understand**	**CO5**
3.	Examine the following terms : (i) Basic Modeling of HVDC System (ii) DC Network Equation (iii) DC Control Equation (15)	6	**Create**	**CO5**
4.	Explain the case study of (i) Description of the system. (ii) Power flow analysis with VSC Based HVDC System. (iii) Power Flow Analysis under Dynamic Conditions. (15)	6	**Create**	**CO5**
5.	Critically examine a case study of a real-world DC power flow problem, focusing on the methodology, constraints, and results.	4	**Analyze**	**CO5**