Academic Course Description

BHARATH UNIVERSITY
Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering

BEE011 & HIGH VOLTAGE DC TRANSMISSION
Sixth Semester (even Semester)

Course (catalog) description

To master the various fundamentals, converter design, protection schemes of HVDC transmission systems. This will help you to gain knowledge and to do research in the area of HVDC transmission systems.

Compulsory/Elective course: Elective course for EEE students

Credit & Contact hours : 3 and 45 hours

Course Coordinator : S.Uma Mageswaran

Instructors : V. Sumathi

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
V. Sumathi	Third year EEE	KS 302	04422290125	sumathiwin@gmail.com	9.00-9.50 AM

Relationship to other courses:

Pre –requisites **:** BEE101(Basic electrical & Electronics)
Assumed knowledge : AC and DC Transmission, Harmonics

Syllabus Contents

UNIT I GENERAL ASPECTS **9**

Historical development HVDC and HVDC link – Comparison of AC and DC Transmission – Application of DC Transmission – Types of DC link – Converter Station - HVDC projects in India and abroad – Advantages and disadvantages of HVDC transmission Principal application of dc transmission – Economical factor – Development of power devices for HVDC transmission – Thyristors - switching and steady state characteristics.

UNIT II INTRODUCTION TO CONVERTERS **9**

Line Commutated Converter – Analysis of Graetz Bridge Neglecting Overlap – Choice of Converter Configurations for any Pulse Number – Analysis of a 12 Pulse Converter – Voltage Source Converter – Basic Two level Converter (Graetz Bridge) – A Three Level Voltage Source Converter – Converter Using Pulse Width Modulation – capacitor Commutated Converter.

UNIT III CONTROL OF CONVERTERS 9

Principles of DC Link Control – Converter Control Characteristics – Firing Angle Control – Current and Extinction Angle Control – Starting and Stopping of DC Link - Power Control - Higher Level Controllers – SVC and STATCOM.

UNIT IV FAULTS AND PROTECTION 9

Converter Faults – commutation failure – Arc through – Misfire – Current extinction – Short Circuit in a Bridge – Protection against Over currents – Over voltages in a converter station – Disturbance on the DC side – Surge Arrestors – Protection Against Overvoltage – Protection against faults in a voltage Source Converter – DC Breakers.

UNIT V HARMONICS AND FILTERS 9

Generation of Harmonics - Characteristics and Non-Characteristic Harmonics - Troubles caused by harmonics – Means of Reducing Harmonics - .Design of AC Filters – Passive AC Filters – DC Filters – Active Filters – Carrier Frequency and RI Noise.

TEXT BOOKS

1. K.R. Padiyar ,"HVDC Power Transmission System Technology and System Interaction"- Willey Eastern Ltd. 1991.
2. E.W Kimbark, "DirectCurrent Transmission", Vol. Willey Inter Science. New York 1971.

Total: 45 HOURS

REFERENCES

1. Colin Adamson and N.G. Hingorani. "High Voltage Direct Current Power Transmission", Garraway limited. England 1960.
2. B.J Kor(ed), "High Voltage Direct Current Converters and Systems", Macdonald and Co, London 1965.
3. B.M WedyBectric "Power Systems", John Wiley and Sons, London 1979.
4. Arrillaga, J., "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
5. Online courses on HVDC Transmission systems-http://nptel.ac.in/courses/108104013/

Professional component

General	-	0%
Basic Sciences	-	0%
Engineering sciences & Technical arts	-	0%
Professional subject	-	0%
Major Elective	-	100%

Broad area : Electrical Machines/Electronics/**Power system**/Control &Instrumentation.

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1	February 2nd week	Session 1 to 14	2 Periods
2	Cycle Test-2	March 2nd week	Session 15 to 28	2 Periods
3	Model Test	April 3rd week	Session 1 to 45	3 Hrs

4	University Examination	TBA	All sessions / Units	3 Hrs.

Mapping of Instructional Objectives with Program Outcome

To master the various fundamentals, converter design, protection schemes of HVDC transmission systems. This will help you to gain knowledge and to do research in the area of HVDC transmission systems.	Correlates to program outcome		
	H	**M**	**L**
1. To learn about the historical development and emergence of HVDC transmission	d,h,j	a,b,c,f,g,l	k
2. To study about the various thyristor converters used in HVDC transmission	a,d,e,h,l,j	d,c,g,l	k
3. To analyze various control methodologies and characteristics of converters	b,d,e,h,l,j,l	f	a,g
4. To understand the principle of protection schemes used in HVDC transmission	b,d,e,l,k,l	c,f,h	a,g,j
5. To learn the fundamentals of ground return, filters and harmonics	a,d,e	b,c,g	j,k,l

H: high correlation, M: medium correlation, L: low correlation

Draft Lecture Schedule

S.NO	Topics	Problem solving (Yes/No)	Text / Chapter
UNIT I			
1.	Historical development HVDC and HVDC link	No	T1,R2
2.	Comparison of AC and DC Transmission	No	
3.	Application of DC Transmission	No	
4.	Types of DC link, Converter Station	No	
5.	HVDC projects in India and abroad	No	
6.	Principal application of dc transmission, Economical factor	No	
7.	Development of power devices for HVDC transmission	No	
8.	Thyristors - switching	No	
9.	steady state characteristics	No	
UNIT II			
10.	Line Commutated Converter	No	T1,T2
11.	Analysis of Graetz Bridge Neglecting Overlap	No	
12.	Choice of Converter Configurations for any Pulse Number	No	
13.	Analysis of a 12 Pulse Converter	No	
14.	Voltage Source Converter	No	
15.	Basic Two level Converter (Graetz Bridge)	No	
16.	Three Level Voltage Source Converter	No	
17.	Converter Using Pulse Width Modulation	No	
18.	capacitor Commutated Converter.	No	
UNIT III			
19.	Principles of DC Link Control	No	T1,T2,R2
20.	Converter Control Characteristics	No	
21.	Firing Angle Control	No	
22.	Current and Extinction Angle Control	No	
23.	Starting and Stopping of DC Link	No	
24.	Power Control	No	
25.	Higher Level Controllers	No	
26.	SVC	No	
27.	STATCOM	No	

UNIT IV			
28.	Converter Faults	No	T1,T2,R1
29.	commutation failure	No	
30.	Arc through	No	
31.	Misfire	No	
32.	Current extinction	No	
33.	Short Circuit in a Bridge, Surge Arrestors	No	
34.	Protection against Over currents	No	
35.	Over voltages in a converter station, Disturbance on the DC side Disturbance on the DC side	No	
36.	Protection against faults in a voltage Source Converter, DC Breakers	No	
UNIT V			
37.	Generation of Harmonics, Characteristics and Non-Characteristic Harmonics	No	T1,T2,R3
38.	Troubles caused by harmonics	No	
39.	Means of Reducing Harmonics	No	
40.	.Design of AC Filters	No	
41.	Passive AC Filters	No	
42.	DC Filters	No	
43.	Active Filters	No	
44.	Active Filters	No	
45.	Carrier Frequency and RI Noise	No	

Teaching Strategies

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures
- Tutorials, which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material.
- Laboratory sessions, which support the formal lecture material and also provide the student with practical construction, measurement and debugging skills.
- Small periodic quizzes, to enable you to assess your understanding of the concepts.

Evaluation Strategies

Cycle Test – I		5%
Cycle Test – II	-	5%
Model Test	-	10%
Attendance	-	5%
Seminar&Assignmen	-	5%
Final exam	-	70%

Prepared by: S.Uma Mageswaran Assistant Professor, Department of EEE **Dated :**

Addendum

ABET Outcomes expected of graduates of B.Tech / EEE / program by the time that they graduate:

a) An ability to apply knowledge of mathematics, science, and engineering fundamentals.
b) An ability to identify, formulate, and solve engineering problems.
c) An ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d) An ability to design and conduct experiments, as well as to analyze and interpret data.
e) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
f) An ability to apply reasoning informed by the knowledge of contemporary issues.
g) An ability to broaden the education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
h) An ability to understand professional and ethical responsibility and apply them in engineering practices.
i) An ability to function on multidisciplinary teams.
j) An ability to communicate effectively with the engineering community and with society at large.
k) An ability in understanding of the engineering and management principles and apply them in project and finance management as a leader and a member in a team.
l) An ability to recognize the need for, and an ability to engage in life-long learning.

Program Educational Objectives

PEO1: PREPARATION
Electrical Engineering Graduates are in position with the knowledge of Basic Sciences in general and Electrical Engineering in particular so as to impart the necessary skill to analyze and synthesize electrical circuits, algorithms and complex apparatus.

PEO2: CORE COMPETENCE
Electrical Engineering Graduates have competence to provide technical knowledge, skill and also to identify, comprehend and solve problems in industry, research and academics related to power, information and electronics hardware.

PEO3: PROFESSIONALISM
Electrical Engineering Graduates are successfully work in various Industrial and Government organizations, both at the National and International level, with professional competence and ethical administrative acumen so as to be able to handle critical situations and meet deadlines.

PEO4: SKILL
Electrical Engineering Graduates have better opportunity to become a future researchers/ scientists with good communication skills so that they may be both good team-members and leaders with innovative ideas for a sustainable development.

PEO5: ETHICS

Electrical Engineering Graduates are framed to improve their technical and intellectual capabilities through life-long learning process with ethical feeling so as to become good teachers, either in a class or to juniors in industry.

Course Teacher	Signature
V. Sumathi	

Course Coordinator **HOD/EEE**

(Mr.S.Uma Mageswaran)