

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE OUTLINE – PART I			
Course Title	HIGH VOLTAGE DC TRANSMISSION		
Course Code	EE 662	No. of Credits	03
Course Code of Pre-requisite subject(s)	EE 601 & EE 603		
Session	JANUARY 2018		
Name of the Faculty	Dr. M.P. SELVAN	Department	ELECTRICAL AND ELECTRONICS
Email	selvanmp@nitt.edu	Telephone No.	250 3262
Course Coordinator	-		
Course Type	<input type="checkbox"/> Core course	<input checked="" type="checkbox"/> X	Elective course

SYLLABUS (As approved in BoS)

Introduction to HVDC transmission, Comparison between HVAC and HVDC systems - economic, technical and reliability, limitations, Types of HVDC links - monopolar, bipolar and homopolar links, Components of HVDC transmission system

Analysis of HVDC Converters, Rectifier and Inverter operation of Graetz circuit without and with overlap. Output voltage waveforms and DC voltage in both rectifier and inverter operation, Equivalent circuit of HVDC link.

Basic means of HVDC system control, desired features, power reversal, Basic controllers - constant ignition angle, constant current and constant extinction/ advance angle control, power control, high level controllers. Converter maloperations - misfire, arc through, commutation failure

Harmonics in HVDC system - Characteristic and uncharacteristic harmonics - troubles due to harmonics – harmonic filters - active and passive filters - Reactive power control of converters, Protection issues in HVDC, over voltage and over current protection,- voltage and current oscillations, DC reactor design, DC Circuit breakers

Recent trends in HVDC transmission-CCC based HVDC system, VSC based HVDC system,- Multi-terminal HVDC systems and HVDC system applications in wind power generation, Interaction between AC and DC systems

COURSE OBJECTIVES

To realize the requirements of HVDC system for long distance bulk power transmission.

To understand the functioning of HVDC system.

To recognize the recent advancements in HVDC Technology.

COURSE OUTCOMES (CO)		
Course Outcomes		Aligned Programme Outcomes (PO)
1	Appraise the need of HVDC technology for bulk power transmission and choose appropriate type of HVDC link and converter.	1,2,8,11,12,14
2	Analyze the operation of Graetz circuit as rectifier and inverter with and without overlap.	1,2
3	Evaluate the operation and efficacy of different controllers and analyze the different faults in HVDC systems.	1,2,6,7,8,12,14
4	Discriminate and evaluate the issues related with harmonics, reactive power control and protection of HVDC system.	1,2,6,7,8,12,14
5	Recognize and appraise the recent trends in HVDC transmission system.	1,2,6,7,8,10,11,12,14

COURSE OUTLINE – PART II

COURSE OVERVIEW

Students get exposure to the transmission of power and power flow analysis of transmission system in the course “Advanced Power System Analysis (EE 601)”. Students are trained in the operation and analysis of power electronics circuits that are employed in AC-DC & DC-AC power conversion through the course “Power Conversion Techniques(EE 603)”. However, every student is left out with surprise: How are the power electronics circuits learned in the course EE 603 used in the large power system network? Does the use of Power Converters help the power transmission system? If so, What is the converter technology that can be utilised? Interestingly, transmission of bulk power over a long distance by high voltage DC system yields a great degree of economy and simple real time control of power transfer. In this course, students will learn about the technical limitations and problems associated with AC power transmission. They will be able to understand the merits of HVDC systems, its operation, control, challenges and the recent developments.

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week	Topic	Mode of Delivery
1	2 nd Week of January (8 th to 12 th) (1 Contact Hour)	Introduction to HVDC transmission System course. Course plan details	Interactive Session
2	3 rd Week of January (15 th – 19 th) (3 Contact Hours)	Technical comparison between HVAC and HVDC systems	Lecture C&T, PPT
3	4 th Week of January (22 nd to 26 th) (3 Contact Hours)	Economical comparison between HVAC and HVDC systems Types of HVDC links	Lecture C&T, PPT

4	5 th Week of January (29 nd Jan to 02 nd Feb) (3 Contact Hours)	Components of HVDC system Discussion Class ASSESSMENT – 1	Lecture C&T, PPT Group Discussion Quiz
5	1 st Week of February (5 th to 9 th Feb) (1 Contact Hour)	Analysis of HVDC Converter, Rectifier Operation without overlap <i>(Doubt clearing class)</i>	Flip Class <i>(Video lecture)</i>
6	2 nd Week of February (12 th to 16 th) (1 Contact Hour)	Analysis of HVDC Converter Rectifier Operation with overlap <i>(Doubt clearing class)</i>	Flip Class <i>(Video lecture)</i>
7	3 rd Week of February (19 th to 23 rd) (1 Contact Hour)	Analysis of HVDC Converter Inverter Operation <i>(Doubt clearing class)</i>	Flip Class <i>(Video lecture)</i>
8	4 th Week of February (26 th Feb to 02 nd Mar) (3 Contact Hours)	ASSESSMENT – 2 Equivalent circuit of HVDC Link <i>(Doubt clearing class)</i> Numerical Sessions	Quiz Flip Class <i>(Video lecture)</i> Tutorial
9	1 st Week of March (05 th to 09 th) (3 Contact Hours)	HVDC Control, desired features, power reversal	Lecture C&T, PPT
10	2 nd Week of March (12 th to 16 th) (2 Contact Hours)	ASSESSMENT – 3 Converter Maloperation <i>(Doubt clearing class)</i>	Numerical Assessment Flip Class <i>(Video lecture)</i>
11	3 rd Week of March (19 th to 23 rd) (3 Contact Hours)	Harmonics & reactive power control Protection Issues HVDC Breaker	Lecture C&T, PPT
12	4 th Week of March (26 th to 30 th) (3 Contact Hours)	CCC based HVDC System VSC based HVDC System Multiterminal HVDC system	Lecture C&T, PPT
13	1 st Week of April (2 nd to 6 th) (4 Contact Hours)	ASSESSMENT – 4	Group Evaluation
14	2 nd Week of April (9 th to 13 th) (4 Contact Hours)	Industrial Visit Industrial Lecture HVDC system application in Wind power Generation Interaction between AC and DC systems	Lecture C&T, PPT

15	3 rd Week of April (16 th to 20 th) (2 Contact Hours)	ASSESSMENT - 5 COMPENSATION ASSESSMENT	Quiz
16	4 th Week of April (23 rd to 27 th) (2 Contact Hours)	ASSESSMENT – 6	End Semester Examination

C & T : Chalk and Talk, PPT : Power Point
Attendance will not be taken during doubt clearing classes

COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Technical Quiz	5 th Week of January	30 Minutes	10
2	Technical Quiz	4 th Week of February	30 Minutes	10
3	Numerical Problems	2 nd Week of March	60 Minutes	20
4	Group Assignment (Group of 2/3 members) Programming/Simulation	1st Week of April	Four weeks	15
5	Technical Quiz	3 rd Week of April	45 Minutes	15
CPA	Compensation Assessment	3 rd Week of April		
6	End Semester Examination (Descriptive Test)	4 th Week of April	90 Minutes	30

CPA is not applicable for Assessment 4 and Assessment 6.

ESSENTIAL READINGS : Textbooks, Reference Books Website address, Journals, etc.

1. Kimbark, E.W., 'Direct Current Transmission-vol.1', Wiley Interscience, New York, 1971.
2. Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.
3. Kamakshiah, S and Kamaraju, V, 'HVDC Transmission', 1st Edition, Tata McGraw Hill Education (India), Newdelhi 2011.
4. Arrilaga, J., 'High Voltage Direct Current Transmission', 2nd Edition, Institution of Engineering and Technology, London, 1998.
5. Vijay K. Sood, 'HVDC and FACTS Controllers', Kluwer Academic Publishers, New Yark, 2004.

COURSE EXIT SURVEY (mention the ways in which the feedback about the course is assessed and indicate the attainment also)

Feedback from the students during class committee meetings

Anonymous feedback through questionnaire (End of the semester)

Institute end semester feedback

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

MODE OF CORRESPONDENCE

1. All the students are advised to check their NITT WEBMAIL regularly. All the correspondence (schedule of classes/ schedule of assessment/ course material/ any other information regarding this course) will be done through their webmail only.
2. Queries (if required) to the course teacher shall only be emailed to selvanmp.psect@gmail.com

ATTENDANCE

1. Attendance will be taken by the faculty in all the contact hours.
2. Every student should maintain minimum 75% attendance in these contact hours to attend the end semester examination.
3. Any student, who fails to maintain 75% and having above 50% attendance should have scored minimum 30% aggregate marks in the assessments 1, 2, 3, 4 and 5 for attending the end semester examination.
4. Any student, who fails to maintain 50% attendance should have scored minimum 60% aggregate marks in the assessments 1, 2, 3, 4 and 5 for attending the end semester examination.
5. Students not having sufficient attendance at the end of the semester and also fail to score the required marks (as mentioned in Points : 3 & 4) will have to RE DO the course.

ASSESSMENT

1. Attending all the assessments are MANDATORY for every student.
2. If any student is not able to attend any of the assessments due to genuine reason, student is permitted to attend the compensation assessment (CPA).
3. At any case, CPA will not be considered as an improvement test.
4. The minimum marks for passing this course and grading pattern will adhere to the regulations of the Institute.

ACADEMIC HONESTY & PLAGIARISM

1. All the students are expected to be genuine during the course work. Taking of information by means of copying simulations, assignments, looking or attempting to look at another student's paper or bringing and using study material in any form for copying during any assessments is considered dishonest.
2. Tendering of information such as giving one's program, simulation work, assignments to another student to use or copy is also considered dishonest.
3. Preventing or hampering other students from pursuing their academic activities is also considered as academic dishonesty.
4. Any evidence of such academic dishonesty will result in the loss of marks on that assessment. Additionally, the names of those students so penalized will be reported to the class committee chairperson and HoD of the concerned department.
5. Students who honestly producing ORIGINAL and OUTSTANDING WORK will be REWARDED.

ADDITIONAL COURSE INFORMATION

The faculty is available for consultation at times as per the intimation given by the faculty.

Queries may also be emailed to the Course Coordinator directly at selvanmp.psect@gmail.com

FOR APPROVAL

Course Faculty  CC-Chairperson  10.01.18 HOD  8.05.18
11/01/18