Academic Course Description

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

BEE016 & FLEXIBLE AC TRANSMISSION SYSTEMS
Sixth Semester (EVEN Semester)

Course (catalog) description

This course introduces the application of a variety of high power-electronic controllers for active and reactive power in transmission lines. Students are exposed to the basics, modeling aspects, control and scope for different types of FACTS controllers

Compulsory/Elective course: Elective for EEE students

Credit hours : 3 &45

Course Coordinator : Dr.V.Jayalakshmi

Instructors **:** Dr.V.Jayalakshmi

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
Dr.V.Jayalakshmi	Third year EEE	KS 302	04422290125	Jayalakshmi.eee@ bharathuniv.ac.in	12.30 PM-1.30 PM

Relationship to other courses:

Pre –requisites **:** BEE505 & POWER GENERATION SYSTEMS

Assumed knowledge : Basic knowledge in power electronics Devices and transmission &Distribution system

Following courses : BEE019 SMART GRID

Syllabus Contents

UNIT I INTRODUCTION 9

Reactive power control in electrical power transmission lines -Uncompensated transmission line - series compensation – Basic concepts of Static Var Compensator (SVC) – Thyristor Controlled Series capacitor (TCSC) – Unified power flow controller (UPFC).

UNIT II STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9

Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling of SVC for power flow and fast transient stability – Applications: Enhancement of transient stability – Steady state power transfer – Enhancement of power system damping.

UNIT III THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Operation of the TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit – Enhancement of system damping.

UNIT IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability - prevention of voltage instability. SSSC-operation of SSSC and the control of power flow–modelling of SSSC in load flow and transient stability studies.

UNIT V CO-ORDINATION OF FACTS CONTROLLERS 9

Controller interactions – SVC – SVC interaction – Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms.

Text Books:

T1. R.Mohan Mathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc, 2002.
T2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible ACTransmission Systems", Standard Publishers Distributors, Delhi- 110 006, 2011.
T3. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008.

References:

R1. A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.
R2. V.K.Sood, HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers, 2004.
R3. Xiao – Ping Zang, Christian Rehtanz and Bikash Pal, "Flexible AC Transmission System:Modelling and Control" Springer, 2012.
R4. http://nptel.ac.in/courses/108104052/26

Computer usage:

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 18	2 Periods
2	Cycle Test-2	March 2nd week	Session 19 to 36	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

This course introduces the application of a variety of high power-electronic controllers for active and reactive power in transmission lines. Students are exposed to the basics, modeling aspects, control and scope for different types of FACTS controllers	Correlates to program outcome		
	H	**M**	**L**
1. To understand various types of power controllers in transmission lines.	a,b,	c,d,e,f,g,i,j,l	h,k
2.To understand the static VAR compensator and its applications.	a,b,e	c,d,f,g,i,j,l	l,k
3.To understand the TCSC controller and its applications.	a,b,e,f	c,d,g,i,j,l	h,k
4. To understand the transient stability and modelling of STATCOM.	a,b,d,e,f	c,g,h,i,j,l	k
5. To learn the concept of coordination of FACTS controllers.	a,b	c,d,e,f,g,i,j,l	k

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

Draft Lecture Schedule

S.NO	Topics	Problem solving (Yes/No)	Text / Chapter
UNIT I	**INTRODUCTION**		
1.	**Reactive power control in electrical power transmission lines**	No	T1 / T3
2.	Uncompensated transmission line	No	
3.	series compensation	No	
4.	series compensation	No	
5.	Basic concepts of Static Var Compensator (SVC)	No	
6.	Basic concepts of Static Var Compensator (SVC)	No	
7.	Thyristor Controlled Series capacitor (TCSC)	No	
8.	Unified power flow controller (UPFC).	No	
9.	Unified power flow controller (UPFC).	No	
UNIT II	**STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS**		
10.	Voltage control by SVC	No	T1/T3
11.	Advantages of slope in dynamic characteristics	No	
12.	influence of SVC on system voltage	No	
13.	Design of SVC voltage regulator	No	
14.	Modelling of SVC for power flow and fast transient stability	No	
15.	Applications: Enhancement of transient stability	No	
16.	Steady state power transfer	No	
17.	Enhancement of power system damping	No	
18.	Enhancement of power system damping	No	
UNIT III	**THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS**		
19.	Operation of the TCSC	No	T1/T2/T3
20.	Different modes of operation	No	
21.	Modelling of TCSC	No	
22.	Variable reactance model	No	
23.	Modelling for Power Flow and stability studies	No	
24.	Applications	No	
25.	Improvement of the system stability limit	No	
26.	Enhancement of system damping	No	
27.	Enhancement of system damping	No	
UNIT IV	**VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS**		
28.	Static Synchronous Compensator (STATCOM)	No	T3
29.	Principle of operation	No	
30.	V-I Characteristics.	No	
31.	Steady state power transfer-enhancement of transient stability	No	
32.	prevention of voltage instability	No	
33.	prevention of voltage instability	No	
34.	SSSC-operation of SSSC and the control of power flow	No	
35.	SSSC-operation of SSSC and the control of power flow	No	
36.	modelling of SSSC in load flow and transient stability studies.	No	

UNIT V	CO-ORDINATION OF FACTS CONTROLLERS		
37.	Controller interactions	No	T1/T3
38.	Controller interactions	No	
39.	SVC interaction	No	
40.	SVC interaction	No	
41.	Co-ordination of multiple controllers using linear control techniques	No	
42.	Co-ordination of multiple controllers using linear control techniques	No	
43.	Co-ordination of multiple controllers using linear control techniques	No	
44.	Control coordination using genetic algorithms	No	
45.	Control coordination using genetic algorithms	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&Assignmei	-	5%
Final exam	-	70%

Prepared by: Dr.V.Jayalakshmi **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
Dr.V.Jayalakshmi	

Course Coordinator **HOD/EEE**

(Dr.V.Jayalakshmi) ( )