INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**Flexible AC Transmission Systems**			
Course Code	**BPE006**			
Regulation	**2017-18**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	3	-	-	3
Course Coordinator	Mr. P. SRIDHAR, professor			
Team of Instructors	Mr. P. SRIDHAR, professor			

I. COURSE OVERVIEW:

1. Interpret the concept of Flexible AC Transmission Systems.
2. Analyze Voltage source converters and Current source converters.
3. Describe static shunt compensation and static VAR generators.
4. Classify reactive power compensation and transient stability enhancement.
5. Apply static series compensation to improve transient stability

II. PREREQUISITES:

Level	Credits	periods	prerequisite
PG	**3**	**3**	**Knowledge of power electronic converters are required**

III. COURSE ASSESSMENT METHODS:

Marks distribution:

Session marks	University end exam marks	Total marks
There shall be two continuous internal assessments (CIA). Each continuous internal assessment is for 30 marks, with subjective exam for 25 marks (duration of 2 hours) and 5 marks for technical paper and term paper. Subjective test of each CIA in the semester shall contain Part-A with 5 compulsory question to answer of one mark each and Part-B with 5 questions each carrying 5 marks and to be answer any four questions. The average of two CIA is the final internal marks. The external question paper approved by COE contains 5 internal choice questions each carrying 14 marks	30	100

giving an total of 70 marks and to be answer all 5 questions	70	

IV. EVALUATION SCHEME:

S.No	Component	Duration	Marks
1	I CIA examination	2 Hours	25
2	I technical paper and term paper	--	05
3	II CIA examination	2 Hours	25
4	II technical paper and term paper	--	05
5	External examination	3 hours	70

V. COURSE OBJECTIVES:

At the end of the course, the students will be able to:

1. Interpret the concept of Flexible AC Transmission Systems.
2. Analyze Voltage source converters and Current source converters.
3. Describe static shunt compensation and static VAR generators.
4. Classify reactive power compensation and transient stability enhancement.
5. Apply static series compensation to improve transient stability.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Interpret the concept of Flexible AC Transmission Systems.
2. Analyze Voltage source converters and Current source converters.
3. Describe static shunt compensation and static VAR generators.
4. Classify reactive power compensation and transient stability enhancement.
5. Apply static series compensation to improve transient stability.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
PO1	**General knowledge**: An ability to apply the knowledge of mathematics, science and Engineering for solving multifaceted issues of Electrical Engineering.	S	Discussion
PO2	**Problem Analysis**: An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.	S	Assignments
PO3	**Design/Development of solutions**: To develop Broad theoretical knowledge in Electrical Engineering and learn the methods of applying them to identify, formulate and solve practical problems involving electrical power.	N	--
PO4	**Conduct investigations of complex problems**: An ability to apply the techniques of using appropriate technologies to investigate, analyze, design, simulate and/or fabricate/commission complete systems involving	H	Discussion

	generation, transmission and distribution of electrical energy		
PO5	**Modern tool usage:** An ability to model real life problems using different hardware and software platforms, both offline and real-time with the help of various tools along with upgraded versions.	H	Discussion ,Assignment
PO6	**The engineer and society:** An Ability to design and fabricate modules, control systems and relevant processes to meet desired performance needs, within realistic constraints for social needs.	N	--
PO7	**Environment and sustainability:** An ability To estimate the feasibility, applicability, optimality and future scope of power networks and apparatus for design of eco-friendly with sustainability	N	--
PO8	**Ethics:** To Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources.	N	--
PO9	**Individual and team work:** an Ability to design schemes involving signal sensing and processing leading to decision making for real time electrical engineering systems and processes at individual and team levels	S	Discussion ,Assignment
PO10	**Communication:** an Ability to work in a team and comprehend his/her scope of work, deliverables , issues and be able to communicate both in verbal ,written for effective technical presentation.	N	--
PO11	**Life-long learning:** An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	H	Discussion ,Seminar
PO12	**Project management and finance**: To be familiar with project management problems and basic financial principles for a multi-disciplinary work.	H	Discussion ,Seminar

N= None S=Supportive H=Highly related

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	N	--
PSO2	**Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	S	Projects
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	S	Projects

N – None **S - Supportive** **H- Highly Related**

IX. SYLLABUS:

UNIT I FACTS CONCEPTS

Facts concept: Transmission inter connections power flow in an AC system, loading capability limits, dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

UNIT II VOLTAGE SOURCE CONVERTERS

Voltage source converters: Single phase and three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation, three level voltage source converter, pulse width modulation converter, basic concept of current source converters and comparison of current source converters with voltage source converters.

UNI III STATIC SHUNT COMPENSATION

Static shunt compensation: Objectives of shunt compensation, midpoint voltage regulation voltage instability prevention, improvement of transient stability, power oscillation damping. Methods of controllable VAR generation, variable impedance type static VAR generators, switching converter type VAR generators, hybrid VAR generators.

UNI IV SVC AND STATCOM

SVC and STATCOM: The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

UNIT V STATIC SERIES COMPENSATORS

Static Series compensators: Concept of series capacitive compensation, improvement of transient stability, power oscillation damping and functional requirements of GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC) and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC.

Text Books:

1. N.G. Hingorani, L. Guygi, "Understanding FACTS Devices", IEEE Press Publications, 1st Edition, 2000.

Reference Books:

1. R. Krishnan, "Electric Motor Drives Modeling, Analysis and Control", Pearson Publications, 1st Edition, 2002.
2. B K Bose, Modern Power Electronics and AC Drives", Pearson Publications, 1st Edition, 2002.
3. MD Murthy, FG Turn Bull, " Power Electronics and Control of AC Motors", Pergman Press, 1st Edition.
4. BK Bose, "Power Electronics and AC Drives", Prentice Hall Eagle wood 1st Edition.

Web References:

1. Power Electronic Web Course by NPTEL, IIT Kharagpur, www.nptel.iitm.ac.in
2. https://www.Bookboon.com/en/introduction-to-power-electronics-ebook/

E-Text Books:

1. http://www.chettinadtech.ac.in/g_articlen/10-10-12/10-10-12-08-46-17-bresnav.pdf

2. http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1208&context=ecetr
3. https://docs.google.com/a/iare.ac.in/file/d/1QAmwi0gy0kOQKiIgpAfxu10N7Bk82TU3avy8wisTBEjtIGuKclHMSwH3-SPH/edit

X. COURSE PLAN:

The course plan is meant as a guideline. There may be probably be changes.

Lecture no.	Topics to be covered	Course Learning objectives	Reference
1	Facts concept: Transmission inter connections power flow in an AC system,	Facts concept: Transmission inter connections power flow in an AC system,	T1T2
2	loading capability limits,	loading capability limits,	T1T2
3	dynamic stability considerations	dynamic stability considerations	T1T2
4	importance of controllable parameters basic types of FACTS controllers,	importance of controllable parameters basic types of FACTS controllers,	T1T2
5	benefits from FACTS controllers	benefits from FACTS controllers	T1T2
6	problems	problems	T1T2
7	Voltage source converters:	Voltage source converters:	T1T2
8	Single phase and three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation,	Single phase and three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation,	T1T2
9	Single phase and three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation,	Single phase and three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation,	T1T2
10	three level voltage source converter	three level voltage source converter	T1T2
11	pulse width modulation converter	pulse width modulation converter	T1T2
12	Basic concept of current source converters and comparison of current source converters with voltage source converters.	Basic concept of current source converters and comparison of current source converters with voltage source converters.	T1T2
13	Basic concept of current source converters and comparison of current source converters with voltage source converters.	Basic concept of current source converters and comparison of current source converters with voltage source converters.	T1T2
14	problems	problems	T1T2
15	problems	problems	T1T2
16	Static shunt compensation:	Static shunt compensation:	T1T2
17	Objectives of shunt compensation,	Objectives of shunt compensation,	T1T2
18	midpoint voltage regulation voltage instability prevention,	midpoint voltage regulation voltage instability prevention,	T1T2

19	improvement of transient stability,	improvement of transient stability,	T1T2
20	power oscillation damping.	power oscillation damping.	T1T2
21	Methods of controllable VAR generation,	Methods of controllable VAR generation,	T1T2
22	variable impedance type static VAR generators,	variable impedance type static VAR generators,	T1T2
23	switching converter type VAR generators,	switching converter type VAR generators,	T1T2
24	hybrid VAR generators	hybrid VAR generators	T1T2
25	problems	problems	T1T2
26	SVC and STATCOM:	SVC and STATCOM:	T1T2
27	The regulation and slope transfer function and dynamic performance,	The regulation and slope transfer function and dynamic performance,	T1T2
28, 29	transient stability enhancement and power oscillation damping operating point control and summary of compensator control.	transient stability enhancement and power oscillation damping operating point control and summary of compensator control.	T1T2
30	transient stability enhancement and power oscillation damping operating point control and summary of compensator control.	transient stability enhancement and power oscillation damping operating point control and summary of compensator control.	T1T2
31	problems	problems	T1T2
32	Static Series compensators:	Static Series compensators:	T1T2
33	Concept of series capacitive compensation,	Concept of series capacitive compensation,	T1T2
34	improvement of transient stability,	improvement of transient stability,	T1T2
35	power oscillation damping and functional requirements of GTO thyristor controlled series capacitor (GSC),	power oscillation damping and functional requirements of GTO thyristor controlled series capacitor (GSC),	T1T2
35	thyristor switched series capacitor (TSSC) and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC	thyristor switched series capacitor (TSSC) and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC	T1T2
36	thyristor switched series capacitor (TSSC) and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC	thyristor switched series capacitor (TSSC) and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC	T1T2
37	thyristor switched series capacitor (TSSC) and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC	thyristor switched series capacitor (TSSC) and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC	T1T2
38	problems	problems	T1T2
39	problems	problems	T1T2
40	revision	revision	T1T2

41	revision	revision	T1T2

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	S			H							S	H			S
II		S		H	H				S		H			S	S
III		S			H				S		S	H			S
IV	S			H					S			S		S	
V		S			H				S		H	H		S	

S=Supportive H=Highly related

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	S			H							S	H			S
2		S		H	H				S		H			S	S
3		S			H				S		S	H			S
4	S			H					S			S		S	
5		S			H				S		H	H		S	

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Prepared by: Mr. P. SRIDHAR professor