KANDULA SRINIVASA REDDY MEMORIAL COLLEGE OF ENGINEERING
(AUTONOMOUS)

KADAPA-516005. AP

(Approved by AICTE, Affiliated to JNTUA, Ananthapuramu, Accredited by NAAC)

(An ISO 9001-2008 Certified Institution)

DEPARTMENT OF EEE

VALUE ADDED COURSE

ON

"AI CONTROL TECHNIQUES FOR FACTS DEVICES"

Coordinator: Mr. N. Siddhik, Assistant Professor, EEE, KSRMCE

Resource Person: Mr. M. Bhaskar Reddy, Associate Professor, EEE, KSRMCE

Duration: **01/02/2023 to 17/02/2023**

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)

Kadapa, Andhra Pradesh, India– 516 005

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An ISO 14001:2004 & 9001: 2015 Certified Institution

Lr./KSRMCE/EEE/2022-23/

Date: 28-01-2023

To
The Principal,
KSRMCE,
Kadapa.

Respected Sir,

Sub: Permission to Conduct Value Added Course on "AI Control Techniques for FACTS Devices" from 01-02-23 to 17-02-23 – Req. – Reg.

The Department of EEE is planning to Conduct Value Added Course on "AI Control Techniques for FACTS Devices" for B. Tech final year students from 01-02-23 to 17-02-23. In this regard, I kindly request you to grant permission to conduct Certification Course.

Thanking you sir,

Forwarded to Principal Sir,
28.1.23

Yours faithfully

(Mr. N. Siddhik)

Permitted
V. S. S. Murty

K.S.R.M. COLLEGE OF ENGINEERING

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Kadapa, Andhra Pradesh, India– 516 005

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Cr./KSRMCE/EEE/2022-23/

Date: 30/01/2023

Circular

The Department of EEE is offering a Value Added Course on "AI Control Techniques for FACTS Devices" from **01/02/2023 to 17/02/2023** to B. Tech final year students. In this regard, interested students are requested to register for the Value Added Course.

For further information contact Course Coordinators.

Course Coordinators: Mr. N. Siddhik, Assistant Professor, Dept. of EEE - KSRMCE.
Contact No: 9642073661

HOD 30-1-23

Dept. of EEE

HEAD
Department of Electrical & Electronics Engineering
K.S.R.M. College of Engineering
Kadapa -516003.

Cc to:

IQAC-KSRMCE

K.S.R.M. COLLEGE OF ENGINEERING

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Kadapa, Andhra Pradesh, India– 516 005

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Date: 01-02-23

DEPARTMENT OF EEE

REGISTRATION FORM

Value Added Course

On

"AI Control Techniques for FCATS Devices" From 01/02/2023 to 17/02/2023

S. No	Full Name	Roll Number	Branch	Semester	Signature
1	ADIMULAM GANGADHAR	209Y1A0201	EEE	VII	A. Gangadhar
2	AMBAVARAM SANJANA (W)	209Y1A0202	EEE	VII	A. Sanjana
3	BANDI NEERAJA REDDY (W)	209Y1A0203	EEE	VII	B. Neeraja reddy.
4	BERI YASWANTH	209Y1A0204	EEE	VII	B. Yaswanth
5	CHEMIKALA RAMA DEVI (W)	209Y1A0205	EEE	VII	C. Rama Devi
6	DUGGIREDDY DHARANI (W)	209Y1A0207	EEE	VII	Dharani
7	DUGGIREDDY TEJASWINI (W)	209Y1A0209	EEE	VII	Tejaswini
8	GADWALA LINGAMAIAH	209Y1A0211	EEE	VII	G. Lingamaian.
9	GANDLA VENKATA SUNIL KUMAR	209Y1A0212	EEE	VII	D. Sunil kumar
10	KANJEEVARAM SAI RAHUL	209Y1A0214	EEE	VII	K. Sai rahul
11	KARNATAKAM LIKHITHA (W)	209Y1A0216	EEE	VII	K. Likhitha
12	KATIKA MOHAMMED KAIF ALI	209Y1A0217	EEE	VII	K. Mohammed Kaif Ali
13	KORAMUTLA MOHAN KRISHNA	209Y1A0218	EEE	VII	K. Mohan Krishna
14	KUMMARA VENKATA	209Y1A0219	EEE	VII	K. Venkata

S. No	Full Name	Roll Number	Branch	Semester	Signature
	SAI				
15	KUMMARI HEMANTH KUMAR	209Y1A0220	EEE	VII	
16	MADIREDDY GOWRI (W)	209Y1A0222	EEE	VII	
17	MALLELA CHANDRA BHARATH KUMAR REDDY	209Y1A0223	EEE	VII	
18	MALLEM CHARAN KUMAR	209Y1A0225	EEE	VII	
19	MUDDA MAHA LAKSHMI (W)	209Y1A0226	EEE	VII	
20	MUPPALLA PAVAN KUMAR	209Y1A0227	EEE	VII	
21	NAREDDY SASI REKHA (W)	209Y1A0228	EEE	VII	
22	NARUBOINA NAVEEN KUMAR	209Y1A0229	EEE	VII	
23	PACHIPALA YOGNA (W)	209Y1A0230	EEE	VII	
24	PANCHAMARTHI DAYANANDA	209Y1A0231	EEE	VII	
25	PENUGONDA RAVI SHANKAR	209Y1A0232	EEE	VII	
26	POTHURAJU SAI VIGNESH	209Y1A0233	EEE	VII	
27	SHAIK ALISHA SAMEERA (W)	209Y1A0240	EEE	VII	
28	SHAIK MAHAMMAD JAVEED	209Y1A0242	EEE	VII	
29	SHAIK MOHAMMED SAMEER	209Y1A0243	EEE	VII	
30	SHAIK PARVEZ	209Y1A0244	EEE	VII	
31	TALUPULA PALLAVI (W)	209Y1A0248	EEE	VII	
32	VEERAMALLU VINAY	209Y1A0249	EEE	VII	
33	YANGAMMAGARI SOMASHEKAR REDDY	209Y1A0252	EEE	VII	
34	BUSAGANI CHANDRA KUMAR	219Y5A0202	EEE	VII	
35	MAYAKUNTLA SRINIDHI (W)	219Y5A0203	EEE	VII	

Coordinators:

HOD

HEAD
Department of Electri
Electronics Enginee
K.S.R.M. College of Engi
Kadapa -516003.

SYLLABUS

AI CONTROL TECHNIQUES FOR FACTS DEVICES

Course Description: This course introduces AI control techniques for FACTS devices. Students will be equipped with fundamentals of FACTS controllers and the possibility of implementing AI Control Techniques..

Course Objectives:

1. Introduce the student to the fundamentals of AI Techniques
2. Acquire knowledge to implement AI Techniques in FACTS devices

Course Outcomes:

1. To understand the fundamentals of AI Techniques
2. Demonstrate various neural networks and genetic algorithms
3. Review basic concepts related to FACTS devices
4. Formulate the problems for solving the various FCATS devices using AI techniques.
5. Testing of various FACTS devices using AI techniques.

Course Content:

Module I:

Conventional reactive power compensation, Theory of Power Transmission Control, Basic principle of FACTS (Flexible AC Transmission System), Principle of Static VAr compensation (SVC). Basic Principle of Thyristor Controlled Series Compensation (TCSC) Basic series and shunt FACTS devices. Advance new generation FACTS devices, Control and coordination of FACTS devices, Locations of FACTS Devices.

Module II:

Concept of artificial intelligence, Problem solving methods and searching techniques. Fuzzy sets, Operation on fuzzy sets, Fuzzy relations, Fuzzy measures, Fuzzy logic, Fuzzy controller.

Module III:

Fundamental concepts, Basic models, Learning rules, Single layer and multi-layer feed-forward and feedback networks, Supervised and unsupervised learning, Recurrent networks, Modular network, Self organizing maps, Function networks, Neural network controller, Basic principle, Evolution of genetic algorithm, Hybrid genetic algorithm. Hybrid Systems: Integrated neural-

fuzzy system simulated evolution for neural network learning, Fast learning algorithms for training NN

Module IV:

Design problems on EHVAC long lines, Sub-synchronous resonance problem and counter measures, High voltage testing of AC equipment, Comparison of EHV AC & DC transmission HVDC system configuration and components conversion and inversion

Module V:

Analysis of three phase bridge converter and Performance equations, Control of HVDC system, Principle of DC link control, current and Extinction angle control, Transmission power control, alternative inverter control modes, Harmonics and AC/DC filters, Interaction responses to DC and AC system faults. Modelling of HVDC system.

Text Books:

1. Understanding FACTS , N.G.Hingorani and L. Gyugyi, IEEE Press 2001
2. FACTS: Modelling and Control, X.P. Zhang, Cristian Rehlanz, Bikash Pal, Springer Publications. 3. FACTS, Y.H. Song, A Johns, IET Publications.
3. ROBUST DESIGN OF FACTS CONTROLLER USING AI TECHNIQUE by Mohapatra, Biswajit / Sahoo, Amit Kumar

Reference Books:

1. Lin, C., Lee, G., Neural Fuzzy Systems, Prentice Hall International Inc. (2000).
2. Rajashekran, S. and VijaylaksmiPai, G.A., Neural Networks, Fuzzy Logic and GeneticAlgorithm Systhesis and Applications, Prentice–Hall of India Private Limited (2004).
3. Taylor, C.W., Power System Stability, McGraw–Hill (2007).
4. Kosko, B., Neural Networks and Fuzzy Systems: a Dynamical systems Approach to Machine Intelligence, Prentice–Hall of India Private Limited (1992).
5. Zurda, J.M., C++ Neural Networks and Fuzzy Logics, BPS Publication (2001).

SCHEDULE

Department of EEE

Value Added Course

On

"AI Control Techniques for FACTS Devices" From 01/02/2023 to 17/02/2023

Date	Timing	Resource Person	Topic to be covered
01/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Conventional reactive power compensation, Theory of Power Transmission Control, Basic principle of FACTS (Flexible AC Transmission System),
02/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Principle of Static VAr compensation (SVC). Basic Principle of Thyristor Controlled Series Compensation (TCSC) Basic series and shunt FACTS devices
03/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Advance new generation FACTS devices.
04/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Control and coordination of FACTS devices, Locations of FACTS Devices.
06/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Concept of artificial intelligence, Problem solving methods and searching techniques
07/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Fuzzy sets, Operation on fuzzy sets, Fuzzy relations, Fuzzy measures, Fuzzy logic, Fuzzy controller.
08/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Fundamental concepts, Basic models, Learning rules, Single layer and
09/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	multi-layer feed-forward and feedback networks, Supervised and unsupervised learning
10/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Recurrent networks, Modular network, Self organizing maps
13/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	, Function networks, Neural network controller
14/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Basic principle, Evolution of genetic

			algorithm, Hybrid genetic algorithm. Hybrid Systems: Integrated neural-fuzzy system simulated evolution for neural network learning, Fast learning algorithms for training NN
15/02/23	3 PM to 6 PM	Mr. M. Bhaskara Reddy	Design problems on EHVAC long lines, Sub-synchronous resonance problem and counter measures, High voltage testing of AC equipment,
16/02/23	4 PM to 6 PM	Mr. M. Bhaskara Reddy	Comparison of EHV AC & DC transmission HVDC system configuration and components conversion and inversion, Analysis of three phase bridge converter and Performance equations, Control of HVDC system
17/02/23	4 PM to 6 PM	Mr. M. Bhaskara Reddy	, Principle of DC link control, current and Extinction angle control, Transmission power control, alternative inverter control modes, Harmonics and AC/DC filters, Interaction responses to DC and AC system faults. Modelling of HVDC system.

Resource Person(s)

Coordinator(s)

HOD

HEAD
Department of Electrical & Electronics Engineering
K.S.R.M. College of Engineering
Kadapa -516003.

K.S.R.M. COLLEGE OF ENGINEERING

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DEPARTMENT OF EEE

Attendance sheet of Value Added Course on "AI Control Techniques for FACTS Devices" From 01/02/2023 to 17/02/2023

Sl. No.	Roll No.	Name	01/02/2023	02/02/2023	03/02/2023	04/02/2023	06/02/2023	07/02/2023	08/02/2023	09/02/2023	10/02/2023	13/02/2023	14/02/2023	15/02/2023	16/02/2023	17/02/2023
1	209Y1A0201	Adimulam Gangadhar														
2	209Y1A0202	Ambavaram Sanjana (W)														
3	209Y1A0203	Bandi Neeraja Reddy (W)														
4	209Y1A0204	Beri Yaswanth														
5	209Y1A0205	Chemikala Rama Devi (W)														
6	209Y1A0207	Duggireddy Dharani (W)														
7	209Y1A0209	Duggireddy Tejaswini (W)														
8	209Y1A0211	Gadwala Lingamaiah														
9	209Y1A0212	Gandla Venkata Sunil Kumar														
10	209Y1A0214	Kanjeevaram Sai Rahul														
11	209Y1A0216	Karnatakam Likhitha (W)														
12	209Y1A0217	Katika Mohammed Kaif Ali														
13	209Y1A0218	Koramutla Mohan Krishna														
14	209Y1A0219	Kummara Venkata Sai														
15	209Y1A0220	Kummari Hemanth Kumar														

16	209Y1A0222	Madireddy Gowri (W)																	
17	209Y1A0223	Mallela Chandra Bharath Kumar Reddy																	
18	209Y1A0225	Mallem Charan Kumar																	
19	209Y1A0226	Mudda Maha Lakshmi (W)																	
20	209Y1A0227	Muppalla Pavan Kumar																	
21	209Y1A0228	Nareddy Sasi Rekha (W)																	
22	209Y1A0229	Naruboina Naveen Kumar																	
23	209Y1A0230	Pachipala Yogna (W)																	
24	209Y1A0231	Panchamarthi Dayananda																	
25	209Y1A0232	Penugonda Ravi Shankar																	
26	209Y1A0233	Pothuraju Sai Vignesh																	
27	209Y1A0240	Shaik Alisha Sameera (W)																	
28	209Y1A0242	Shaik Mahammad Javeed																	
29	209Y1A0243	Shaik Mohammed Sameer																	
30	209Y1A0244	Shaik Parvez																	
31	209Y1A0248	Talupula Pallavi (W)																	
32	209Y1A0249	Veeramallu Vinay																	
33	209Y1A0252	Yangammagari Somashekar Reddy																	
34	219Y5A0202	Busagani Chandra Kumar																	
35	219Y5A0203	Mayakuntla Srinidhi (W)																	

Coordinator(s)

HoD

HEAD
Department of Electrical & Electronics Engineering
K.S.R.M. College of Engineering
Kadapa -516003.

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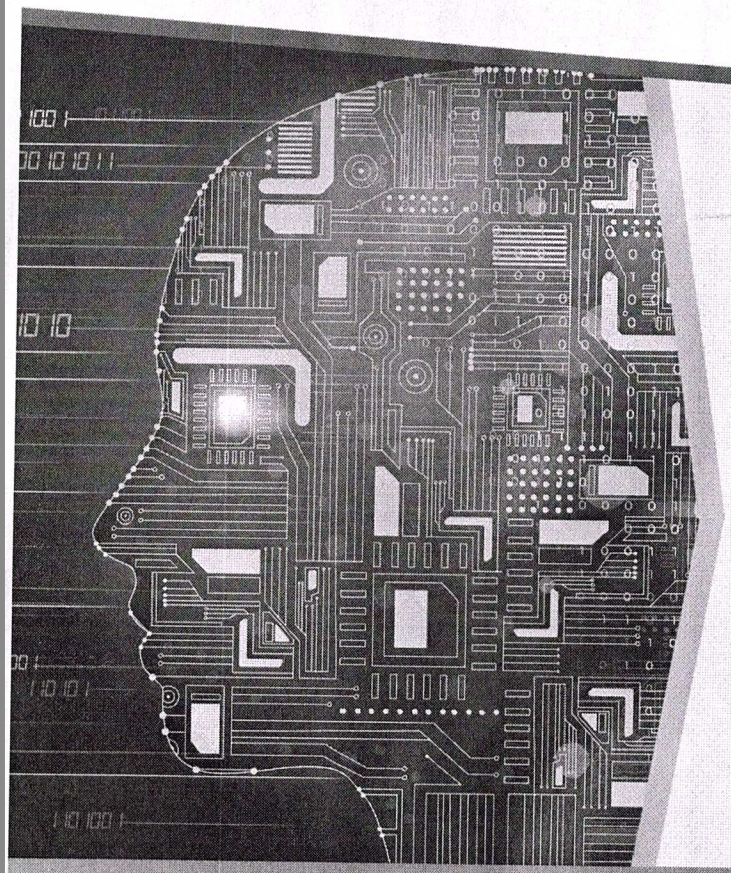
sh, India– 516 005
New Delhi & Affiliated to JNTUA, Ananthapuramu.

CONTROL TECHNIQUES FOR FACTS DEVIC



Department of EEE, KSRMCE

SJ 112

01-02-23
to
17-02-23

Resource Person **Mr. M. Bhaskara Reddy**
Associate Professor, EEE

Coordinator **Mr. N. Siddhik**

rthy
)

Dr. Kandula Chandra Obul Reddy
(MD, KGI)

Smt. K.Rajeswari
(Correspondent,Secretary,Treasurer)

Sri K. Madan Mohan Reddy
(Vice – Chairman)

Sri K. Raja Mol
(Chairm

eofficial

www.ksrmce.ac.in

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Department of EEE

Activity Report

Name of the Activity	:	Value Added Course
Title of the Course	:	AI Control Techniques for FACTS Devices
Date (s) covered	:	01-02-2023 to 17-02-2023
No of Hours	:	40
Target Audience	:	B. Tech VII semester students
No. of Participants	:	35
Resource Persons	:	Mr. M. Bhaskara Reddy Associate Professor, EEE, KSRMCE
Venue of the Event	:	SJ-112

Certificate Course Description:

Department of EEE, KSRMCE has organized a Value Added Course on "AI Control Techniques for FACTS Devices" from 01-02-2023 to 17-02-2023. This course covers 40 hours duration. Totally 35 students has registered for this course. The resource persons are explained about various AI control techniques for FCATS devices. Design of FACTS using AI techniques has been implemented in MATLAB Simulink by the students. The prescribed syllabus of this value added course is enclosed here with this report.

The pictures taken during the course are given below:

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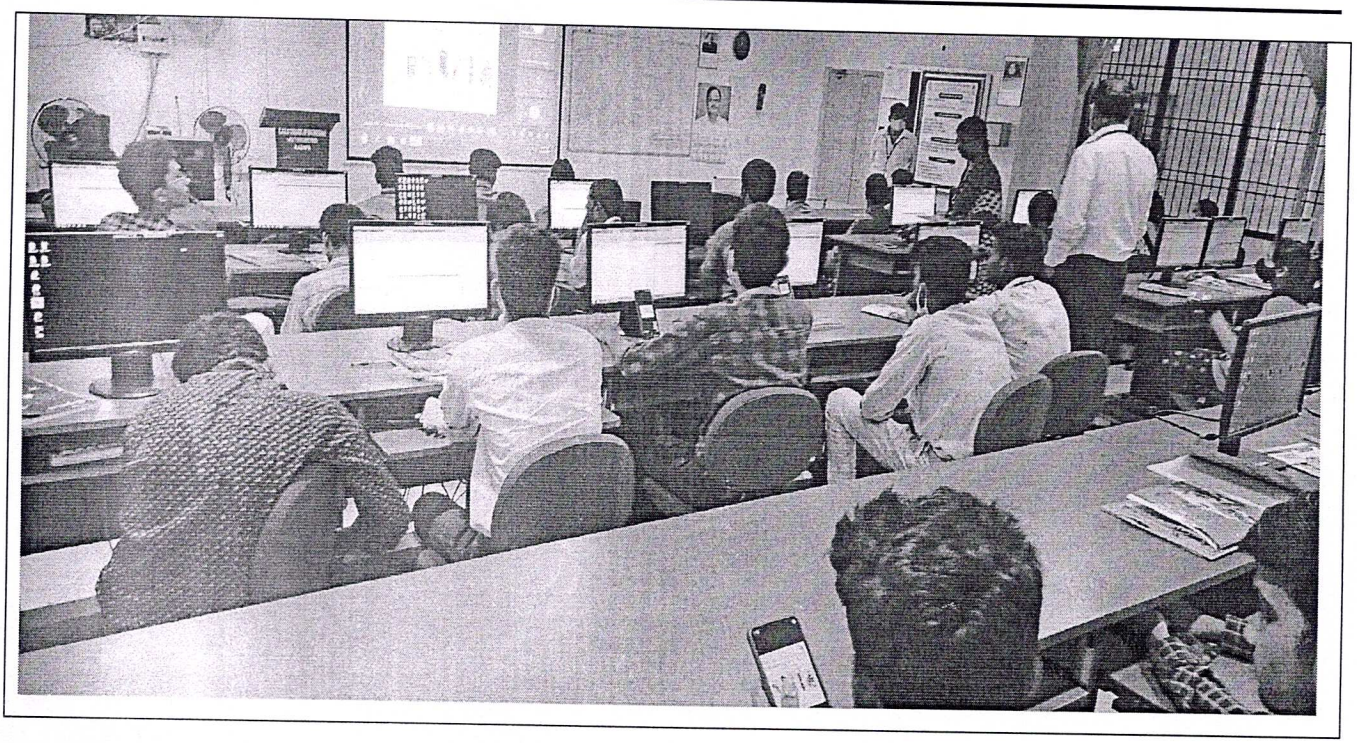

Coordinator

Head of the Department

HEAD
Department of Electrical &
Electronics Engineering
K.S.R.M. College of Engineering
Kadapa -516003.

Principal

K.S.R.M. COLLEGE OF ENGINEERING

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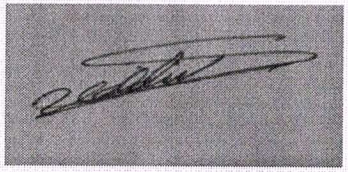
Kadapa, Andhra Pradesh, India– 516 005

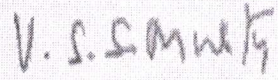
Certificate

This is to certify that **Adimulam Gangadhar** bearing roll no: **209Y1A0201** has attended a Value Added Course on **AI Control Techniques for FACTS Devices** organized by the Department of EEE, KSRM College of Engineering (Autonomous) from 01-02-23 to 17-02-23



Co-ordinators

HoD, EEE



Principal

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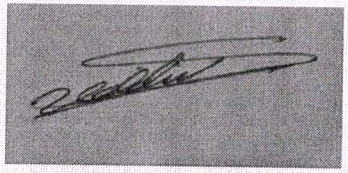
Kadapa, Andhra Pradesh, India– 516 005

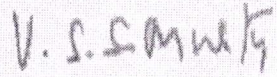
Certificate

This is to certify that **Chemikala Rama Devi** bearing roll no: **209Y1A0205** has attended a Value Added Course on **AI Control Techniques for FACTS Devices** organized by the Department of EEE, KSRM College of Engineering (Autonomous) from 01-02-23 to 17-02-23



Co-ordinators

HoD, EEE



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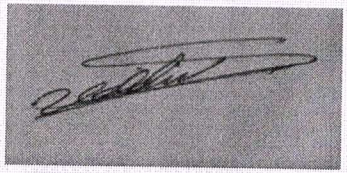
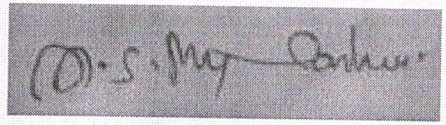
Kadapa, Andhra Pradesh, India– 516 005

Certificate

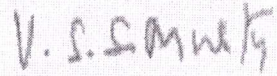
This is to certify that **Kanjeevaram Sai Rahul** bearing roll no: **209Y1A0214** has attended a Value Added Course on **AI Control Techniques for FACTS Devices** organized by the Department of EEE, KSRM College of Engineering (Autonomous) from 01-02-23 to 17-02-23



Co-ordinators



HoD, EEE



Principal

Feedback form on Value Added Course " AI Control Techniques for FACTS Devices" from 01-02-23 to 17-02-23

* Indicates required question

1. Roll Number *

_____

2. Name of the Student *

_____

3. The objectives of the Value Added Course were met (Objective) *

Mark only one oval.

- ◯ Excellent
- ◯ Good
- ◯ Satisfactory
- ◯ Poor

4. The content of the course was organized and easy to follow (Delivery) *

Mark only one oval.

- ◯ Excellent
- ◯ Good
- ◯ Satisfactory
- ◯ Poor

5. The Resource Persons were well prepared and able to answer any question * (Interaction)

Mark only one oval.

- ◯ Excellent
- ◯ Good
- ◯ Satisfactory
- ◯ Poor

6. The exercises/role play were helpful and relevant (Syllabus Coverage) *

Mark only one oval.

- ◯ Excellent
- ◯ Good
- ◯ Satisfactory
- ◯ Poor

7. The Value Added Course satisfy my expectation as a value added Programme * (Course Satisfaction)

Mark only one oval.

- ◯ Excellent
- ◯ Satisfactory
- ◯ Good
- ◯ Poor

8. Any Issues

_____

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Kadapa,Andhra Pradesh, India– 516 005

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Value Added Course on "AI Control Techniques for FACTS Devices"
01/02/2023 to 17/02/2023
Feedback responses

S.No.	Roll number	Name of the Student	The objectives of the Value Added Course were met (Objective)	The content of the course was organized and easy to follow (Delivery)	The Resource Persons were well prepared and able to answer any question (Interaction)	The exercises/role play were helpful and relevant (Syllabus Coverage)	The Value Added Course satisfy my expectation as a value added Programme (Course Satisfaction)	Any Issues
1	209Y1A0201	Adimulam Gangadhar	Excellent	Excellent	Excellent	Excellent	Excellent	Nothing
2	209Y1A0202	Ambavaram Sanjana (W)	Excellent	Excellent	Excellent	Excellent	Excellent	very good
3	209Y1A0203	Bandi Neeraja Reddy (W)	Good	Good	Good	Good	Good	very good
4	209Y1A0204	Beri Yaswanth	Excellent	Excellent	Excellent	Excellent	Excellent	very good
5	209Y1A0205	Chemikala Rama Devi (W)	Excellent	Excellent	Excellent	Excellent	Excellent	nothing
6	209Y1A0207	Duggireddy Dharani (W)	Excellent	Excellent	Excellent	Excellent	Excellent	Good
7	209Y1A0209	Duggireddy Tejaswini (W)	Excellent	Excellent	Excellent	Excellent	Excellent	Good
8	209Y1A0211	Gadwala Lingamaiah	Excellent	Excellent	Excellent	Excellent	Excellent	nothing

9	209Y1A0212	Gandla Venkata Sunil Kumar	Excellent	Excellent	Excellent	Excellent	Excellent	nothing
10	209Y1A0214	Kanjeevaram Sai Rahul	Good	Good	Good	Good	Good	nothing
11	209Y1A0216	Karnatakam Likhitha (W)	Excellent	Excellent	Excellent	Excellent	Excellent	Good
12	209Y1A0217	Katika Mohammed Kaif Ali	Excellent	Excellent	Excellent	Excellent	Excellent	Good
13	209Y1A0218	Koramutla Mohan Krishna	Good	Good	Good	Good	Good	very good
14	209Y1A0219	Kummara Venkata Sai	Excellent	Excellent	Excellent	Excellent	Excellent	very good
15	209Y1A0220	Kummari Hemanth Kumar	Excellent	Excellent	Excellent	Excellent	Excellent	nothing
16	209Y1A0222	Madireddy Gowri (W)	Good	Good	Good	Good	Good	very good
17	209Y1A0223	Mallela Chandra Bharath Kumar Reddy	Excellent	Excellent	Excellent	Excellent	Excellent	no
18	209Y1A0225	Mallem Charan Kumar	Good	Good	Good	Good	Good	nithing
19	209Y1A0226	Mudda Maha Lakshmi (W)	Excellent	Excellent	Excellent	Excellent	Excellent	Good
20	209Y1A0227	Muppalla Pavan Kumar	Excellent	Excellent	Excellent	Excellent	Excellent	Good
21	209Y1A0228	Nareddy Sasi Rekha (W)	Excellent	Excellent	Excellent	Excellent	Excellent	Good
22	209Y1A0229	Naruboina Naveen Kumar	Excellent	Excellent	Excellent	Excellent	Excellent	Good
23	209Y1A0230	Pachipala Yogna (W)	Excellent	Excellent	Excellent	Excellent	Excellent	Good
24	209Y1A0231	Panchamarthi Dayananda	Good	Good	Good	Good	Good	Good
25	209Y1A0232	Penugonda Ravi Shankar	Excellent	Excellent	Excellent	Excellent	Excellent	Good
26	209Y1A0233	Pothuraju Sai Vignesh	Excellent	Excellent	Excellent	Excellent	Excellent	Nothing
27	209Y1A0240	Shaik Alisha Sameera (W)	Excellent	Excellent	Excellent	Excellent	Excellent	no
28	209Y1A0242	Shaik Mahammad Javeed	Excellent	Excellent	Excellent	Excellent	Excellent	no
29	209Y1A0243	Shaik Mohammed	Excellent	Excellent	Excellent	Excellent	Excellent	no

		Sameer						
30	209Y1A0244	Shaik Parvez	Excellent	Excellent	Excellent	Excellent	Excellent	no
31	209Y1A0248	Talupula Pallavi (W)	Excellent	Excellent	Excellent	Excellent	Excellent	nothing
32	209Y1A0249	Veeramallu Vinay	Good	Good	Good	Good	Good	Nothing
33	209Y1A0252	Yangammagari Somashekar Reddy	Excellent	Excellent	Excellent	Excellent	Excellent	no
34	219Y5A0202	Busagani Chandra Kumar	Excellent	Excellent	Excellent	Excellent	Excellent	Nothing
35	219Y5A0203	Mayakuntla Srinidhi (W)	Excellent	Excellent	Excellent	Excellent	Excellent	Good

Coordinator

HoD/EEE

K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516005
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
VALUE ADDED COURSE ON
AI CONTROL TECHNIQUES FOR FACTS DEVICES FROM 01/02/2023 TO 17/02/2023
AWARD LIST

S.No	Roll Number	Name of the Student	Marks Obtained
1	209Y1A0201	Adimulam Gangadhar	12
2	209Y1A0202	Ambavaram Sanjana (W)	16
3	209Y1A0203	Bandi Neeraja Reddy (W)	17
4	209Y1A0204	Beri Yaswanth	19
5	209Y1A0205	Chemikala Rama Devi (W)	15
6	209Y1A0207	Duggireddy Dharani (W)	18
7	209Y1A0209	Duggireddy Tejaswini (W)	16
8	209Y1A0211	Gadwala Lingamaiah	14
9	209Y1A0212	Gandla Venkata Sunil Kumar	14
10	209Y1A0214	Kanjeevaram Sai Rahul	17
11	209Y1A0216	Karnatakam Likhitha (W)	16
12	209Y1A0217	Katika Mohammed Kaif Ali	16
13	209Y1A0218	Koramutla Mohan Krishna	19
14	209Y1A0219	Kummara Venkata Sai	20
15	209Y1A0220	Kummari Hemanth Kumar	15
16	209Y1A0222	Madireddy Gowri (W)	16
17	209Y1A0223	Mallela Chandra Bharath Kumar Reddy	16
18	209Y1A0225	Mallem Charan Kumar	18
19	209Y1A0226	Mudda Maha Lakshmi (W)	18
20	209Y1A0227	Muppalla Pavan Kumar	19
21	209Y1A0228	Nareddy Sasi Rekha (W)	17
22	209Y1A0229	Naruboina Naveen Kumar	15
23	209Y1A0230	Pachipala Yogna (W)	16
24	209Y1A0231	Panchamarthi Dayananda	15
25	209Y1A0232	Penugonda Ravi Shankar	17
26	209Y1A0233	Pothuraju Sai Vignesh	16
27	209Y1A0240	Shaik Alisha Sameera (W)	16
28	209Y1A0242	Shaik Mahammad Javeed	15
29	209Y1A0243	Shaik Mohammed Sameer	17
30	209Y1A0244	Shaik Parvez	15
31	209Y1A0248	Talupula Pallavi (W)	19
32	209Y1A0249	Veeramallu Vinay	16
33	209Y1A0252	Yangammagari Somashekar Reddy	19
34	219Y5A0202	Busagani Chandra Kumar	14
35	219Y5A0203	Mayakuntla Srinidhi (W)	16

Coordinator(s)

HoD EEE

HEAD
Department of Electrical & Electronics Engineering
K.S.R.M. College of Engineering
Kadapa -516003.

12

K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516005
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
VALUE ADDED COURSE ON
AI CONTROL TECHNIQUES FOR FACTS DEVICES FROM 01/02/2023TO 17/02/2023
ASSESSMENT TEST **Date:** 17/2/2023

Roll Number: 20941A0201 **Name of the Student:** A. Gangadhar

Time: 20 Min **(Objective Questions)** **Max.Marks:20**

Note: Answer the following Questions and each question carries one mark.

1. FACTS devices used in [b]
   A. Generation B. AC Transmission C. DC Transmission D. None

2. Voltage Control means [c]
   A. Boosting the feeder voltage B. Reducing the Line Voltage
   C. Voltage level within the allowable limits D. None

3. Line drop compensation corrects for [d]
   A. Line drop lagging P.F B. Voltage at leading P.F
   C. Transformer voltage drop D. voltage drop in feeder lines

4. Which are the shunt compensation? [b d]
   A. TCSC B. SSSC C. UPFC D. SVC

5. FACTS devices are generally used for to compensate_____of the transmission [c]
   A. reactive power B. active power c. apparent power d. None

6. Transmission efficiency increases as [a]
   A. voltage and power factor both increase
   B. B. voltage and power factor both decrease
   C. voltage increases but power factor decreases
   D. D. voltage decreases but power factor increases.

7. SVC and STATCOM are_____ devices. [d]
   A. series B. series and shunt C. shunt and series D. shunt

8. SVC stands for_____. [b]
   A. Static Var Compensator B. Static voltage controller
   B. Static var converter D. Static voltage converter

9. STATCOM is_____ regulating device. [c]
   A. Current B. Voltage C. Current and Voltage D. Power factor

10. The main Objective of series compensation [a]
A. It improve the power factor B. It reduces the fault currents
B. Reduce the voltage drop over long distance D. None

11. TCSC is a [a]
A. Shunt compensation device B. Series compensation device
B. C. Both A & B D. None of the above

12. Disadvantage with series compensation [d]
A. Reduce the stability B. increase the voltage drop
C. Reduce the power factor D. Increase in fault current

13. Transmission Interconnection is done for_____ [d]
A. economic reasons B. to reduce the cost of electricity and
C. to improve reliability of power supply. D. All of these

14. FACTS controllers can enable a line to carry power closer to its_____ [b]
A. Full efficiency B. Dielectric rating c. Thermal rating D. Both A and B

15. What limits the loading capability_____ [b]
A. Thermal B. Dielectric
C. Stability D. All of these

16. Basic types of FACTS controller_____ [b]
A. Series Controllers and Shunt Controllers B. Combined series-series Controllers
C. Combined series-shunt Controllers D. All of these

17. The voltage fluctuations are largely a consequence of the _____ in series impedances of lines, transformers, and generators. [d]
A. Current B. Power C. Voltage drop D. None of these

18. Objectives of Load compensation_____ [d]
A. Power-factor correction. B. Improvement of voltage regulation.
C. Load balancing D. All of these

19. What is the necessity of compensation? [a]
A. Voltage profile B. Power angle characteristics
C. Stability margin D. Damping to power oscillations

20. FACTS mainly find application in following areas. [a]
A. Power transmission B. Power Quality C. Railway Grid Connection
D. Wind power grid Connection

16

K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516005
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
VALUE ADDED COURSE ON
AI CONTROL TECHNIQUES FOR FACTS DEVICES FROM 01/02/2023TO 17/02/2023
ASSESSMENT TEST **Date:** 17/02/23

Roll Number: 209Y1A0202 **Name of the Student:** A. Sanjana

Time: 20 Min **(Objective Questions)** **Max.Marks:20**

Note: Answer the following Questions and each question carries one mark.

1. FACTS devices used in [b]
   A. Generation B. AC Transmission C. DC Transmission D. None

2. Voltage Control means [C]
   A. Boosting the feeder voltage B. Reducing the Line Voltage
   C. Voltage level within the allowable limits D. None

3. Line drop compensation corrects for [b]
   A. Line drop lagging P.F B. Voltage at leading P.F
   C. Transformer voltage drop D. voltage drop in feeder lines

4. Which are the shunt compensation? [d]
   A. TCSC B. SSSC C. UPFC D. SVC

5. FACTS devices are generally used for to compensate_____of the transmission [b]
   A. reactive power B. active power c. apparent power d. None

6. Transmission efficiency increases as [a]
   A. voltage and power factor both increase
   B. B. voltage and power factor both decrease
   C. voltage increases but power factor decreases
   D. D. voltage decreases but power factor increases.

7. SVC and STATCOM are_____ devices. [d]
   A. series B. series and shunt C. shunt and series D. shunt

8. SVC stands for_____. [b]
   A. Static Var Compensator B. Static voltage controller
   B. Static var converter D. Static voltage converter

9. STATCOM is_____ regulating device. [C]
   A. Current B. Voltage C. Current and Voltage D. Power factor

10. The main Objective of series compensation [b]
A. It improve the power factor B. It reduces the fault currents
B. Reduce the voltage drop over long distance D. None

11. TCSC is a [a]
A. Shunt compensation device B. Series compensation device
B. C. Both A & B D. None of the above

12. Disadvantage with series compensation [c]
A. Reduce the stability B. increase the voltage drop
C. Reduce the power factor D. Increase in fault current

13. Transmission Interconnection is done for_____ [d]
A. economic reasons B. to reduce the cost of electricity and
C. to improve reliability of power supply. D. All of these

14. FACTS controllers can enable a line to carry power closer to its_____ [d]
A. Full efficiency B. Dielectric rating c. Thermal rating D. Both A and B

15. What limits the loading capability_____ [d]
A. Thermal B. Dielectric
C. Stability D. All of these

16. Basic types of FACTS controller_____ [d]
A. Series Controllers and Shunt Controllers B. Combined series-series Controllers
C. Combined series-shunt Controllers D. All of these

17. The voltage fluctuations are largely a consequence of the _____ in series impedances of lines, transformers, and generators. [d]
A. Current B. Power C. Voltage drop D. None of these

18. Objectives of Load compensation_____ [d]
A. Power-factor correction. B. Improvement of voltage regulation.
C. Load balancing D. All of these

19. What is the necessity of compensation? [a]
A. Voltage profile B. Power angle characteristics
C. Stability margin D. Damping to power oscillations

20. FACTS mainly find application in following areas. [a]
A. Power transmission B. Power Quality C. Railway Grid Connection
D. Wind power grid Connection

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K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516005
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
VALUE ADDED COURSE ON
AI CONTROL TECHNIQUES FOR FACTS DEVICES FROM 01/02/2023TO 17/02/2023
ASSESSMENT TEST **Date:** 17/02/2023

Roll Number: 20Q4A0203 **Name of the Student:** B. Neeraja Reddy

Time: 20 Min **(Objective Questions)** **Max.Marks:20**

Note: Answer the following Questions and each question carries one mark.

1. FACTS devices used in [a]
   A. Generation B. AC Transmission C. DC Transmission D. None

2. Voltage Control means [c]
   A. Boosting the feeder voltage B. Reducing the Line Voltage
   C. Voltage level within the allowable limits D. None

3. Line drop compensation corrects for [a]
   A. Line drop lagging P.F B. Voltage at leading P.F
   C. Transformer voltage drop D. voltage drop in feeder lines

4. Which are the shunt compensation? [b]
   A. TCSC B. SSSC C. UPFC D. SVC

5. FACTS devices are generally used for to compensate_____of the transmission [a]
   A. reactive power B. active power c. apparent power d. None

6. Transmission efficiency increases as [a]
   A. voltage and power factor both increase
   B. B. voltage and power factor both decrease
   C. voltage increases but power factor decreases
   D. D. voltage decreases but power factor increases.

7. SVC and STATCOM are_____ devices. [d]
   A. series B. series and shunt C. shunt and series D. shunt

8. SVC stands for_____. [b]
   A. Static Var Compensator B. Static voltage controller
   B. Static var converter D. Static voltage converter

9. STATCOM is_____ regulating device. [C]
   A. Current B. Voltage C. Current and Voltage D. Power factor

10. The main Objective of series compensation [b]
A. It improve the power factor B. It reduces the fault currents
B. Reduce the voltage drop over long distance D. None

11. TCSC is a [b]
A. Shunt compensation device B. Series compensation device
B. C. Both A & B D. None of the above

12. Disadvantage with series compensation [d]
A. Reduce the stability B. increase the voltage drop
C. Reduce the power factor D. Increase in fault current

13. Transmission Interconnection is done for_____ [d]
A. economic reasons B. to reduce the cost of electricity and
C. to improve reliability of power supply. D. All of these

14. FACTS controllers can enable a line to carry power closer to its_____ [d]
A. Full efficiency B. Dielectric rating c. Thermal rating D. Both A and B

15. What limits the loading capability_____ [d]
A. Thermal B. Dielectric
C. Stability D. All of these

16. Basic types of FACTS controller_____ [d]
A. Series Controllers and Shunt Controllers B. Combined series-series Controllers
C. Combined series-shunt Controllers D. All of these

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A. Current B. Power C. Voltage drop D. None of these

18. Objectives of Load compensation_____ [d]
A. Power-factor correction. B. Improvement of voltage regulation.
C. Load balancing D. All of these

19. What is the necessity of compensation? [a]
A. Voltage profile B. Power angle characteristics
C. Stability margin D. Damping to power oscillations

20. FACTS mainly find application in following areas. [a]
A. Power transmission B. Power Quality C. Railway Grid Connection
D. Wind power grid Connection

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K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516005
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
VALUE ADDED COURSE ON
AI CONTROL TECHNIQUES FOR FACTS DEVICES FROM 01/02/2023TO 17/02/2023
ASSESSMENT TEST **Date:** 17-2-2023

Roll Number: 209Y1A0204 **Name of the Student:** B. Yaswanth

Time: 20 Min **(Objective Questions)** **Max.Marks:20**

Note: Answer the following Questions and each question carries one mark.

1. FACTS devices used in [a]
   A. Generation B. AC Transmission C. DC Transmission D. None

2. Voltage Control means [c]
   A. Boosting the feeder voltage B. Reducing the Line Voltage
   C. Voltage level within the allowable limits D. None

3. Line drop compensation corrects for [a]
   A. Line drop lagging P.F B. Voltage at leading P.F
   C. Transformer voltage drop D. voltage drop in feeder lines

4. Which are the shunt compensation? [d]
   A. TCSC B. SSSC C. UPFC D. SVC

5. FACTS devices are generally used for to compensate_____of the transmission [b]
   A. reactive power B. active power c. apparent power d. None

6. Transmission efficiency increases as [a]
   A. voltage and power factor both increase
   B. B. voltage and power factor both decrease
   C. voltage increases but power factor decreases
   D. D. voltage decreases but power factor increases.

7. SVC and STATCOM are_____ devices. [d]
   A. series B. series and shunt C. shunt and series D. shunt

8. SVC stands for_____. [a]
   A. Static Var Compensator B. Static voltage controller
   B. Static var converter D. Static voltage converter

9. STATCOM is_____ regulating device. [c]
   A. Current B. Voltage C. Current and Voltage D. Power factor

10. The main Objective of series compensation [b]
A. It improve the power factor B. It reduces the fault currents
B. Reduce the voltage drop over long distance D. None

11. TCSC is a [a]
A. Shunt compensation device B. Series compensation device
B. C. Both A & B D. None of the above

12. Disadvantage with series compensation [d]
A. Reduce the stability B. increase the voltage drop
C. Reduce the power factor D. Increase in fault current

13. Transmission Interconnection is done for_____ [d]
A. economic reasons B. to reduce the cost of electricity and
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14. FACTS controllers can enable a line to carry power closer to its_____ [d]
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15. What limits the loading capability_____ [d]
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C. Stability D. All of these

16. Basic types of FACTS controller_____ [d]
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18. Objectives of Load compensation_____ [d]
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C. Load balancing D. All of these

19. What is the necessity of compensation? [a]
A. Voltage profile B. Power angle characteristics
C. Stability margin D. Damping to power oscillations

20. FACTS mainly find application in following areas. [a]
A. Power transmission B. Power Quality C. Railway Grid Connection
D. Wind power grid Connection

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K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516005
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
VALUE ADDED COURSE ON
AI CONTROL TECHNIQUES FOR FACTS DEVICES FROM 01/02/2023TO 17/02/2023
ASSESSMENT TEST **Date:** 17.2.23.

Roll Number: 209Y1AD219 **Name of the Student:** K. Venkata Sai

Time: 20 Min **(Objective Questions)** **Max.Marks:20**

Note: Answer the following Questions and each question carries one mark.

1. FACTS devices used in [a]
   A. Generation B. AC Transmission C. DC Transmission D. None

2. Voltage Control means [c]
   A. Boosting the feeder voltage B. Reducing the Line Voltage
   C. Voltage level within the allowable limits D. None

3. Line drop compensation corrects for [a]
   A. Line drop lagging P.F B. Voltage at leading P.F
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4. Which are the shunt compensation? [d]
   A. TCSC B. SSSC C. UPFC D. SVC

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   A. voltage and power factor both increase
   B. B. voltage and power factor both decrease
   C. voltage increases but power factor decreases
   D. D. voltage decreases but power factor increases.

7. SVC and STATCOM are_____ devices. [d]
   A. series B. series and shunt C. shunt and series D. shunt

8. SVC stands for_____. [a]
   A. Static Var Compensator B. Static voltage controller
   B. Static var converter D. Static voltage converter

9. STATCOM is_____ regulating device. [c]
   A. Current B. Voltage C. Current and Voltage D. Power factor

10. The main Objective of series compensation [b]
A. It improve the power factor B. It reduces the fault currents
B. Reduce the voltage drop over long distance D. None

11. TCSC is a [a]
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B. C. Both A & B D. None of the above

12. Disadvantage with series compensation [d]
A. Reduce the stability B. increase the voltage drop
C. Reduce the power factor D. Increase in fault current

13. Transmission Interconnection is done for_____ [d]
A. economic reasons B. to reduce the cost of electricity and
C. to improve reliability of power supply. D. All of these

14. FACTS controllers can enable a line to carry power closer to its_____ [d]
A. Full efficiency B. Dielectric rating c. Thermal rating D. Both A and B

15. What limits the loading capability_____ [d]
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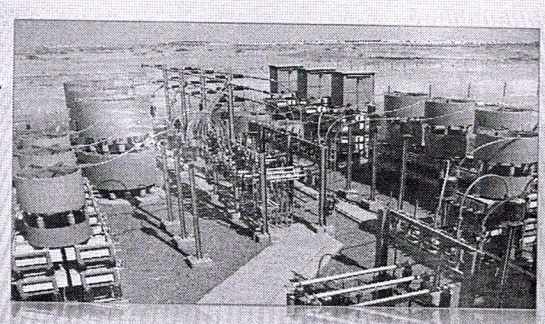
18. Objectives of Load compensation_____ [d]
A. Power-factor correction. B. Improvement of voltage regulation.
C. Load balancing D. All of these

19. What is the necessity of compensation? [a]
A. Voltage profile B. Power angle characteristics
C. Stability margin D. Damping to power oscillations

20. FACTS mainly find application in following areas. [a]
A. Power transmission B. Power Quality C. Railway Grid Connection
D. Wind power grid Connection



VALUE ADDED COURSE ON AI TECHNIQUES FOR FACTS DEVICES

BY - Mr. M. Bhaskara Reddy
Associate Professor, EEE, KSRMCE

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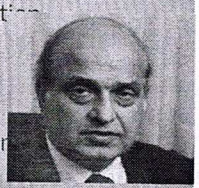
WHAT IS FACTS DEVICES?

- The concept of FACTS (Flexible Alternating Current Transmission System) refers to a family of power electronics-based devices able to enhance AC system controllability and stability and to increase power transfer capability.
- FACTS is defined by the IEEE as "a power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability."
- According to Siemens "FACTS Increase the reliability of AC grids and reduce power delivery costs. They improve transmission quality and efficiency of power transmission by supplying inductive or reactive power to the grid

PIONEERING IN FACTS

- DR.Narine G.Hingorani is the father of FACTS TENHNOLOGY.
- He worked in bournville power administrat[illegible]
- This is a 500kv, 3phase 60Hz substation.
- C.J.Slatt Substation near Arlington, Oregon



HISTORY, CONCEPTS, BACKGROUND, AND ISSUES

- **Origin of FACTS**
  - **-Oil Embargo of 1974 and 1979**
  - **-Environmental Movement**
  - **-Magnetic Field Concerns**
  - **-Permit to build new transmission lines**
  - **-HVDC and SVCs**
  - **-EPRI FACTS Initiative (1988)**
  - **-Increase AC Power Transfer (GE and DOE Papers)**
  - **-The Need for Power semiconductors**
- **Why we need transmission interconnection**
  - **-Pool power plants and load centers to minimize generation cost**
  - **-Important in a deregulated environment**
- **Opportunities for FACTS**
  - **Increase power transfer capacity**
  - **SVC (Nebraska GE 1974, Minnesota Westinghouse 1975, Brazil Siemens 1985)**
  - **TCSC, UPFC AEP 1999**

POWER FACTOR AFFECTS TRANSMISSION LINE ?

- Presence of thick insulators and long transmission line.
- Improper distribution of load factors.
- For e.g.-inductors are said to consume reactive power & capacitor said to be supply it.
- Improper distribution of these loads causes power factor below one

CORRECTION- By using facts device ,we maintain power factor ,avoids losses.

BENEFITS OF FACTS DEVICES

- Better utilization of existing transmission system assets.
- Increased transmission system reliability & availability.
- Increased dynamic & transient grid.
- Stablility & reduction of loop flows.
- Increased quality of supply for sensitive industries.
- Environmental benefits.

WHY FACTS DEVICES?

The recent development of power electronics, FACTS Tech. provides opportunity to -

- Increase loading capacity of transmission line.
- Prevent blackouts.
- Improve generation productivity.
- Reduce circulation reactive power.
- Reduce damping and oscillations.

KINDS OF FACTS DEVICES

- SERIES COMPENSATION
  - TCSC
  - TCSR
  - TSSC
  - TSSR
- SHUNT COMPENSATION
  - STATCOM
  - STAT VAR (SVC)
    - TCR
    - TSR
    - TSC

FIG.FACTS CONTROLLERS

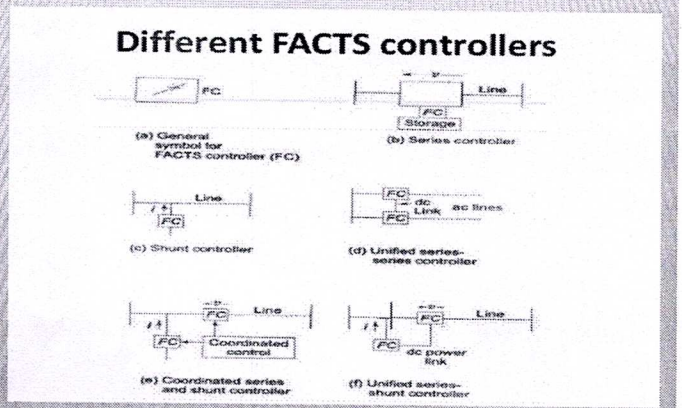
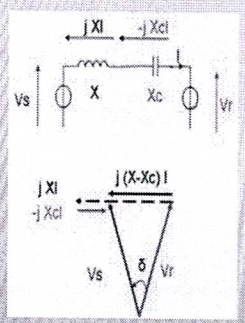
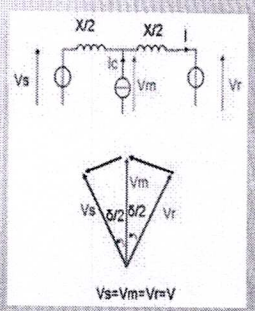


FIG.SERIES AND SHUNT FACTS





STATIC SYNCHRONOUS SERIES COMPENSATOR (SSSC)

- Thyristor-controlled series capacitor (TCSC)- a series capacitor bank is shunted by a thyristor-controlled reactor.
- Thyristor-switched series reactor (TSSR): a series reactor bank is shunted by a thyristor-switched reactor.
- Thyristor-switched series capacitor (TSSC)- a series capacitor bank is shunted by a thyristor-switched reactor.
- Thyristor-switched series reactor (TSSR)- a series reactor bank is shunted by a thyristor-switched reactor.

STATIC VAR COMPENSATOR

- It is providing for fast acting reactive power on high voltage electricity transmission network.
- It is used for regulating voltage, power factor, harmonics & stabilizing the system.
- Designed to bring the system closer to unity power factor.

STATIC VAR COMPENSATOR (SVC)

- Variable Thyristor controlled shunt impedance

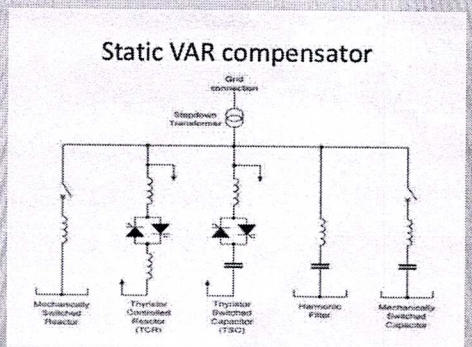
*Variable reactive power source

*Provides ancillary services
- -Maintains a smooth voltage profile
- -Increases transfer capability
- -Reduces losses

*Mitigates active power oscillations

*Controls dynamic voltage swings under various system conditions

FIG. STATIC VAR COMPENSATOR



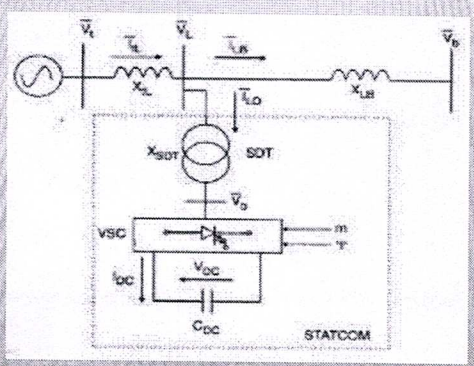
STATIC VAR COMPENSATOR (SVC) TYPES

- Thyristor-controlled reactor (TCR)
- Thyristor-switched reactor (TSR
- Thyristor-switched capacitor (TSC)

STATCOM

- It is a regulating device used on alternating current electricity transmission network.
- To reduce poor power factor & poor voltage regulation.
- It is based on power electronics voltage source inverter.
- It is acts as either a source or sink of reactive AC POWER.

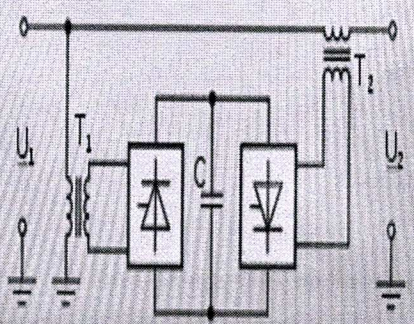
FIG. STATCOM



UNIFIED POWER FLOW CONTROLLER

- Latest in series connected FACTS controllers.
- The UPFC is a combination of a static synchronous series compensator .
- It allows function such as stability control to suppress power system oscillations & transient stability of power stability.

FIG.UNIFIED POWER FLOW CONTROLLER



TECHNICAL BENEFITS

DEVICES	LOAD FLOW CONTROL	VOLTAGE CONTROL	TRANSIENT STABILITY	DYNAMIC STABILITY
SVC	LESS	HIGH	LOW	MEDIUM
STATCOM	LESS	HIGH	MEDIUM	MEDIUM
TCSC	MEDIUM	LESS	HIGH	MEDIUM
UPFC	HIGH	HIGH	MEDIUM	MEDIUM

INFERENCE OF FACTS

- MAINTENANCE –

1.Minimal & similar to req. shunt capacitor, reactor and X-mer.

2.Amount of maintenance ranges- 150 to 200 man hrs/yr.

OPERATION-

1.Operated automatically.

2.Can be done locally and remotely.

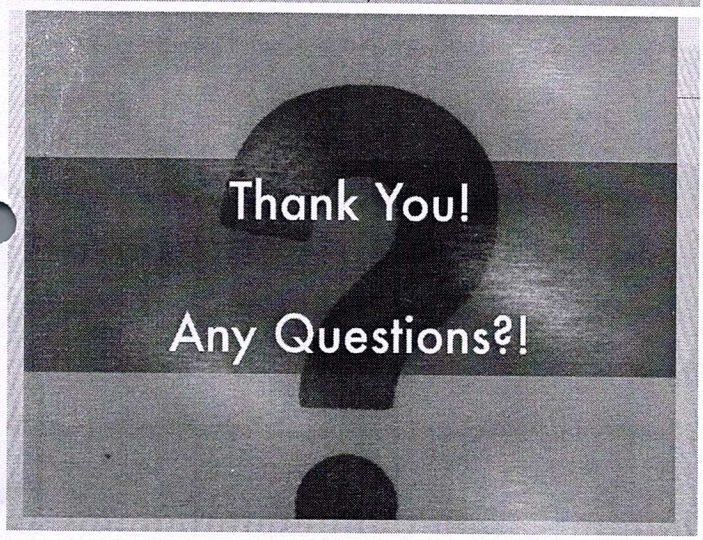
APPLICATION OF FACTS

- Steady state voltage stability.
- Power flow control.
- Damping of power system oscillations.
- Reducing generation costs.
- Hvdc link application.
- Deregulated power system.
- Flicker mitigation.

FUTURE ENHANCEMENT OF FACTS

- Several FACTS devices have been introduced for various application world-wide.
- Number of new types of devices are in the stage of being introduced in practice.
- Many FACTS devices are in under research-

1.Hybrid flow controller(HFC)
2.Distributed power flow controller(DPFC)
3.C-UPFC (centre node).



CONCLUSION

- Due to enhancement of transmission line of power system, we keep increasing the demand as well as with high efficiency which become a sort of designing of new components.
- The development of high power inverter of high performance at low cost is necessary to consolidate compensators as STATCOM,SSSC,UPFC etc
- The areas is to be improved would be as-

1.Converter topology.
2.Basic control strategies.
3.The application of multilevel facts devices.