DEPARTMENT OF ELECTRICAL ENGINEERING
Faculty of Engineering and Technology
JAMIA MILLIA ISLAMIA

JAMIA NAGAR, NEW DELHI – 110025
Ph.: 26982651, 26985831,269831717Ext. 387
Fax : 011 - 26981261, GRAMS: JAMIA

Date: 17.10.2019

Courses Focused on Employability/Entrepreneurship/Skill Development

This is to certify that the following courses offered during 2014-2019 by the Department of Electrical Engineering are focused on enhancing the Employability/Entrepreneurship/Skill Development.

Name of the Course	Course Code	Name of the Programme	Activities with direct bearing on Employability/ Entrepreneurship/ Skill development	Year of Introduction
Bachelor course	B14	B. Tech. (Electrical Engineering)	Industrial Training	1985
			Seminar	
			Project	
			Microcontroller and its Applications (EES-703)	
			Energy Management System (EES-803)	
			Programming Languages (EES-404)	
			Soft Computing (EES-705)	
Master course	M46	M. Tech. in Electrical Power System & Management (EPSM)	Seminar	2003
			Project	
			Smart Grid Technologies (EEM-308)	
			Automation Systems (EEM-107)	
Master course	M47	M. Tech. in Control & Instrumentation (CIS)	Seminar	2012
			Project	
			Automation Systems (EEM-107)	
			Intelligent Techniques (EEM-101)	
Bachelor course (Evening)	B17	B.E. (Electrical Engineering) (Evening)	Seminar	1991
			Project	
			Soft Computing	

(Prof. Z. A. Jaffery)
Head

Department of Electrical Engineering
Faculty of Engineering and Technology
Jamia Millia Islamia, New Delhi, INDIA

List of Courses for UG

Programme: **B. Tech. in Electrical Engineering**

The overall credits structure

Core Courses		Elective Courses	
Category	Credits	Category	Credits
DC:	125	CBCS:	27
SEC:	27	DE:	12
AECC	20	-	
Total	172	Total	39

Total Credits=211

CBCS: Choice Based Credit System

Course No.	Course Title	L T P	Credits
EES-304	Signals and Systems	3 1 0	4
EES-405	Engineering Mathematics-III	3 1 0	4
EES-504	Electrical Measurement-I	3 1 0	4
EES-604	Power Station Practice	3 1 0	4
EES-703	Renewable and Sustainable Energy Systems	3 1 0	4
EES-803	Process Control	3 1 0	4
EES-804	Electrical Machine Design	3 1 0	4
EES-805	Advanced Protective Relays	3 1 0	4
EES-806	Utilization of Electrical Energy	3 1 0	4

DC: Departmental core

EES-301	Electrical Machines-I	3 1 0	4
EES-302	Network Analysis & Synthesis	3 1 0	4
EES-303	Analog Electronics	3 1 0	4
EES-331	Electrical Machines-I Lab.	0 0 4	2
EES-401	Electrical Machines –II	3 1 0	4
EES-402	Digital Electronics	3 1 0	4
EES-403	Power Systems-I	3 1 0	4
EES-404	Programming Languages	3 1 0	4
EES-431	Electrical Machines-II Lab.	0 0 4	2
EES-501	Control Systems - I	3 1 0	4
EES-502	Power Electronics	3 1 0	4
EES-503	Communication Systems	3 1 0	4
EES-505	Power Systems-II	3 1 0	4
EES-531	Control Systems Lab	0 0 4	2
EES-601	Switchgear and Protection	3 1 0	4
EES-602	Electrical measurement-II	3 1 0	4
EES-701	Advanced Power Systems	3 1 0	4
EES-731	Power Systems Lab	0 0 4	2
EES-750	Minor Project	0 0 12	6
EES-801	Industrial Management	3 1 0	4
EES-850	Major Project	0 0 16	8

DE: Departmental electives

EES-605	Electric Drives	3 1 0	4
EES-606	Computer Architecture	3 1 0	4
EES-607	Engineering Materials	3 1 0	4
EES-608	PLC	3 1 0	4
EES-705	Soft Computing	3 1 0	4
EES-706	Digital Signal Processing	3 1 0	4
EES-707	High Voltage Engineering	3 1 0	4
EES-708	Special Electrical Machines	3 1 0	4
EES-709	Bio Medical Instrumentation	3 1 0	4
EES-710	HVDC Transmission	3 1 0	4
EES-807	Data Communications and Computer Networks	3 1 0	4
EES-808	Advanced Microprocessors	3 1 0	4
EES-809	Micro Controllers	3 1 0	4

SEC: Skill Enhancement Courses

EES-332	Network Analysis & Synthesis Lab.	0 0 4	2
EES-333	Analog Electronics Lab.	0 0 4	2
EES-432	Digital Electronics Lab.	0 0 4	2
EES-434	Programming Languages Lab	0 0 4	2
EES-532	Power Electronics Lab	0 0 4	2
EES-533	Communication Systems Lab	0 0 4	2
EES-631	Switchgear and Protection Lab	0 0 4	2
EES-632	Electrical Measurement Lab	0 0 4	2
EES-633	Microprocessor Lab	0 0 4	2
EES-640	Seminar	0 0 4	2
EES-732	Smart Grid - SCADA Lab	0 0 4	2
EES-840	Industrial Training*	0 0 4	2

AECC: Ability Enhancement Compulsory Course

EES-305	Electromagnetic Field Theory	3 1 0	4
EES-603	Microprocessor	3 1 0	4
EES-702	Smart Grid Technologies	3 1 0	4
EES-802	Control Systems-II	3 1 0	4

HEAD
Deptt. of Electrical Engineering
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JAMIA MILLIA ISLAMIA
(A Central University by an Act of Parliament)
Department of Applied Sciences & Humanities
Faculty of Engineering and Technology
Maulana Mohammed Ali Jauhar Marg, New Delhi-110025 Tel.: 26988846, 26981717 Ext. 2510
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Choice Based Credits System Course Structure
B. Tech. I Year (All Branches/Sections)

I Semester

Course Code	Course Title	Credits	Period Per Week			Marks			Remarks
			L	T	P	Sessional	Theory	Practical	
AS-101	**Communication Skills**	**3**	**3**	**--**	**--**	**30**	**45**		**AECC**
AS-151	Language Lab	1	--	--	2	15	--	10	**AECC**
AS-102	Engineering Physics – I	3	2	1	--	30	45		Core
AS-152	Engineering Physics Lab – I	1	--	--	2	15	--	10	Core
AS-103	Engineering Chemistry – I	3	2	1	--	30	45		Core
AS-153	Engineering Chemistry Lab – I	1	--	--	2	15	--	10	Core
AS-104	Engineering Mathematics – I	4	3	1	--	40	60		Core
ME-101	Basics of Mechanical Engineering	3	2	1	--	30	45		Core
CE-101	Basics of Civil & Environmental Engineering	3	2	1	--	30	45		Core
ME-151	Workshop Practice	2	--	--	4	30	--	20	Core
Total		**24**	**14**	**5**	**10**	**265**	**285**	**50**	
		Total Hrs.			**29**	**600**			

II Semester

Course Code	Course Title	Credits	Period Per Week			Marks			Remarks
			L	T	P	Sessional	Theory	Practical	
AS-201	**Human Resource Management**	**3**	**2**	**1**	**--**	**30**	**45**		**SEC**
AS-202	Engineering Physics – II	3	2	1	--	30	45		Core
AS-252	Engineering Physics Lab – II	1	--	--	2	15	--	10	Core
AS-203	Engineering Chemistry – II	3	2	1	--	30	45		Core
AS-253	Engineering Chemistry Lab – II	1	--	--	2	15	--	10	Core
AS-204	Engineering Mathematics – II	4	3	1	--	40	60		Core
AS-205	**Innovative Sciences & Technology**	**3**	**2**	**1**	**--**	**30**	**45**		**CBCS**
EE-101	Basic Electrical Engineering	3	2	1	--	30	45		Core
EC-101	Basic Electronics & Communication	3	2	1	--	30	45		Core
CS-101	Fundamentals of Computing	3	2	--	--	30	45		Core
ME – 250	Engineering Graphics	2	--	--	4	30	--	20	Core
Total		**29**	**18**	**8**	**8**	**310**	**375**	**40**	
		Total Hrs.			**34**	**725**			

05/02/16

(Prof. Chaudhary Wali Mohammad)
HEAD **Head**
Dept. of Applied Sc. & Humn.
Faculty of Engg. & Tech.
Jamia Millia Islamia
New Delhi-110025

Department of Electrical Engineering
Jamia Millia Islamia

B. TECH. ELECTRICAL ENGINEERING COURSE STRUCTURE UNDER THE CHOICE BASE CREDIT SYSTEM (CBCS)

Effective from July 2016, II Year Batch

Category of Courses

DC:	Departmental core
CBCS:	Choice Based Credit System
SEC:	Skill Enhancement Courses
AECC:	Ability Enhancement Compulsory Course
DE:	Departmental electives

Abbreviation

L	Lecture
T	Tutorial
P	Practical
CCA	Continuous Class Assessment
MSE	Mid Semester Evaluation

B. TECH. ELECTRICAL ENGINEERING –II YEAR

Third Semester												
S. No	Course No.	Course Name	Type of Course	CREDIT	Periods Per week			Examination Scheme (Distribution of Marks)				
								Mid Semester Evaluation			End Semester Evaluation	Total Marks
					L	T	P	CCA	MSE-1	MSE-2		
01	EES-301	Electrical Machines-I	**DC**	4	3	1	-	10	15	15	60	100
02	EES-302	Network Analysis & Synthesis	**DC**	4	3	1	-	10	15	15	60	100
03	EES-303	Analog Electronics	**DC**	4	3	1	-	10	15	15	60	100
04	EES-304	Signals and Systems	**CBCS**	4	3	1	-	10	15	15	60	100
05	EES-305	Electromagnetic Field Theory	**AECC**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EES-331	Electrical Machines-I Lab.	**DC**	2	-	-	4	30	-	-	20	50
07	EES-332	Network Analysis & Synthesis Lab.	**SEC**	2	-	-	4	30	-	-	20	50
08	EES-333	Analog Electronics Lab.	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**26**								**650**
Fourth Semester												
01	EES-401	Electrical Machines –II	**DC**	4	3	1	-	10	15	15	60	100
02	EES-402	Digital Electronics	**DC**	4	3	1	-	10	15	15	60	100
03	EES-403	Power Systems-I	**DC**	4	3	1	-	10	15	15	60	100
04	EES-404	Programming Languages	**DC**	4	3	1	-	10	15	15	60	100
05	EES-405	Engineering Mathematics-III	**CBCS**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EES-431	Electrical Machines-II Lab.	**DC**	2	-	-	4	30	-	-	20	50
07	EES-432	Digital Electronics Lab.	**SEC**	2	-	-	4	30	-	-	20	50
08	EES-434	Programming Languages Lab	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**26**							**Total**	**650**

2/06/16
HEAD
Deptt. of Electrical Engineering
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Jamia Millia Islamia
New Delhi-110025

Department of Electrical Engineering
Jamia Millia Islamia

B. TECH. ELECTRICAL ENGINEERING COURSE STRUCTURE UNDER THE CHOICE BASE CREDIT SYSTEM (CBCS)

Effective from July 2017, III Year Batch

Category of Courses

DC:	Departmental core
CBCS:	Choice Based Credit System
SEC:	Skill Enhancement Courses
AECC:	Ability Enhancement Compulsory Course
DE:	Departmental electives

Abbreviation

L	Lecture
T	Tutorial
P	Practical
CCA	Continuous Class Assessment
MSE	Mid Semester Evaluation

B. TECH. ELECTRICAL ENGINEERING –III YEAR

S. No.	Course No.	Course Name	Type of Course	CREDIT	Periods Per week			Examination Scheme (Distribution of Marks)				
								Mid Semester Evaluation			End Semester Evaluation	Total Marks
					L	T	P	CCA	MSE-1	MSE-2		
Fifth Semester												
01	EES-501	Control Systems - I	**DC**	4	3	1	-	10	15	15	60	100
02	EES-502	Power Electronics	**DC**	4	3	1	-	10	15	15	60	100
03	EES-503	Communication Systems	**DC**	4	3	1	-	10	15	15	60	100
04	EES-504	Electrical Measurement-I	**CBCS**	4	3	1	-	10	15	15	60	100
05	EES-505	Power Systems-II	**DC**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EES-531	Control Systems Lab	**DC**	2	-	-	4	30	-	-	20	50
07	EES-532	Power Electronics Lab	**SEC**	2	-	-	4	30	-	-	20	50
08	EES-533	Communication Systems Lab	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**26**								**650**
Sixth Semester												
01	EES-601	Switchgear and Protection	**DC**	4	3	1	-	10	15	15	60	100
02	EES-602	Electrical measurement-II	**DC**	4	3	1	-	10	15	15	60	100
03	EES-603	Microprocessor	**AECC**	4	3	1	-	10	15	15	60	100
04	EES-604	Power Station Practice	**CBCS**	4	3	1	-	10	15	15	60	100
05	-	Elective-I	**DE**	4	3	1	-	10	15	15	60	100
Elective-I	EES-605 Electric Drives /EES-606 Computer Architecture / EES-607 Engineering Materials/ EES-608 PLC											
PRACTICAL (LAB./SEMINAR)												
06	EES-631	Switchgear and Protection Lab	**SEC**	2	-	-	4	30	-	-	20	50
07	EES-632	Electrical Measurement Lab	**SEC**	2	-	-	4	30	-	-	20	50
08	EES-633	Microprocessor Lab	**SEC**	2	-	-	4	30	-	-	20	50
09	EES-640	Seminar	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**28**							**Total**	**700**

04-6-2016

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New Delhi-110025

Department of Electrical Engineering
Jamia Millia Islamia

B. TECH. ELECTRICAL ENGINEERING COURSE STRUCTURE UNDER THE CHOICE BASE CREDIT SYSTEM (CBCS)

Effective from July 2018, Final Year Batch

Category of Courses

DC:	Departmental core
CBCS:	Choice Based Credit System
SEC:	Skill Enhancement Courses
AECC:	Ability Enhancement Compulsory Course
DE:	Departmental electives

Abbreviation

L	Lecture
T	Tutorial
P	Practical
CCA	Continuous Class Assessment
MSE	Mid Semester Evaluation

B. TECH. ELECTRICAL ENGINEERING –IV YEAR

S. No.	Course No.	Course Name	Type of Course	CREDIT	Periods Per week			Examination Scheme (Distribution of Marks)				
								Mid Semester Evaluation			End Semester Evaluation	Total Marks
					L	T	P	CCA	MSE-1	MSE-2		
Seventh Semester												
01	EES-701	Advanced Power Systems	**DC**	4	3	1	-	10	15	15	60	100
02	EES-702	Smart Grid Technologies	**AECC**	4	3	1	-	10	15	15	60	100
03	EES-703	Renewable and Sustainable Energy Systems	**CBCS**	4	3	1	-	10	15	15	60	100
04	-	Elective-II	**DE**	4	3	1	-	10	15	15	60	100
Elective-II	EES-705 Soft Computing / EES-706 Digital Signal Processing / EES-707 High Voltage Engineering / EES-708 Special Electrical Machines / EES-709 Bio Medical Instrumentation/ EES-710 HVDC Transmission											
PRACTICAL (LAB./MINOR PROJECT)												
05	EES-731	Power Systems Lab	**DC**	2	-	-	4	30	-	-	20	50
06	EES-732	Smart Grid - SCADA Lab	**SEC**	2	-	-	4	30	-	-	20	50
07	EES-750	Minor Project	**DC**	6	-	-	12	90	-	-	60	150
			Total	**26**							**Total**	**650**
Eighth Semester												
01	EES-801	Industrial Management	**DC**	4	3	1	-	10	15	15	60	100
02	EES-802	Control Systems-II	**AECC**	4	3	1	-	10	15	15	60	100
03	-	Elective-III	**CBCS**	4	3	1	-	10	15	15	60	100
04	-	Elective-IV	**DE**	4	3	1	-	10	15	15	60	100
Elective-III	EES-803 Process Control / EES-804 Electrical Machine Design / EES-805 Advanced Protective Relays / EES-806 Utilization of Electrical Energy											
Elective-IV	EES-807 Data Communications and Computer Networks, EES-808Advanced Microprocessors/EES-809- Micro Controllers											
PRACTICAL (LAB./MAJOR PROJECT)												
05	EES-840	Industrial Training*	**SEC**	2	-	-	4	30	-	-	20	50
06	EES-850	Major Project	**DC**	8	-	-	16	120	-	-	80	200
			Total	**26**							**Total**	**650**

* During last summer vacation (Minimum 4 weeks)

24/06/2016
HEAD
Deptt. of Electrical Engineering
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Jamia Millia Islamia
New Delhi-110025

Department of Electrical Engineering
Faculty of Engineering and Technology
Jamia Millia Islamia, New Delhi, INDIA

List of Courses for PG

Programme: M. Tech. in Control and Instrumentation (CIS)
M. Tech. in Electrical Power System Management (EPSM)

The overall credits structure for CIS

Core Courses		Elective Courses	
Category	Credits	Category	Credits
DC:	32	CBCS:	12
SEC:	10	DE:	16
AECC	04	-	-
Total	46	Total	28

Total Credits=74

The overall credits structure for EPSM

Core Courses		Elective Courses	
Category	Credits	Category	Credits
DC:	36	CBCS:	12
SEC:	10	DE:	12
AECC	04	-	-
Total	50	Total	24

Total Credits=74

CBCS: Choice Based Credit System

Course No.	Course Title	L T P	Credits
EEM-101	Intelligent Techniques	3 1 0	4
EEM-201	Optimization Techniques	3 1 0	4
EEM-303	Multi Sensor Data Fusion	3 1 0	4
EEM-304	Biomedical Instrumentation	3 1 0	4
EEM-305	Non Linear Control System	3 1 0	4
EEM-306	Advanced Power Electronics	3 1 0	4
EEM-308	Smart Grid Technologies	3 1 0	4
EEM-309	EHVAC and DC Transmission	3 1 0	4

DC: Departmental core

EEM-102	Instrumentation Systems	3 1 0	4
EEM-103	Optimal Control Theory	3 1 0	4
EEM-109	Power System Modeling	3 1 0	4
EEM-111	Renewable and Sustainable Energy Systems	3 1 0	4
EEM-202	Adaptive and Robust Control	3 1 0	4
EEM-209	Power System Dynamics and Stability	3 1 0	4
EEM-350	Minor Project	0 0 16	8
EEM-450	Dissertation	0 0 24	12

DE: Departmental electives

EEM-104	Modelling and Simulation	3 1 0	4
EEM-105	Robotics and Control	3 1 0	4
EEM-106	Applied Mathematics for Engineers	3 1 0	4
EEM-107	Automation Systems	3 1 0	4
EEM-108	Process Control	3 1 0	4
EEM-112	Modeling and Simulation	3 1 0	4
EEM-113	Power Quality and FACTS	3 1 0	4
EEM-204	Communication Protocol	3 1 0	4
EEM-205	Advance Digital Signal Processing	3 1 0	4
EEM-206	Smart sensors and Internet of Things	3 1 0	4
EEM-207	Embedded Systems	3 1 0	4
EEM-208	Digital Control System	3 1 0	4
EEM-213	Digital Power System Protection	3 1 0	4
EEM-214	Power System Planning and Reliability	3 1 0	4
EEM-215	Power System Analysis	3 1 0	4

SEC: Skill Enhancement Courses

EEM-132	Instrumentation System Lab	0 0 4	2
EEM-134	SCADA Lab	0 0 4	2
EEM-232	Advance Control System Lab	0 0 4	2
EEM-339	Power System Automation Laboratory	0 0 4	2
EEM-240	Seminar	0 0 4	2
EEM-301	Digital Instrumentation	3 1 0	4
EEM-302	Wireless Sensor Networks	3 1 0	4
EEM-306	Advanced Power Electronics	3 1 0	4
EEM 307	Restructuring and Deregulation of Power System	3 1 0	4

AECC: Ability Enhancement Compulsory Course

EEM-203	Transducer technology	3 1 0	4
EEM-211	Transmission and Distribution Automation	3 1 0	4

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Department of Electrical Engineering
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M. Tech. in Electrical Power System Management (EPSM)

Course Structure under the Choice Base Credit System (CBCS)

Category of Courses

DC: Departmental core
CBCS: Choice Based Credit System
SEC: Skill Enhancement Courses
AECC: Ability Enhancement Compulsory Course
DE: Departmental electives

Abbreviation

L Lecture
T Tutorial
P Practical
CCA Continuous Class Assessment
MSE Mid Semester Evaluation

M. Tech. in Electrical Power System Management–I Year, Effective from July 2015, I Year Batch

S. No	Course No.	Course Name	Type of Course	CREDIT	Periods Per week			Examination Scheme (Distribution of Marks)				
					L	T	P	Mid Semester Evaluation CCA	MSE-1	MSE-2	End Semester Evaluation	Total Marks
First Semester												
01	EEM-101	Intelligent Techniques	**CBCS**	4	3	1	-	10	15	15	60	100
02	EEM-107	Automation Systems	**DC**	4	3	1	-	10	15	15	60	100
03	EEM-109	Power System Modeling	**DC**	4	3	1	-	10	15	15	60	100
04	EEM-111	Renewable and Sustainable Energy Systems	**DC**	4	3	1	-	10	15	15	60	100
05	-	Elective-1	**DE**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EEP-134	SCADA Lab	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**22**								**550**
Elective –I: EEM-106 Applied Mathematics for Engineers/EEM-112 Modeling and Simulation/EEM-113 Power Quality and FACTS												
Second Semester												
01	EEM-201	Optimization Techniques	**CBCS**	4	3	1	-	10	15	15	60	100
02	EEM-209	Power System Dynamics and Stability	**DC**	4	3	1	-	10	15	15	60	100
03	EEM-211	Transmission and Distribution Automation	**AECC**	4	3	1	-	10	15	15	60	100
04	-	Elective-II	**DE**	4	3	1	-	10	15	15	60	100
05	-	Elective-III	**DE**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EEM-239	Power System Automation Laboratory	**SEC**	2	-	-	4	30	-	-	20	50
	EEM-240	Seminar	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**24**							**Total**	**600**
Elective –II: EEM-213 Digital Power System Protection/EEM- 214 Power System Planning and Reliability **Elective-III:** EEM-204 Communication Protocol/EEM-215 Power System Analysis												

M. Tech. in Electrical Power System Management–II Year, Effective from July 2016, I Year Batch

S. No.	Course No.	Course Name	Type of Course	CREDIT	Periods Per week			Examination Scheme (Distribution of Marks)				
					L	T	P	Mid Semester Evaluation CCA	MSE-1	MSE-2	End Semester Evaluation	Total Marks
Third Semester												
01	-	Elective –IV	**SEC**	4	3	1	-	10	15	15	60	100
02	-	Elective –V	**CBCS**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EEM-350	Minor Project	**DC**	8	-	-	16	120	-	-	80	200
			Total	**16**								**400**
Elective –IV: EEM 307 Restructuring and Deregulation of Power System/ EEM 306 Advanced Power Electronics **Elective –V:** EEM-308 Smart Grid Technologies/EEM 309 EHVAC and DC Transmission												
Fourth Semester												
01	EEM-450	Dissertation	**DC**	12	-	-	24	180	-	-	120	300
			Total	**12**							**Total**	**300**

Total Credits (22+24+16+12=74)

01/06/2016

HEAD
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Faculty of Engg. & Tech.
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New Delhi-110025

Department of Electrical Engineering
Faculty of Engineering and Technology
Jamia Millia Islamia, New Delhi, INDIA

List of Courses for PG

Programme: M. Tech. in Control and Instrumentation (CIS)
M. Tech. in Electrical Power System Management (EPSM)

The overall credits structure for CIS

Core Courses		Elective Courses	
Category	Credits	Category	Credits
DC:	32	CBCS:	12
SEC:	10	DE:	16
AECC	04	-	-
Total	46	Total	28

Total Credits=74

The overall credits structure for EPSM

Core Courses		Elective Courses	
Category	Credits	Category	Credits
DC:	36	CBCS:	12
SEC:	10	DE:	12
AECC	04	-	-
Total	50	Total	24

Total Credits=74

CBCS: Choice Based Credit System

Course No.	Course Title	L T P	Credits
EEM-101	Intelligent Techniques	3 1 0	4
EEM-201	Optimization Techniques	3 1 0	4
EEM-303	Multi Sensor Data Fusion	3 1 0	4
EEM-304	Biomedical Instrumentation	3 1 0	4
EEM-305	Non Linear Control System	3 1 0	4
EEM-306	Advanced Power Electronics	3 1 0	4
EEM-308	Smart Grid Technologies	3 1 0	4
EEM-309	EHVAC and DC Transmission	3 1 0	4

DC: Departmental core

EEM-102	Instrumentation Systems	3 1 0	4
EEM-103	Optimal Control Theory	3 1 0	4
EEM-109	Power System Modeling	3 1 0	4
EEM-111	Renewable and Sustainable Energy Systems	3 1 0	4
EEM-202	Adaptive and Robust Control	3 1 0	4
EEM-209	Power System Dynamics and Stability	3 1 0	4
EEM-350	Minor Project	0 0 16	8
EEM-450	Dissertation	0 0 24	12

DE: Departmental electives

EEM-104	Modelling and Simulation	3 1 0	4
EEM-105	Robotics and Control	3 1 0	4
EEM-106	Applied Mathematics for Engineers	3 1 0	4
EEM-107	Automation Systems	3 1 0	4
EEM-108	Process Control	3 1 0	4
EEM-112	Modeling and Simulation	3 1 0	4
EEM-113	Power Quality and FACTS	3 1 0	4
EEM-204	Communication Protocol	3 1 0	4
EEM-205	Advance Digital Signal Processing	3 1 0	4
EEM-206	Smart sensors and Internet of Things	3 1 0	4
EEM-207	Embedded Systems	3 1 0	4
EEM-208	Digital Control System	3 1 0	4
EEM-213	Digital Power System Protection	3 1 0	4
EEM-214	Power System Planning and Reliability	3 1 0	4
EEM-215	Power System Analysis	3 1 0	4

SEC: Skill Enhancement Courses

EEM-132	Instrumentation System Lab	0 0 4	2
EEM-134	SCADA Lab	0 0 4	2
EEM-232	Advance Control System Lab	0 0 4	2
EEM-339	Power System Automation Laboratory	0 0 4	2
EEM-240	Seminar	0 0 4	2
EEM-301	Digital Instrumentation	3 1 0	4
EEM-302	Wireless Sensor Networks	3 1 0	4
EEM-306	Advanced Power Electronics	3 1 0	4
EEM 307	Restructuring and Deregulation of Power System	3 1 0	4

AECC: Ability Enhancement Compulsory Course

EEM-203	Transducer technology	3 1 0	4
EEM-211	Transmission and Distribution Automation	3 1 0	4

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Department of Electrical Engineering
Faculty of Engineering and Technology
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M. Tech. in Control and Instrumentation (CIS)

Course Structure under the Choice Base Credit System (CBCS)

Category of Courses

DC: Departmental core
CBCS: Choice Based Credit System
SEC: Skill Enhancement Courses
AECC: Ability Enhancement Compulsory Course
DE: Departmental electives

Abbreviation

L Lecture
T Tutorial
P Practical
CCA Continuous Class Assessment
MSE Mid Semester Evaluation

M. Tech. in Control and Instrumentation–I Year, Effective from July 2015, I Year Batch

First Semester

S. No	Course No.	Course Name	Type of Course	CREDIT	Periods Per week			Examination Scheme (Distribution of Marks)				
					L	T	P	Mid Semester Evaluation CCA	MSE-1	MSE-2	End Semester Evaluation	Total Marks
01	EEM-101	Intelligent Techniques	**CBCS**	4	3	1	-	10	15	15	60	100
02	EEM-102	Instrumentation Systems	**DC**	4	3	1	-	10	15	15	60	100
03	EEM-103	Optimal Control Theory	**DC**	4	3	1	-	10	15	15	60	100
04	-	Elective I	**DE**	4	3	1	-	10	15	15	60	100
05	-	Elective –II	**DE**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EEM-132	Instrumentation System Lab	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**22**								**550**

Elective –I: EEM-104 Modelling and Simulation/EEM-105 Robotics and Control/EEM-106 Applied Mathematics for Engineers
Elective –II: EEM-107 Automation Systems/EEM-108 Process Control

Second Semester

01	EEM-201	Optimization Techniques	**CBCS**	4	3	1	-	10	15	15	60	100
02	EEM-202	Adaptive and Robust Control	**DC**	4	3	1	-	10	15	15	60	100
03	EEM-203	Transducer Technology	**AECC**	4	3	1	-	10	15	15	60	100
04	-	Elective III	**DE**	4	3	1	-	10	15	15	60	100
05	-	Elective –IV	**DE**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EEM-232	Advance Control System Lab	**SEC**	2	-	-	4	30	-	-	20	50
07	EEM-240	Seminar	**SEC**	2	-	-	4	30	-	-	20	50
			Total	**24**							**Total**	**600**

Elective –III: EEM-204 Communication Protocol/ EEM-205 Advance Digital Signal Processing
Elective –IV: EEM-206 Smart sensors and Internet of Things/EEM-207 Embedded Systems/EEM-208 Digital Control System

M. Tech. in Control and Instrumentation–II Year, Effective from July 2016, I Year Batch

Third Semester

S. No.	Course No.	Course Name	Type of Course	CREDIT	Periods Per week			Examination Scheme (Distribution of Marks)				
					L	T	P	Mid Semester Evaluation CCA	MSE-1	MSE-2	End Semester Evaluation	Total Marks
01	-	Elective –V	**SEC**	4	3	1	-	10	15	15	60	100
02	-	Elective –VI	**CBCS**	4	3	1	-	10	15	15	60	100
PRACTICAL (LAB.)												
06	EEM-350	Minor Project	**DC**	8	-	-	16	120	-	-	80	200
			Total	**16**								**400**

Elective –V: EEM-301Digital Instrumentation/EEM-302 Wireless Sensor Networks
Elective –VI: EEM-303 Multi Sensor Data Fusion/EEM-304 Biomedical Instrumentation/EEM-305 Non Linear Control System/ EEM-306 Advanced Power Electronics

Fourth Semester

01	EEM-450	Dissertation	**DC**	12	-	-	24	180	-	-	120	300
			Total	**12**							**Total**	**300**

Total Credits (22+24+16+12) =74

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COURSE STRUCTURE AND CURRICULUM

(w.e.f. 2013-2014)

M. TECH. PROGRAMME
CONTROL AND INSTRUMENTATION SYSTEMS

COURSE STRUCTURE

M. Tech. (Control and Instrumentation Systems)

SEMESTER I

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
EEM-101	Intelligent Techniques	3	1	0	10	30	60	100	4
EEM-102	Automation System	3	1	0	10	30	60	100	4
EEM-103	Instrumentation Systems	3	1	0	10	30	60	100	4
EEM-105	Optimal Control Theory	3	1	0	10	30	60	100	4
	Elective-I	3	1	0	10	30	60	100	4
EEM-153	Instrumentation Systems Lab	0	0	4	20	10	20	50	2
TOTAL		**15**	**5**	**4**	**70**	**160**	**320**	**550**	**22**

SEMESTER II

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
EEM-201	Optimization Techniques	3	1	0	10	30	60	100	4
EEM-202	Communication Protocols	3	1	0	10	30	60	100	4
EME-205	Adaptive & Robust Control	3	1	0	10	30	60	100	4
EEM-206	Transducer Technology	3	1	0	10	30	60	100	4
	Elective-II	3	1	0	10	30	60	100	4
EEM-251	Seminar	0	0	4	20	10	20	50	2
EEM-255	Advance Control Systems Lab	0	0	4	20	10	20	50	2
TOTAL		**15**	**5**	**8**	**90**	**170**	**340**	**600**	**20**

SEMESTER III

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
	Elective-III	3	1	0	10	30	60	100	4
	Elective-IV	3	1	0	10	30	60	100	4
EEM-351	Minor Project	0	0	16	40	80	80	200	8
TOTAL		**6**	**2**	**16**	**60**	**140**	**200**	**400**	**16**

SEMESTER IV

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
EEM-451	Dissertation	0	0	24	80	100	120	300	12
TOTAL		**0**	**0**	**24**	**80**	**100**	**120**	**300**	**12**

Elective I

1. EEM-106 Modeling and Simulation
2. EEM-107 Applied Mathematics for Electrical Engineers

Elective II

1. EEM-211 Embedded Systems
2. EEM-212 Advanced Digital Signal Processing

Elective III

1. EEM-311 Wireless Sensor Networks
2. EEM-312 Multisensor Data Fusion
3. EEM-313 Advance Process Control

Elective IV

1. EEM-316 Advanced Power Electronics
2. EEM-317 Mechatronics
3. EEM-318 Biomedical Instrumentation
4. EEM-319 Robotics

EEM-101 Intelligent Techniques

L-T-P (3-1-0) Credit (4)

Unit I: Soft Computing
Hard Computing: Features of Hard Computing, Soft Computing: features of soft computing, Hybrid Computing, Fuzzy Set Theory: fuzzy versus crisp sets, basic fuzzy set operations, linguistic variables, membership functions, fuzzy Cartesian product, fuzzy relations, fuzzy rules.

Unit II: Fuzzy Implications
Approximate reasoning, fuzzy modelling, fuzzification, inferencing and defuzzification, fuzzy modeling and control schemes for nonlinear systems, applications in power system.

Unit III: Fundamentals of Neural Networks
Biological neural networks, models of an artificial neuron, neural network architectures, characteristics of neural networks, McCulloch-Pitts neuron, learning methods, Hebbian learning rules, Hebb nets.

Unit IV: Backpropagation Networks
Architecture of backpropagation networks, perceptron model, single layer and multi-layer perceptron models, backpropagation learning, tuning parameters of backpropagation networks, neuro-fuzzy models, adaptive neuro-fuzzy inference system (ANFIS), applications.

Unit V: Neuro-Fuzzy Systems
Architectures of neuro-fuzzy systems; Cooperative neuro-fuzzy systems, Neural Network driven fuzzy reasoning, Hybrid neuro-fuzzy system; Construction of neuro-fuzzy systems: Structure if identification phase, parameter learning phase.

Text/Reference Books:

1. Fakhreddine O. Karray and Clarence W De Silva, “Soft Computing and Intelligent Systems Design: Theory, Tools and Applications” Pearson Education.
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications”, Prentice Hall of India, New Delhi.
3. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and applications, Prentice Hall of India, New Delhi.
4. Jyh-Shing Roger, Chuen-Tsai Sun, Eui Mizutani, Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Prentice Hall of India, New Delhi.
5. Simon S Haykin, “Neural networks and learning machines”, Prentice Hall of India, New Delhi.

EEM 102 Automation Systems

L-T-P (3-1-0) Credit (4)

Unit I

Automation systems, Advantages of automation, Components of process control systems, Evolution of Control systems. Single loop control, Centralized control, Distributed control systems, Open systems, SCADA systems. Types of data available, Analog, Digital, Pulse data, Redundancy. Data communication components and protocols.

Unit II:

Programmable Logic Controllers (PLC) Functional description, input/output systems, CPU, memory Unit, Programmer Units, Peripheral devices, PLC Vs Computers, Advantages of PLCs, controller programming tools, Ladder Diagram programming. phase locked loop, Interposing relays, type and structure of relays.

Unit III:

Distributed Control Systems (DCS) PLC Vs DCS systems, DCS architecture, Local control units, dedicated card controllers, Unit Operations controllers, DCS multiplexers, DCS system integration, Automation Standards, salient features.

Unit IV:

Supervisory Control and Data acquisition (SCADA) Systems, Types of supervisory systems, Components of SCADA Systems. Remote terminal unit (RTU), Communication subsystem, Protocols, Logic subsystem, termination subsystem, test and power supply subsystem, Phasor measurement Units, Phasor Data concentrator and communication, Intelligent Electronic Devices.

Unit V:

SCADA master station configurations, hardware and software components, Communication systems, Human Machine interface. SCADA application functions, Intelligent Electronic devices. Practical PLC, DCS, PMU and SCADA applications and implementations

Text/Reference Books:

1. Automation Handbook Vol I Bela G. Liptac, CRC Press.
2. Fundamentals of Supervisory systems, IEEE tutorial.
3. John W Webb & Ronald A Reiss, Programmable Logic Controllers, principles and applications, Prentice Hall of India.
4. Related Research papers.

EEM-103 Instrumentation Systems

L-T-P (3-1-0) Credit (4)

Unit- I

Transducer Characteristics **:** General concepts and terminology of measurement systems: Transfer Function, Span (Full-Scale Input), Full-Scale Output, Accuracy, Calibration, Calibration Error, Hysteresis, Nonlinearity, Saturation, Repeatability, Dead Band, Resolution, Special Properties, Output Impedance, Excitation, Dynamic Characteristics, Environmental Factors, Reliability. Modeling and analysis of the measuring system, standards and calibration of the measuring instrument.

Unit-II

Transducers: Classifications, working principle, construction and design of various active and passive transducers. Voltage and current transducers, Tap position transducers. Hall effect transducers, optical transducers. Semiconductor traducers for physical and chemical parameters measurement**.**

Unit-III

Design of detection electronics and signal conditioning circuits for various resistive, capacitive, inductive transducers. Active filters, Impedance matching, loading effect. Introduction to electromagnetic coupling (EMC), inference coupling mechanism, shielding. Concepts of interfaces with digital device like computer, microcontroller microprocessor.

Unit-IV

Applications of Industrial transducers: Hotwire anemometer, infrared, seismic and nuclear energy transducer, Transducers activated RFID tags.

Unit-V

Controller modes Discontinuous, two positions, multi position, floating control, continuous control, proportional, integral, derivative and composite modes of control.

Text/Reference Books:

1. C.D. Jhonson, Process Control Instrumentation Technology, PHI, India.
2. Doeblin E.O. Measurement Systems-Application and Design, Fourth Edition, McGraw Hill International Edition, New York.
3. Jacob Fraden, Hand book of Modern Sensors: Physics, Design and applications, publication by Springer.
4. John P. Bentley, Principle of measurement systems, Third edition, addition Wesley Longman Ltd.
5. Gregory K. McMillan and Doughlas M. Considine, Industrial Instruments and Controls handbook, Tata Mc Graw Hill.
6. L.D. Goettsche, Maintenance of Instruments and Systems – Practical guides for measurements and control, ISA.

EEM-105 Optimal Control Theory

L-T-P (3-1-0) Credit (4)

UNIT I Mathematical Modelling and Performance Measures

Problem formulation – Mathematical model – Physical constraints - Performance measure Optimal control problem. Standard form of optimal control problem. Performance measures/indexs for optimal control problem. Selection of performance measure/index.

UNIT II Linear Regulator Problems

Derivation of Matrix Riccati equation. Use of linear state regulator theory to design and solve other linear optimal control problems. Sub optimal linear regulators- continuous time systems. Minimum time problems – Minimum control – effort problems. Optimal and sub-optimal linear regulators for discrete time systems, Singular intervals in optimal control problems.

UNIT III Dynamic Programming

Optimal control law – Principle of optimality. Optimal control system. Recurrence relation of dynamic programming – computational procedure. Characteristics of dynamic programming solution. Hamilton – Jacobi – Bellman equation. Continuous linear regulator problems.

UNIT IV Calculus of Variations

Fundamental concepts. Functionals. Piecewise – smooth extremals Constrained extrema. Variational approach to optimal control problems – Necessary conditions for optimal control– Linear regulator problems. Linear tracking problems. Pontryagin's minimum principle and state inequality constraints.

UNIT V Numerical Techniques For Optimal Control

Numerical solution of 2-point boundary value problem by steepest descent method, Fletcher Powell method solution of Ricatti equation by negative exponential and interactive methods, Multi stage decision process in discrete time, Multi stage decision process in continuous time – Numerical solution of Two point boundary –value problems. Methods of steepest decent and variation of extremes. Quasi-linearization. Gradient projection algorithm. Minimization of functions

Text /Reference Books:

1. Donald E. Kirk, Optimal Control Theory: An Introduction, Prentice-Hall networks series.
2. Anderson .B. D. O, Moore .J. B, Optimal control linear Quadratic methods, Prentice Hall of India, New Delhi.
3. Sage A. P, White .C. C, Optimum Systems Control, Second Edition, Prentice Hall.
4. D. S. Naidu. *Optimal Control Systems*, CRC Press.
5. B.A Francis, A course in H_∞ control theory, Lecture notes in control and Information Sciences, Spriger-Verlag.

EEM-106 Modeling And Simulation

L-T-P (3-1-0) Credit-4

UNIT-1: System Models

The concepts of a system, System environment, Stochastic activities, Continuous and Discrete Systems, System Modeling, Types of models, Static physical models, Dynamic physical models, Static mathematical models, Dynamic mathematical models, Principles used in modeling.

UNIT-II: System Simulation

The technique of Simulation, The Monte Carlo method, Comparison of simulation and analytical methods, Experimental nature of simulation, Types of system simulation, Numerical computation technique for continuous models, Numerical computation technique for Discrete models, Distributed lag models, Cobweb models, Progress of a simulation study.

UNIT-III: Probability Concepts in Simulation

Stochastic variables, Discrete probability functions, Measures of probability functions, Continuous uniformly distributed random numbers, Random number generators (RNG), multiplicative congruential method, Mixed multiplicative congruential method, Other methods of random number generation.

UNIT-IV: Basic Queuing Models and Arrival patterns

Congestion in Systems, Arrival patterns, Poisson arrival patterns, Exponential distribution, Coefficient of variation, The Erlang distribution, Hyper-exponential distribution, Service times, Normal distribution, Basic queuing models, Short hand notation for queuing and loss models, Queuing disciplines, Measures of queues, Mathematical solutions of queuing problems.

UNIT-V: Simulation Experiments and Statistical Data Analysis

Experiments and Statistical inference, Nature of the problem, Estimation methods, Simulation run statistics, Replication of runs, Elimination of initial bias, Batch means, Regenerative techniques, Time series analysis, autoregressive processes, Validation and Testing of simulation models.

Text /Reference Books:

1. Gordan G., “System Simulation,” Prentice Hall of India.
2. Kobayashi H., mark B. L., “System Modeling and Analysis,” Pearson Education, Inc, New Delhi.

EEM-107 Applied Mathematics for Electrical Engineers

L-T-P (3-1-0) Credit (4)

UNIT-I Advanced Matrix Theory

Eigen-values using QR transformations – Generalized eigen vectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT-II Linear Programming

Formulation – Graphical Solution – Simplex Method – Two Phase Method – Transportation and Assignment Problems.

UNIT-III One Dimensional Random Variables

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT-IV Queueing Models

Poisson Process – Markovian queues – Single and Multi Serve r Models – Little's formula – Machine Interference Model – Steady State analysis – Self Service queue.

UNIT-V Computational Methods in Engineering

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank- Nicolson implicit scheme – olution of wave equation.

Text/Reference Books:

1. Bronson, R., Matrix Operation, Schaum's outline series, McGraw Hill, New York.
2. Taha, H. A., Operations Research: An Introduction, Seventh Edition, Pearson Education Asia, New Delhi.
3. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, Probability and Statistics for Engineers & Scientists, Asia.
4. Donald Gross and Carl M. Harris, Fundamentals of Queueing theory, John Wiley and Sons, New York.

EEM-153 Instrumentation Systems Lab

L-T-P (0-0-4) Credit (2)

This laboratory course is designed based on theory course of “Instrumentation Systems” (EEM-103). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include response characteristics of thermistor, current measurement using Hall effect transducer, controller using optical transducer (LDR), response characteristics and coefficients of RTD, phase detection electronics circuit for capacitive transducer with 7556 dual timer, active bridge circuit, active low and high pass filter, LABVIEW® and DAQ card for LVDT transducer, pressure measurement at remote location using RFID activated transducer. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers.

EEM-201 Optimization Techniques

L-T-P (3-1-0) Credit (4)

UNIT-I

Introduction to optimization, functions of single variable, functions of several variables, formulation of optimization problems. Review of classical methods, linear programming, non-linear programming.

UNIT-II

Constraint optimality criteria, constrained optimization, constraint direct search method, linearization methods for constrained problems, transformation method. Nonlinear programming: problem formulation, Quadratic Approximation Methods for Constrained Problems Unconstrained minimization techniques.

UNIT-III

Dynamic programming: sub-optimization, multistage optimization problem. Multi-objective and goal programming: problem formulation, solution of a multi-objective problem. Case studies

UNIT-IV

Introduction to Stochastic Optimization Techniques, types: Local Search, Population Based, Introduction to Genetic Algorithms, Motivation from Nature, Genetic Algorithms: Working Principle: Representation, Fitness Assignment, Reproduction, Crossover, Mutation, Constraint Handling, Real Parameter Genetic Algorithms, Combined Genetic Algorithm, Advanced Genetic Algorithms, Applications.

UNIT-V

Ant Colony Optimization: Introduction, Ant System, Ant Colopny System, ANTS, Significant Problems, Convergence Proofs. Discrete Particle Swarm Optimization (PSO): Introduction, PSO Elements: Position and State Space, Objective Function, Velocity, PSO Algorithm, Examples and Results, Applications.

Text/Reference Books:

1. Singiresu S. Rao, 'Optimization Techniques', New Age International Publishers.
2. D. P. Kothari and J. S. Dhillon, 'Power System Optimization, Tata McGraw Hill.
3. C. Mohan and Kusum Deep, 'Optimization Techniques, New Age International Publishers.
4. Godfrey C. Onwubolu, B. V. Babu, "New Optimization Techniques in Engineering", Springer-Verlag.
5. Marco Dorigo, Thomas Stützle, "Ant colony optimization", MIT Press.
6. Thomas Wiesi, "Global Opimization Algorithms", ebook. http://www.it-weise.de/.

EEM-202 Communication Protocols

L-T-P (3-1-0) Credit (4)

UNIT-I: Introduction to Communication Protocols
Data Communication basics, OSI reference model, Network Classification, Device Networks, Control Networks, Enterprise Networks.

UNIT-II: Networks in Process Automation
Introduction to Networks in process automation, Information flow requirements, Industry Networks, Network selection.

UNIT-III: Proprietary and open networks
Network Architectures, Building blocks, Industry open protocols: RS-232, RS- 422, RS-485, Ethernet, Modbus, Profibus, Fieldbus; Hardware: Fieldbus Design, Advantages and Limitations.

UNIT-IV: Introduction to wireless Protocols
WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave, IRIB-B.

UNIT-V: Communication Protocols for Power System
Communication requirements for power system automation, Protocols used, Need for Interoperable Communication, Overview of IEC 61850 Standard: Data Models, Communication Services, GOOSE Communication: Implementation and its advantages.

Text/References/Books:

1. B.G. Liptak, '*Process Software and Digital Network"*, CRC Press ISA- The Instrumentation, Systems, and Automation Society.
2. User Manuals of Foundation Fieldbus, Profibus, Modbus, Ethernet, Devicenet, Controlnet, IEC 61850.
3. Peterson Davie, "Computer Networks—A System Approach", Maugann Kauffmann Publisher.

EEM-205 Adaptive and Robust Control

L-T-P (3-1-0) Credit (4)

UNIT-I

System Identification: Introduction, dynamic systems, models, system identification procedure. Simulation and Prediction. Non-parametric time and frequency domain methods. Linear dynamic system Identification: Overview, excitation signals, general model structure, time series models, models with output feedback, models without output feedback. Convergence and consistency.

UNIT-II

Parameter estimation methods, minimizing prediction errors, linear regressions and Least squares method, Instrumental – variable method, prediction error method. Recursive algorithms. Closed-loop Identification.

UNIT-III

Adaptive Control: Close loop and open loop adaptive control. Self-tuning controller. Auto tuning for PID controllers: Relay feedback, pattern recognition, correlation technique.

UNIT-IV

Adaptive Smith predictor control: Auto-tuning and self-tuning Smith predictor. Adaptive advanced control: Pole placement control, minimum variance control, generalized predictive control.

UNIT-V

Robust control. Definition and problem statement, the H(n) norm, H_∞ norm, frequency domain formulation, state space formulation robust stabilization H2 optimal control, H_∞ control.

Text/Reference Books:

1. Ljung .L, System Identification: Theory for the user, Prentice Hall, Englewood Cliffs.
2. Astrom .K, Adaptive Control, Second Edition, Pearson Education Asia Pte Ltd.
3. Chang C. Hong, Tong H. Lee and Weng K. Ho, Adaptive Control, ISA press, Research Triangle Park.
4. Nelles. O, Nonlinear System Identification, Springer Verlag, Berlin.

EEM-206 Transducer Technology

L-T-P (3-1-0) Credit (4)

UNIT-I

Chemical transducer characteristics, specific difficulties, sensing mechanism, Toxic gas transducer: metal oxide, chemFET, electrochemical transducer, potentiometric, conductometric, amperometric, biochemical, enzyme transducer.

UNIT-II

Special Transducers: Tactile, Piezoelectric, Magnetostrictive, Magneto resistive, Electromagnetic transducers, thermo-electric transducer, semiconductor temperature transducer, pH measurement, ultrasonic transducer for viscosity measurement. Transducer arrays, electronic nose, signal processing for electronic nose, smart transducer.

Unit III: Dissolved Gas Analysis (DGA) of Transformer Oil

Dissolved gas in transformer oil, dissolved gas analysis (DGA), Standards for interpretation of DGA, DGA base fault diagnosis methods: Rogers Ratio Method, Dornenburg's Method, Duval's Triangle Method and softomputing techniques.

UNIT-IV

Digital Interfacing techniques. Interfaces, processors, code converters, linearizers. Single transmission .Cable transmission of analog and digital signal, fibre optic signal transmission, radio, telemetry, pneumatic transmission.

UNIT-V

Signal Display/Recording systems. Graphic display systems, storage oscilloscope, recorders:ink, thermal, UV.

Text/Reference Books:

1. Doeblin E.O. Measurement Systems-Application and Design, Fourth Edition, McGraw Hill International Edition, New York.
2. Jacob Fraden, Hand book of Modern Sensors: Physics, Design and applications, publication by Springer.
3. Patranabis, D – Sensors and Transducers, Wheeler Pub., New Delhi.
4. Murthy, D.V.S., Transducers and Instrumentation, PHI, New Delhi.
5. Swobada, G; Telecontrol: Methods and Applications of Telemetry and Remote Control.
6. Van Nostrand. Newbert, H. K. – Instrument Transducers, Oxford University Press.

EEM-211 Embedded System Design

L-T-P(3-1-0) Credit (4)

Unit-1

Introduction to embedded systems: Categories of embedded systems, overview of embedded system architecture, Microcontroller programming and structured design, Factors to be considered in selecting a microcontroller, recent trends in embedded systems.

Unit-2

Custom Single purpose Processor: RT level combinational components, RT level sequential components. Custom single purpose processor design; RT level Custom single purpose processor design, General purpose processor: basic architecture, data path, control unit.

Unit-3

Real Time Operating System (RTOS) based Embedded System Design: Operating system basics, Types of operating systems, Tasks, process and threads, Multiprocessing and Multitasking, Task scheduling, Threads, processes and scheduling: putting them altogether, Task communication, Task synchronization, Device Drivers, How to choose an RTOS.

Unit-4

Overview of 8051 microcontrollers. Designing with 8051, why 8051 microcontroller, Programming with 8051 microcontroller, different addressing modes supported by 8051 microcontroller., The 8051 instruction sets. Some examples of System design using 8051/8052 microcontroller.

Unit-5

Introduction to AVR family of microcontrollers, Introduction to AtXmega 128A1 Microcontroller, AVR CPU, EBI- external bus interference, DMAC, system clock and clock option, Power management, Programmable multilevel interrupt controller, I/O ports, instruction set. Design examples using AtXmega128A1.

Text/Reference Books:

1. "Embedded System Design- A Unified Hardware/ Software Introduction", Frank Vahid and Tony Givar gis, John Wiley & Sons.
2. "Introduction to Embedded Systems", Shibu K V, Tata McGraw Hill.
3. "The 8051 Microcontroller and Embedded systems", Mazidi M L, Mazidi J G, Mckinlay R D, Pearson Education Inc, New Delhi.
4. "Embedded C Programming and the Atmel AVR", Barnett R, O'Cull L, Cox S, Thomson Delmar Learning, Canada.
5. "X-Mega- A Manual"- Atmel Corporation.

EEM-212 Advanced Digital Signal Processing

L-T-P (3-1-0) Credit (4)

Unit -I

Review of Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT) and Discrete Cosine Transform (DCT). Convolution and Correlation. Time frequency analysis and its need. Short time Fourier Transform.

Unit - II.

Multirate digital signal processing: Basic multirate operations. Efficient structures for decimation and interpolation. Decimation and interpolation and interpolation with polyphase filters. Sampling rate conversion by non-integer factor. Design of practical sampling rate converters. Multirate filtering applications.

UNIT-III

Spectrum Estimation and Analysis: Principles of spectrum estimation. Periodogram method, modified Periodogram methods, the Blackman-Tukey methods, fast correlation method. Autoregressive spectrum estimation: Autoregressive model and filter. Power spectrum density of AR series. Some practical applications.

Unit -IV

Adaptive Filtering: Principles of adaptive filtering. Least mean square (LMS) adaptive algorithm its implementation and limitations. Recursive least square (RLS) adaptive algorithm, its implementation and limitations. Basic Wiener filter theory. Applications of adaptive filters in noise cancellations, echo cancellation.

Unit – V

Digital Signal Processors: Basic computer architectures for signal processing. General purpose digital signal processors; fixed point digital signal processors and floating point digital signal processors. Implementation of DSP algorithms on general purpose digital signal processors.

Text/Reference Books:

1. Emmanuel C. Ifeachor and B. W. Jervice, " Digital Signal Processing", Pearson Education, New Delhi.
2. Li Tan, "Digital Signal Processing" Published by Elsevier Inc., New Delhi.
3. B. Widrow and S. D Stearns, "Adaptive Signal Processing", Pearson Education, New Delhi.
4. Simon Hykins, "Adaptive Filter Theory", Prentice Hall, New Jersey.

EEM-251 Seminar

L-T-P (0-0-4) Credit (2)

All the students of II semester will be required to deliver a seminar on the topic relevant to recent trends in "Control and Instrumentation Systems" using power point presentation. Topics are selected in consultation with their supervisors. Presentation will be of 15 minutes duration followed by a question answer session at least two times in a semester before the duly constituted committee of the Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the seminar in the form of hard copy must also be submitted in the office before the final evaluation by External Examiners.

EEM-255 Advance Control Systems Laboratory

L-T-P (0-0-4) Credit (2)

This laboratory course is designed based on theory course of "Adaptive & Robust Control" (EEM-205). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include angular position error detector, DC motor angular position control system, simulation of linear systems, DC motor speed control system etc. The objective of the lab practice is to develop and enhance students' analytical and problem tackling skills. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers.

EEM-311 Wireless Sensor Networks

L-T-P (3-1-0) Credit (4)

Unit I Introduction

Introduction and overview of Wireless Sensor Networks (WSN), Commercial and Scientific Applications of WSN, Category of Applications of WSN, Challenges for WSN, Enabling Technologies for WSN.

Unit II Architecture

Single node Architecture: Hardware Components, Energy Consumption of Sensor nodes, Operating Systems and Execution Environments, Examples of Sensor Nodes, Network Architecture: WSN Scenarios, Optimization Goals and figures of Merits, Design principles for WSNs, Service Interfaces for WSNs, Gateway Concepts.

Unit III Protocols

Physical Layer: Wireless Channel and Communication Fundamentals, Physical Layer & Transceiver Design Considerations in WSN, MAC Protocols: Fundamentals, MAC Protocols for WSNs, IEEE802.15.4 MAC Protocol, Routing Protocols: Gossip and agent based unicast protocols, Energy Efficient Unicast, Broadcast and Multicast, Geographic Routing, Transport Control Protocols: Traditional Protocols, Design Issues, Examples of Transport Protocols, Performance of Transport Control Protocols.

Unit IV Information Processing

Sensor Tasking and Control: Information-Based Sensor Tasking, Joint Routing Information Aggregation, Sensor Network Databases: Challenges, Query Interfaces, In-Network Aggregation, Data Centric Storage, Data Indices and Range queries, Distributed Hierarchical Aggregation, Temporal Data.

Unit V Platform & Tools

Operating Systems for Sensor Networks: Introduction, Design Issues, Examples of Operating Systems, Node Level Simulators, Performance and Traffic Management Issues: WSN Design Issues, Performance Modelling of WSNs, Emerging Applications and Future Research Directions.

Text/Reference Books:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks: Technology, Protocols, and Applications”, John wiley & Sons.
2. Holger Karl, Andreas Willig, “Protocols and architectures for wireless sensor networks”, John wiley & Sons.
3. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks; An Information Processing Approach”, Elsevier.
4. C. S. Raghavendra, Krishna M. Shivalingam, Taieb Znati, “Wireless sensor networks”, Springer Verlag.
5. H. Edgar, Jr. Callaway, “Wireless Sensor networks, Architectures and Protocols”, CRC Press.

EEM-312 Multisensor Data Fusion

L-T-P (3-1-0) Credit (4)

UNIT-I Introduction

Sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics.

UNIT-II Algorithms for Data Fusion

Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration.

UNIT-III Estimation

Kalman filtering, practical aspects of Kalman filtering, extended Kalmal filters. Decision level identify fusion. Knowledge based approaches.

UNIT-IV Advanced Filtering

Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.

UNIT-V High Performance Data Structures

Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system.

Text/Reference Books:

1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston.
2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey.
3. Arthur Gelb, Applied Optimal Estimation, M.I.T. Press.
4. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company.

EEM-313 Advanced Process Control

L-T-P (3-1-0) Credit (4)

UNIT-I

Review of basics of Process Control, Control objective and benefits, Elements of Process dynamics, interacting and non-interacting systems, Process degrees of freedom, Piping and instrumentation drawings

UNIT-II

Fundamental of control valves, Types of control valves, control valves characteristics, control valves sizing and selection, Cavitations and Flashing problems in control valves,

UNIT-III

Feedback control configuration, feed-forward control configuration, Cascade control configuration, Ratio control configuration, Spilt range control configuration, Internal Model controller (IMC), other types of control configuration, Statistical Process Control (SPC) concept, Design procedure.

UNIT-IV

Effect of two position controller, effect of proportional controller mode, effect of Integral controller mode, effect of derivative controller mode, effect of composite (PID) controller mode, controller tuning methods, process reaction curve method, Quarter-amplitude criterion (Cohen-coon corrections), Ziegler-Nichols tuning method

UNIT-V

Electronic implementation of controller modes, introduction to operational amplifiers, introduction to pneumatic elements, implementation of pneumatic controller modes, hydraulic implementation of controller modes

Case study: Design of Fuzzy-Logic and Neural Network based controllers.

Text/Reference Books:

1. Thomas E. Marlin 'Process Control: Designing Processes and Control Systems for Dynamic Performance', McGraw-Hill International Edition.
2. Jose A. Romagnoli, Ahmet Palazoglu, 'Introduction to process Control' CRC Taylor and Francis group.
3. B.G. Liptak, 'Handbook of Instrumentation- Process Control', Tata McGraw Hill.
4. Les A. Kane, 'Handbook of Advanced Process Control Systems and Instrumentation' Springer.
5. P Sai Krishna " Process Control Engineering", I. K Internationals Pvt. Ltd.

EEM-316 Advance Power Electronics

L-T-P (3-1-0) Credit (4)

UNIT- 1

Steady state and switching characteristics of BJT, Power Mosfet, Cool MOS, SITs, IGBT. Series and Parallel Operation. MOSFET Operation: Operating principle , characteristics, Turn on, Turn Off losses.

UNIT- II

Review of Step- down, Step up Operation, Performance parameters, Converter classifications, Switching mode regulators- Buck, Boost and Buck-Boost, Cuk, SEPIC regulators. DC Power Supplies- SMPS DC Power supplies, Flyback converter, Forward Converter, Push-Pull Converter, Half bridge Converter, Full Bridge Converter, Resonant DC Power Supplies.AC Power Supplies – SMPS AC Power Supplies, Resonant AC Power supplies.

UNIT- III

Review of Voltage source and control source inverters, PWM strategies- Sinusoidal, Trapezoidal, Staircase, stepped, harmonic injected, delta modulation. Space Vector modulation- Concept of Space Vector, space vector switching. Multilevel Inverters – Diode Clamped, improved diode clamped, flying capacitor, cascaded. Application of Multilevel inverters.

UNIT – IV

Transformer Design, DC Inductor, Magnetic Saturation, Capacitor design and ESR effect, Control Circuits, Stability Analysis of Power supply converters.

UNIT- V

Electromagnetic Interference- Common mode, Differential mode noise, EMI Filter, FCC, IEC Standards, UL standards, Active Power Factor correction, Electronic Ballast for various lamps.

Text Book/References:

1. Rashid. M.H., " Power Electronics, Circuits, Devices and Application.", Pearson Education Inc, New Delhi .
2. B. Keith, " SMPS Handbook" McGrawHill Handbook.
3. Ned Mohan, Undeland, Robin, "Power Electronics, Converters, Application and Design", John Wiley and Sons. Inc, New York.
4. P.C. Sen, "Modern Power Electronics", Wheeler publishing corporation, First edition, New Delhi.

EEM-317 Mechatronics

L-T-P (3-1-0) Credit (4)

UNIT-I

Introduction: definition, trends, control systems, micro-controller based controllers, PC based controllers.

UNIT-II

Design of sensor and signal conditioning for Displacement, position, velocity, force, pressure, temperature.

UNIT-III

Precision mechanical actuation: Pneumatic, Electro-pneumatic, Hydraulic, Electro-hydraulic actuation systems, ball screw and nut, linear motion guides, linear bearings, bearings, harmonic transmission, motor/drive selection.

UNIT-IV

Electro mechanical drives: relays and solenoid, stepper motors, DC-brushed / brushless motors, DC servo motors, breaking methods, PWM, Bi-polar driver, MOSFET drivers, SCR drivers, Variable Frequency Drives.

UNIT-V

Micro-controller and interfacing: Digital signal interfacing techniques, Analog signal interfacing with ADC and DAC. Programmable logic and motion controller: programming, interfacing of sensors and actuators to PLC, Simultaneous control of axes integration of axes and I/Os.

Text/Reference Books:

1. Devid G. Alciatore, Michael B. Histand , 'Introduction to Mechatronics and measurement systems', 2nd Edition, McGraw-Hill.
2. Bella G Liptak, 'Instrument Engineer' Handbook, Vol. 1, 2 and 3, CRC Press.
3. Ajay V. Deshmukh, 'Microcontrollers', 1st edition, Tata McGraw-Hill.

EEM-318 Advance Biomedical Instrumentation

L-T-P (3-1-0) Credit-4

Unit-1

Evolution of medical instrument, components of a medical instrumentation system, Classification of medical instruments, Electrical activity of cells, Electrode-skin interface, Origin of Biopotentials, Biopotential amplifiers, and Biopotential signal processors.

Unit-2

Computer based medical instrumentation - Computerised versions of ECG, EEG, EMG, Tread Mill Test ECG– Foetal monitor, cardiac arrthymias and its monitoring through Holter monitor, Operation theatre equipment and Critical Care instrumentation - Patient monitors, pulse oximetry, ICU ventilators, Event monitors.

Unit-3

Specialized Therapeutic and diagnostic equipment - Cardiac pacemakers, heart lung machines, Haemodialysis - design, clinical laboratory instrumentation, Audiometer, Phonocardiogram, Emerging trends in medical diagnostics and therapy. Electromagnetic Blood flow meters, Ultrasonic Blood Flow meters, Laser Doppler Blood Flow Meters.

Unit-4

Stimulators: types of stimulators, electrodiagnostic/therapeutic stimulator, peripheral nerve stimulator, AC and DC defibrillators. Elements of electrical safety- Built-in safety features for medical instruments.

Unit-5

Electroencephalography (EEG), Concept of BCI (Brain control interface) : Invasive and Non-invasive Types, EEG Standards, EEG Data Acquisition. Detection of physiological parameters using electrical impedance technique.

Text/Reference Books:

1. Raja Rao, C; Guha, S.K. Principles of Medical Electronics and Biomedical. Instrumentation. Orient Longman.
2. Geddes L. A and Baker L.E, ‘Principles of Applied Biomedical Instrumentation, Wiley-Interscience.
3. John G. Webster. Medical Instrumentation: Application and design, John wiley & sons.
4. Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer. Biomedical Instrumentation and measurements, Pearson Education Asia.
5. Joseph J. Carr and John M. Brown. Introduction of Biomedical Equipment Technology, Pearson Education Asia.

EEM-319 Robotics

L-T-P (3-1-0) Credit (4)

UNIT-I Introduction

Types of Industrial Robots, definition, classifications based on work envelope ,Generations configurations and control loops, basic parts and functions,specifications. Robots components-Degrees of freedom-Robot joints- coordinates- Reference frames-workspace, Euler angle representation Robot languages, need for robot social issues

UNIT-II Kinematics Of Robot System

Robot motion – Kinematics of Robot motion – Direct kinematics – linkages and joints – mechanism – method for location and orientation of objects – drive systems – end effectors – types, selection, classification and design of grippers – gripper force analysis. Mechanism-matrix representation-homogenous transformation, DH representation-Inverse kinematics-solution and programming-degeneracy and dexterity

UNIT-III Differential Motion and Velocities

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-Design-Lagrangian mechanics-dynamic equations-static force analysis, Langrange- Euler formulation

UNIT-IV Robotic Sensors and Vision System

Functions of Sensors – Position and proximity's sensing – tactile sensing – sensing joint forces – vision system – object recognition and image transformation – safety monitoring sensor systems – image analysis – application of image processing. Two and three dimensional images-spatial and frequency domain representation-noise and edges- convolution masks-Processing techniques-thersholding-noise reduction-edge detection-segmentation-Image analysis and object recognition

UNIT-V Robot Control System

Sensor characteristics Hydraulic, Pneumatic and electric actuators-trajectory planning, decentralized PID control- non-linear decoupling control. Joint and Actuator Control Scheme, Computed torque technique, variable structure control, adaptive control

Text/Reference Books:

1. Fu, Gonzalez and Lee," Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill.
2. R.D. Klafter, TA Chmielewski and Michael Negin, "Robotic Engineering: An Integrated approach", Prentice Hall of India.
3. Yoram Koren, Robotics, McGraw Hill.
4. Groover, M.P. Industrial Robotics, Prentice Hall.
5. Janakiraman P.A. Robotics and Image Processing, Tata McGraw Hill.
6. R. K. Mittal and I . J. Nagrath, "Robotics and Control" Tata McGraw Hill.
7. Robert J. Schilling, "Fundamentals of Robotics", Prentice-Hall of India.

EEM-351 Project

L-T-P (0-0-16) Credit (8)

The Project is aimed at training the students to analyze any problem in the field of Control and Instrumentation systems independently. The project may be analytical, computational and experimental or combination of them based on the latest developments in the relevant areas. It should consist of objectives of study, scope of work, critical literature review and preliminary work done pertaining to the seminar undertaken in Semester II. All the students are required to implement a research paper already published. During the project period, every student has to present the progress of their works before the duly constituted committee of internal teachers of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

EEM-451 Dissertation

L-T-P (0-0-24) Credit (12)

Dissertation is a continuation of the project work done by the student during Semester III. The dissertation report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical computation and experimental aptitude of the students as applicable. During the dissertation period, every student has to present the progress of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the dissertation in the form of hard copy must be submitted in the office at least two weeks before the final viva voce is conducted by the External Examiner.

COURSE STRUCTURE AND CURRICULUM

(w.e.f. 2013-2014)

M. TECH. PROGRAMME
ELECTRICAL POWER SYSTEMS MANAGEMENT

COURSE STRUCTURE

M. Tech. (Electrical Power Systems Management)

SEMESTER I

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
EEM-101	Intelligent Techniques	3	1	0	10	30	60	100	4
EEM-102	Automation System	3	1	0	10	30	60	100	4
EEM-103	Instrumentation Systems	3	1	0	10	30	60	100	4
EEM-104	Power System Modelling	3	1	0	10	30	60	100	4
	Elective-I	3	1	0	10	30	60	100	4
EEM-152	SCADA Lab	0	0	4	20	10	20	50	2
TOTAL		**15**	**5**	**4**	**70**	**160**	**320**	**550**	**22**

SEMESTER II

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
EEM-201	Optimization Techniques	3	1	0	10	30	60	100	4
EEM-202	Communication Protocols	3	1	0	10	30	60	100	4
EEM-203	Transmission and Distribution Automation	3	1	0	10	30	60	100	4
EEM-204	Energy Management Systems	3	1	0	10	30	60	100	4
	Elective-II	3	1	0	10	30	60	100	4
EEM-251	Seminar	0	0	4	20	10	20	50	2
EEM-253	Power System Automation Laboratory	0	0	4	20	10	20	50	2
TOTAL		**15**	**5**	**8**	**90**	**170**	**340**	**600**	**24**

SEMESTER III

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
	Elective-III	3	1	0	10	30	60	100	4
	Elective-IV	3	1	0	10	30	60	100	4
EEM-351	Project	0	0	16	40	80	80	200	8
TOTAL		**6**	**2**	**16**	**60**	**140**	**200**	**400**	**16**

SEMESTER IV

COURSE NUMBER	COURSE NAME	TEACHING SCHEME (PERIODS PER WEEK)			EXAMINATION SCHEME (DISTRIBUTION OF MARKS)			TOTAL MARKS	CREDIT
		L	T	P	Mid Semester Evaluation		End Semester Evaluation		
					CCA	MTE			
EEM-451	Dissertation	0	0	24	80	100	120	300	12
TOTAL		**0**	**0**	**24**	**80**	**100**	**120**	**300**	**12**

Elective I

1. EEM-106 Modeling and Simulation
2. EEM-107 Applied Mathematics for Electrical Engineers

Elective II

1. EEM 206 Digital Protection of Power Systems
2. EEM 207 Power System Reliability

Elective III

1. EEM-301 Restructuring & Deregulation of Power
2. EEM-302 EHV AC & DC Transmission

Elective IV

1. EEM-306 Advanced Power Electronics
2. EEM-307 Renewable and Sustainable Energy Systems
3. EEM-308 Power Quality and FACTS

EEM-101 Intelligent Techniques

L-T-P (3-1-0) Credit (4)

Unit I: Soft Computing
Hard Computing: Features of Hard Computing, Soft Computing: features of soft computing, Hybrid Computing, Fuzzy Set Theory: fuzzy versus crisp sets, basic fuzzy set operations, linguistic variables, membership functions, fuzzy Cartesian product, fuzzy relations, fuzzy rules.

Unit II: Fuzzy Implications
Approximate reasoning, fuzzy modelling, fuzzification, inferencing and defuzzification, fuzzy modeling and control schemes for nonlinear systems, applications in power system.

Unit III: Fundamentals of Neural Networks
Biological neural networks, models of an artificial neuron, neural network architectures, characteristics of neural networks, McCulloch-Pitts neuron, learning methods, Hebbian learning rules, Hebb nets.

Unit IV: Backpropagation Networks
Architecture of backpropagation networks, perceptron model, single layer and multi-layer perceptron models, backpropagation learning, tuning parameters of backpropagation networks, neuro-fuzzy models, adaptive neuro-fuzzy inference system (ANFIS), applications.

Unit V: Neuro-Fuzzy Systems
Architectures of neuro-fuzzy systems; Cooperative neuro-fuzzy systems, Neural Network driven fuzzy reasoning, Hybrid neuro-fuzzy system; Construction of neuro-fuzzy systems: Structure if identification phase, parameter learning phase.

Text/Reference Books:

1. Fakhreddine O. Karray and Clarence W De Silva, “Soft Computing and Intelligent Systems Design: Theory, Tools and Applications” Pearson Education.
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications”, Prentice Hall of India, New Delhi.
3. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and applications, Prentice Hall of India, New Delhi.
4. Jyh-Shing Roger, Chuen-Tsai Sun, Eui Mizutani, Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Prentice Hall of India, New Delhi.
5. Simon S Haykin, “Neural networks and learning machines”, Prentice Hall of India, New Delhi.

EEM 102 Automation Systems

L-T-P (3-1-0) Credit (4)

Unit I

Automation systems, Advantages of automation, Components of process control systems, Evolution of Control systems. Single loop control, Centralized control, Distributed control systems, Open systems, SCADA systems. Types of data available, Analog, Digital, Pulse data, Redundancy. Data communication components and protocols.

Unit II:

Programmable Logic Controllers (PLC) Functional description, input/output systems, CPU, memory Unit, Programmer Units, Peripheral devices, PLC Vs Computers, Advantages of PLCs, controller programming tools, Ladder Diagram programming. phase locked loop, Interposing relays, type and structure of relays.

Unit III:

Distributed Control Systems (DCS) PLC Vs DCS systems, DCS architecture, Local control units, dedicated card controllers, Unit Operations controllers, DCS multiplexers, DCS system integration, Automation Standards, salient features.

Unit IV:

Supervisory Control and Data acquisition (SCADA) Systems, Types of supervisory systems, Components of SCADA Systems. Remote terminal unit (RTU), Communication subsystem, Protocols, Logic subsystem, termination subsystem, test and power supply subsystem, Phasor measurement Units, Phasor Data concentrator and communication, Intelligent Electronic Devices.

Unit V:

SCADA master station configurations, hardware and software components, Communication systems, Human Machine interface. SCADA application functions, Intelligent Electronic devices. Practical PLC, DCS, PMU and SCADA applications and implementations

Reference Books:

1. Automation Handbook Vol I Bela G. Liptac, CRC Press.
2. Fundamentals of Supervisory systems, IEEE tutorial.
3. John W Webb & Ronald A Reiss, Programmable Logic Controllers, principles and applications, Prentice Hall of India.
4. Related Research papers

EEM-103 Instrumentation Systems

L-T-P (3-1-0) Credit (4)

Unit- I

Transducer Characteristics **:** General concepts and terminology of measurement systems: Transfer Function, Span (Full-Scale Input), Full-Scale Output, Accuracy, Calibration, Calibration Error, Hysteresis, Nonlinearity, Saturation, Repeatability, Dead Band, Resolution, Special Properties, Output Impedance, Excitation, Dynamic Characteristics, Environmental Factors, Reliability. Modeling and analysis of the measuring system, standards and calibration of the measuring instrument.

Unit-II

Transducers: Classifications, working principle, construction and design of various active and passive transducers. Voltage and current transducers, Tap position transducers. Hall effect transducers, optical transducers. Semiconductor traducers for physical and chemical parameters measurement**.**

Unit-III

Design of detection electronics and signal conditioning circuits for various resistive, capacitive, inductive transducers. Active filters, Impedance matching, loading effect. Introduction to electromagnetic coupling (EMC), inference coupling mechanism, shielding. Concepts of interfaces with digital device like computer, microcontroller microprocessor.

Unit-IV

Applications of Industrial transducers: Hotwire anemometer, infrared, seismic and nuclear energy transducer, Transducers activated RFID tags.

Unit-V

Controller modes Discontinuous, two positions, multi position, floating control, continuous control, proportional, integral, derivative and composite modes of control.

Text/Reference Books:

1. C.D. Jhonson, Process Control Instrumentation Technology, PHI, India.
2. Doeblin E.O. Measurement Systems-Application and Design, Fourth Edition, McGraw Hill International Edition, New York-Fifth Edition.
3. Jacob Fraden, Hand book of Modern Sensors: Physics, Design and applications, publication by Springer, Fourth Edition.
4. John P. Bentley, Principle of measurement systems, Third edition, addition Wesley Longman Ltd. UK.
5. Gregory K. McMillan and Doughlas M. Considine, Industrial Instruments and Controls handbook, Tata Mc Graw Hill Edition.
6. L.D. Goettsche, Maintenance of Instruments and Systems – Practical guides for measurements and control, ISA.

EEM-104 Power System Modelling

L-T-P (3-1-0) Credit (4)

Unit I

Review of network matrices; introduction to graph theory, basic loops, basic cut-sets, incidence matrices, augmented cut-set and loop incidence matrices, primitive network, network performance equations, bus admittance matrix, direct inspection method, step by step procedure, singular transformation and non singular transformation.

Unit II

Bus impedance matrix, partial network, procedure for finding elements of Z- bus, algorithm for formulation of Z-bus with and without coupled elements, addition of branch, addition of link, modification of Z- bus for changes in network.

Unit III

Introduction to load flow analysis, development of load flow equations, iterative methods, Techniques used in N-R method, sparse matrix, triangular factorization, fast decoupled load flow.

Unit IV

Modeling of Single Machine infinite bus system, Mathematical modeling of multi machine system, Dynamics and transient stability analysis of single machine system and multi machine system.

Unit V

Short circuit studies of large power system networks, algorithm for calculating system condition after the occurrence of faults, comparison between symmetrical components and phase coordinated method of short circuit studies.

Text/Reference Books:

1. Modern Power system Analysis, I.J. Nagrath and D. P. Kothari; Tata Mc Graw Hill, New Delhi.
2. Electrical Power System; New Age International Publishers.
3. Power System Analysis, B. Subramanyam, B. Venkata Prasantha, I. K. International Publishing House, New Delhi.
4. Power Generation, Operation and Control, Wood and Woollenberg, John Wiley and Sons.
5. Computer Method in Power Systems, Stas El Abiad.
6. Advanced Power System Analysis and Dynamics, L.P. Singh, Wiley Eastern Limited, New Delhi.

EEM-106 Modeling and Simulation

L-T-P (3-1-0) Credit-4

UNIT-1: System Models

The concepts of a system, System environment, Stochastic activities, Continuous and Discrete Systems, System Modeling, Types of models, Static physical models, Dynamic physical models, Static mathematical models, Dynamic mathematical models, Principles used in modeling.

UNIT-II: System Simulation

The technique of Simulation, The Monte Carlo method, Comparison of simulation and analytical methods, Experimental nature of simulation, Types of system simulation, Numerical computation technique for continuous models, Numerical computation technique for Discrete models, Distributed lag models, Cobweb models, Progress of a simulation study.

UNIT-III: Probability Concepts in Simulation

Stochastic variables, Discrete probability functions, Measures of probability functions, Continuous uniformly distributed random numbers, Random number generators (RNG), multiplicative congruential method, Mixed multiplicative congruential method, Other methods of random number generation.

UNIT-IV: Basic Queuing Models and Arrival patterns

Congestion in Systems, Arrival patterns, Poisson arrival patterns, Exponential distribution, Coefficient of variation, The Erlang distribution, Hyper-exponential distribution, Service times, Normal distribution, Basic queuing models, Short hand notation for queuing and loss models, Queuing disciplines, Measures of queues, Mathematical solutions of queuing problems.

UNIT-V: Simulation Experiments and Statistical Data Analysis

Experiments and Statistical inference, Nature of the problem, Estimation methods, Simulation run statistics, Replication of runs, Elimination of initial bias, Batch means, Regenerative techniques, Time series analysis, autoregressive processes, Validation and Testing of simulation models.

Text/Reference Books:

1. Gordan G., “System Simulation,” Prentice Hall of India.
2. Kobayashi H., mark B. L., “System Modeling and Analysis,” Pearson Education, Inc, New Delhi.

EEM-107 Applied Mathematics for Electrical Engineers

L-T-P (3-1-0) Credit (4)

UNIT-I Advanced Matrix Theory

Eigen-values using QR transformations – Generalized eigen vectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT-II Linear Programming

Formulation – Graphical Solution – Simplex Method – Two Phase Method – Transportation and Assignment Problems.

UNIT-III One Dimensional Random Variables

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT-IV Queueing Models

Poisson Process – Markovian queues – Single and Multi Serve r Models – Little's formula – Machine Interference Model – Steady State analysis – Self Service queue.

UNIT-V Computational Methods In Engineering

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank- Nicolson implicit scheme – olution of wave equation.

Text/Reference Books:

1. Bronson, R., Matrix Operation, Schaum's outline series, McGraw Hill, New York.
2. Taha, H. A., Operations Research: An Introduction, Seventh Edition, Pearson Education Edition, Asia, New Delhi.
3. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, Probability and Statistics for Engineers & Scientists, Asia, 8th Edition.
4. Donald Gross and Carl M. Harris, Fundamentals of Queueing theory, 2nd edition, John Wiley and Sons, New York.

EEM-152 SCADA Lab

L-T-P (0-0-4) Credit (2)

This laboratory course is designed based on theory course of “Automation System” (EEM-102). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include hardware of SCADA system, software structure of SCADA lab, system configuration and I/O mapping, Engineering and operator software customization, graphics development etc. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers.

EEM-201 Optimization Techniques

L-T-P (3-1-0) Credit (4)

UNIT-I

Introduction to optimization, functions of single variable, functions of several variables, formulation of optimization problems. Review of classical methods, linear programming, non-linear programming.

UNIT-II

Constraint optimality criteria, constrained optimization, constraint direct search method, linearization methods for constrained problems, transformation method. Nonlinear programming: problem formulation, Quadratic Approximation Methods for Constrained Problems Unconstrained minimization techniques.

UNIT-III

Dynamic programming: sub-optimization, multistage optimization problem. Multi-objective and goal programming: problem formulation, solution of a multi-objective problem. Case studies

UNIT-IV

Introduction to Stochastic Optimization Techniques, types: Local Search, Population Based, Introduction to Genetic Algorithms, Motivation from Nature, Genetic Algorithms: Working Principle: Representation, Fitness Assignment, Reproduction, Crossover, Mutation, Constraint Handling, Real Parameter Genetic Algorithms, Combined Genetic Algorithm, Advanced Genetic Algorithms, Applications.

UNIT-V

Ant Colony Optimization: Introduction, Ant System, Ant Colopny System, ANTS, Significant Problems, Convergence Proofs. Discrete Particle Swarm Optimization (PSO): Introduction, PSO Elements: Position and State Space, Objective Function, Velocity, PSO Algorithm, Examples and Results, Applications.

Text/Reference Books:

1. Singiresu S. Rao, ‘Optimization Techniques’, New Age International Publishers.
2. D. P. Kothari and J. S. Dhillon, ‘Power System Optimization, Tata McGraw Hill.
3. C. Mohan and Kusum Deep, ‘Optimization Techniques, New Age International Publishers.
4. Godfrey C. Onwubolu, B. V. Babu, “New Optimization Techniques in Engineering”, Springer-Verlag.
5. Marco Dorigo, Thomas Stützle, “Ant colony optimization”, MIT Press.
6. Thomas Wiesi, “Global Opimization Algorithms”, ebook. http://www.it-weise.de/.

EEM-202 Communication Protocols

L-T-P (3-1-0) Credit (4)

UNIT-I: Introduction to Communication Protocols
Data Communication basics, OSI reference model, Network Classification, Device Networks, Control Networks, Enterprise Networks.

UNIT-II: Networks in Process Automation
Introduction to Networks in process automation, Information flow requirements, Industry Networks, Network selection.

UNIT-III: Proprietary and open networks
Network Architectures, Building blocks, Industry open protocols: RS-232, RS- 422, RS-485, Ethernet, Modbus, Profibus, Fieldbus; Hardware: Fieldbus Design, Advantages and Limitations.

UNIT-IV: Introduction to wireless Protocols
WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave, IRIB-B.

UNIT-V: Communication Protocols for Power System
Communication requirements for power system automation, Protocols used, Need for Interoperable Communication, Overview of IEC 61850 Standard: Data Models, Communication Services, GOOSE Communication: Implementation and its advantages.

Text/References/Books:

1. B.G. Liptak, '*Process Software and Digital Network"*, CRC Press ISA- The Instrumentation, Systems, and Automation Society.
2. User Manuals of Foundation Fieldbus, Profibus, Modbus, Ethernet, Devicenet, Controlnet, IEC 61850.
3. Peterson Davie, "Computer Networks—A System Approach", Maugann Kauffmann Publisher.

EEM-203 Transmission and Distribution Automation

L-T-P (3-1-0) Credit (4)

Unit I:

Overview of transmission system, SCADA in Power systems. AGC, Energy Management Systems, FACTS, HVDC, Under Frequency Relay (UFR), df/dt control, Islanding. Regional grids, Specifications and details. Functions of the SCADA hierarchical levels in Transmission Master stations.

Unit II:

Utility distribution system, Types of distribution feeder configurations; Grid network, radial, loop, grounding, Load and fault characteristics. Distribution transformers and regulators. Application of capacitors for distribution system,. Losses and loss reduction in Distribution systems. Over voltages in Distribution systems.

Unit III:

Introduction to Distribution Automation (DA), Constituents of DA, Feeder automation application functions, Outage management, customer information systems, AMI, Distribution load flow & fault location algorithms for distribution system.

Unit IV:

Substations, Bus Switching Schemes, Types of substations; GIS, Air Insulated, HV Power Electronic. Smart Grid; Smart Transmission (WAMS, Smart Distribution, Demand Side Integration (Demand Response & Demand Side Management), Energy Storage, Renewable Source Integration.

Unit V:

Substation integration and automaton, Application functions Interface between substation and automation. Open systems, architecture functional data paths, new vs existing substations.

Text/Reference Books:

1. Power Distribution Engineering: James J. Burke, Marcel Dekker, Inc.
2. Electric Power Substation Engineering John D. Mc Donald CRC Press, , Taylor and Francis
3. Control and Automation of Electrical Power Distribution systems, James Northcote-Green, R Wilson, CRC Press, Taylor and Francis.
4. Electric Power Distribution, Automation, Protection and Control, James Momoh, CRC press, Taylor and Francis.
5. Related Research papers.

EEM -204 Energy Management Systems

L-T-P (3-1-0) Credit (4)

Unit I

Power system security, , factors affecting power system security, contingency analysis, linear sensitivity factors, contingency selection, concentric relaxation, calculation of network sensitivity factors. Transmission planning criteria.

Unit II

Power system state estimation. Maximum likely hood weighted least squares estimation, matrix formation. State estimation of an AC network.

Unit III

Detection and identification of bad measurements in state estimation. Network observability. Applications. Dynamic (linear) state estimation using PMU measurements

Unit IV

Economic load dispatch, system constraints, economic dispatch with and without losses, exact transmission loss formula, modified coordination equation, economic scheduling of hydrothermal plants, optimal power flow, multiobjective optimal power flow.

Unit V

Economy interchange between interconnected utilities. Interchange evaluation. Power pools, transmission effects and issues

References:

1. Power generation Operation & Control, Allen J. Wood and Bruce Woollenberg, John Wiley & Sons.
2. Transmission planning criteria: CEA manual.
3. PMU Dynamic State Estimation: CEA Manual.
4. POSOCO Operator examination handbook.

EEM-205 Digital Protection of Power System

L-T-P (3-1-0) Credit (4)

UNIT-1:
Relaying Evolution, Disadvantages of Conventional Relays, Computer Relaying Architecture, Performance and Operational Characteristics, Cost/Benefits considerations, Substation Computer Hierarchy.

UNIT-2:
Signal Conditioning Subsystems, Analog-to-Digital Conversion, Sampling, Digital Filtering in Protection Relays; Time domain, Frequency domain, Types of Digital Filters, Spectral Analysis; Discrete Fourier Transform, Fast Fourier Transform, Walsh Function Analysis.

UNIT-3:
Relaying as Parameter Estimation, Transmission Line Protection, Transformer Protection, Generator Protection, Bus Protection, Reactor Protection, Symmetrical Component Distance Relay, Distribution Over-current Protection.

UNIT-4
Substation Communication Networks, Bandwidth, Data Rate, End-to-end Delays, Digital Data Transmission, Ethernet in Substation, Fiber Optic Communication, End-to-end Delay Standards for Protection Applications.

UNIT-5
Substation Environment, Industry Environment Standards, EMI and Countermeasures, Supplementary Equipments in Substation, Travelling Waves due to faults, Directional wave Relay, Travelling wave Distance Relay, Travelling wave Differential Relay, Fault Location Algorithm.

Text/References Books:

1. Phadke A.G., James S. Thorp, “Computer Relaying for Power System”, John Wiley & Sons Inc.
2. James J. Bruke, “Power Distribution Engineering”, Mark Dekker Inc.
3. John A. T., Salman S. K., “ Digital Protection for Power System”, Power & Energy Series, Issue 15 of IEE power series, ISBN-086341303X, 9780863413032, IET.
4. Singh L. P., “Digital Protection- Protective Relaying from Electromechanical to Microprocess”, New Age International.

EEM-206 Power System Planning and Reliability

L-T-P (3-1-0) Credit (4)

Unit I: System Planning

Introduction, Objectives & Factors affecting to System Planning , Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning.

Unit-II: Reliability

Reliability, Failure, Concepts of Probability, Evaluation Techniques (i) Markov Process (ii) Recursive Technique, Stochastic Prediction of Frequency and Duration of Long & Short Interruption, Adequacy of Reliability, Reliability Cost.

Unit III: Generation Planning and Reliability

Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods, Interconnected System, Factors Affecting Interconnection under Emergency Assistance.

Unit IV: Transmission Planning and Reliability

Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.

Unit V: Distribution Planning and Reliability

Radial Networks, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices. Parallel & Meshed Networks, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Breaker Failure.

Text/Reference Books:

1. Power System Planning - R.L. Sullivan, Tata McGraw Hill Publishing Company Ltd.
2. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication.
3. Electricity Economics & Planning – T. W. Berrie, Peter Peregrinus Ltd., London.

EEM-251 Seminar

L-T-P (0-0-4) Credit (2)

All the students of II semester will be required to deliver a seminar on the topic relevant to recent trends in Electrical Power Systems using power point presentation. Topics are selected in consultation with their supervisors. Presentation will be of 15 minutes duration followed by a question answer session at least two times in a semester before the duly constituted committee of the Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the seminar in the form of hard copy must also be submitted in the office before the final evaluation by External Examiners.

EEM-253 Power System Automation Laboratory

L-T-P (0-0-4) Credit (2)

This laboratory course is designed based on theory course of "Transmission and Distribution Automation" (EEM-203). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include power system simulation studies like load flow study, short circuit analysis etc. using PSCAD software, testing and performance of IEDs, PMUs etc. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers.

EEM-301 Restructuring and Deregulation of Power System

L-T-P (3-1-0) Credit (4)

UNIT-1:
Open access in electricity sector, types of open access- medium term. Competitive Electricity Market and Balancing Mechanism, Scheduling.

UNIT-2:
Traditional Central Utility Model, Reform Motivations, Separation of Ownership and Operation, Central Dispatch versus Market Solution, Independent System Operator (ISO). Components of Restructured Systems: Gencos, Discos and Retailers, ,

UNIT-3:
Wholesale Electricity Market Characteristics: Central Auction, Bidding, Market Clearing and Pricing, Bilateral Trading, Scheduling, Gaming, Ancillary. Maximalist ISO, Minimalist ISO Model. Deregulation in Distribution.

UNIT-4:
Role of TP: Vertically Integrated Utility, Three Models of the Electricity Market, For-profit TP. Incentive Rate Design, Priority Insurance Scheme, Transmission Expansion in deregulated Environment. Transmission Owners

UNIT-5:
ISOs, Power Exchange (PX), Scheduling Coordinators. PX and ISO: Functions and Responsibilities, Trading Arrangements: The Pool, Pool and Bilateral Trades, Multilateral Trades, Congestion Management in Open-access Transmission Systems, Open-access Coordination Strategies.

Text/Reference Books:

1. Loi Lei Lai, “Power System Restructuring and Deregulation: Trading Performance and Information Technology”, John Wiley & Sons Ltd.
2. CERC Regulations on Grand og Connectivity, Medium term Open Access and Long Term Open Access; Regulations.
3. CERC Regulation on Open Access-2008 [CERC Compendium].
4. POSOCO Manual on Electricity Market.

EEM-302 EHVAC and HVDC Transmission

L-T-P (3-1-0) Credit (4)

UNIT-1

Introduction to EHV AC and HVDC transmission-Comparison –Economic, Technical performance – Reliability – Limitations for EHVAC and HVDC transmission, Distance-problems involved in EHVAC transmission, Modeling of AC and DC Networks, Modeling of DC links, Solution of DC load flow, Per Unit System for DC Quantities, Solution of DC power flow.

UNIT-II

Principles of HVDC Transmission, Terminal equipments and their controls, Reactive power control. Choice of converter configuration, Modeling and analysis of HVDC converters, Analysis of converters for HVDC System: characteristics and their control, DC Link Control Harmonics and filters, Generation of harmonics, multi-terminal DC system.

UNIT-III

Protection, Converter Faults, Protection against over currents, over-voltages, HVDC circuit breakers, Protection by DC reactors, Insulation coordination, Earth return: Use of earth and sea return. Simulation of HVDC Systems: Digital dynamic simulation of converters and DC systems.

UNIT-IV

Parameters of EHVAC Lines for modes of propagation, resistance and Inductance of ground returns, Voltage Gradient of conductors Corona effects: Power loss and Audible Noise, Charge-Voltage diagram. Attenuation of traveling waves, Audible noise levels. Power frequency voltage control: Generalised constants, Cascade connection of components-shunt and series compensation. Sub-synchronous Resonance in series- capacitor compensated lines.

UNIT-V

Origin of overvoltage and their types, short circuit current and circuit breaker. Recovery voltage and the circuit breaker, Overvoltage caused by interruption of inductive and capacitive currents, Ferro resonance over voltage, calculation of switching surges single phase equivalents, Reduction of switching surges on EHV systems.

TEXT/REFERENCE BOOKS:

1. Begamudre R.D , "*Extra High Voltage AC Transmission Engineering*", Wiley Eastern Ltd., Second edition.
2. K.R, Padiyar, *HDVC Power Transmission System*, Wiley Eastern Ltd.
3. E.W. Kimbark, *Direct Current Transmission, Vol*:1 Wiley Interscience.
4. D. Chakrabarti, D.P.Kothari, A.K. Mukhopdadhyay ,"*Performance, Operation & Control of EHV Power Transmission System* ", Wheeler publications.
5. J. Arrillage et. Al *Computer Modeling of Electrical Power System*, John Wiley.
6. Adams and Hingorani, "*HVDC transmission*".New Age.
7. P.S.Kundur, *Power System Stability and Control*, Wiley Eastern Ltd.

EEM-306 Advance Power Electronics

L-T-P (3-1-0) Credit (4)

UNIT- 1

Steady state and switching characteristics of BJT, Power Mosfet, Cool MOS, SITs, IGBT. Series and Parallel Operation. MOSFET Operation: Operating principle , characteristics, Turn on, Turn Off losses.

UNIT- II

Review of Step- down, Step up Operation, Performance parameters, Converter classifications, Switching mode regulators- Buck, Boost and Buck-Boost, Cuk, SEPIC regulators. DC Power Supplies- SMPS DC Power supplies, Flyback converter, Forward Converter, Push-Pull Converter, Half bridge Converter, Full Bridge Converter, Resonant DC Power Supplies.AC Power Supplies – SMPS AC Power Supplies, Resonant AC Power supplies.

UNIT- III

Review of Voltage source and control source inverters, PWM strategies- Sinusoidal, Trapezoidal, Staircase, stepped, harmonic injected, delta modulation. Space Vector modulation- Concept of Space Vector, space vector switching. Multilevel Inverters – Diode Clamped, improved diode clamped, flying capacitor, cascaded. Application of Multilevel inverters.

UNIT – IV

Transformer Design, DC Inductor, Magnetic Saturation, Capacitor design and ESR effect, Control Circuits, Stability Analysis of Power supply converters.

UNIT- V

Electromagnetic Interference- Common mode, Differential mode noise, EMI Filter, FCC, IEC Standards, UL standards, Active Power Factor correction, Electronic Ballast for various lamps.

Text Book/References:

1. Rashid. M.H., " Power Electronics, Circuits, Devices and Application.", Pearson Education Inc, New Delhi.
2. B. Keith, " SMPS Handbook" McGrawHill Handbook.
3. Ned Mohan, Undeland, Robin, "Power Electronics, Converters, Application and Design", John Wiley and Sons. Inc, New York.
4. P.C. Sen, "Modern Power Electronics", Wheeler publishing corporation, New Delhi.

EEM-307 Renewable and Sustainable Energy Systems

L-T-P (3-1-0) Credit (4)

Unit I:
Overview of conventional and renewable energy technologies, World and India's energy scenario & Energy Security, energy growth patterns, projection of energy Demands.

Unit II:
Solar radiation, availability, measurement, estimation and modelling, solar photovoltaic's and Concentrated Solar Power (CSP), solar thermal systems, application of photovoltaic system for power generation, concentrating solar power generation, applications, Inverters.

Unit III :
Wind resource assessments and Forecasting, site assessment, power in wind, general theories of wind machines, wind energy conversion systems (WECS) and Integration to the Grid.

Unit IV:
Potential, availability of biomass, bio conversion process, bio gas and bio power.

Unit V:
Micro grid; Fuel cell, hydrogen energy, Energy Storage, hybrid and integrated energy systems.

Text/ References Books:

1. B. H. Khan, Non Conventional Energy Resources, TMH.
2. D. P. Kothari, Renewable Energy and Emerging Technologies, PHI.
3. C. S. Solanki, Solar Photovoltaics, PHI.
4. C. S. Solanki, Renewable Energy, PHI.
5. Freris L. L., Wind Energy Conversion Systems, PHI.
6. J. A. Duffie and W. A. Beckmen, Solar Engineering of Thermal Processes, John Wiley.
7. S. P. Sukhatme, Solar Energy-Principles of Thermal Collection and Storage, TMH.
8. MNRE Manual.

EEM-308 Power Quality and FACTS

L-T-P (3-1-0) Credit (4)

UNIT-1

Definition of Power Quality, Power Quality Issues, power quality indices, Power Quality v/s Equipment Immunity, Electric Power Quality Standards. Power Frequency Disturbances, Voltage Sag, Isolation Transformers, Voltage Regulators, Uninterruptible Power Source Systems and non-linear loads.

UNIT-II

Types and Causes of Transients, Definition of Harmonics, Causes of Voltage and Current Harmonics. Individual and Total Harmonic Distortion, Effect of Harmonics on Power System Devices, Guidelines for Harmonic Voltage and Current Limitation, Harmonic Mitigation.

UNIT-III

Power Quality Measurement Devices: Harmonic Analyzers, Transient- disturbance analyzers, Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods , Elimination/suppression of harmonics using passive, active and hybrid filters.

UNIT-IV

FACTS concepts and general considerations, converters for static compensation, SVC and STATCOM: Operation control and comparison, static series compensation, static voltage phase angle regulators: TCVR & TCPAR, Unified Power Flow Controllers-operation, comparison with other FACTS devices, control of P and Q, special purpose FACTS devices, Interline Power Flow Controllers: operation and control.

UNIT-V

Power Quality issues related to distribution systems – custom power devices – Distribution STATCOM – Dynamic Voltage restorer – Unified Power Quality Conditioner – Application of D-STATCOM, DVR and UPQC for improving power quality in distribution systems.

TEXT/REFERENCE BOOKS:

1. G.T. Heydt, *Electric Power Quality,* West Lafayette, IN: Stars in a Circle.
2. A Ghosh, G. Ledwich, *Power Quality Enhancement Using Custom Power Devices.* Kluwer Academic.
3. R.C. Dugan, M.F. McGranaghan and H.W. Beaty, *Electric Power Systems Quality* New York: McGraw-Hill.
4. Math. H. J. Bollen, *"Understanding Power Quality Problems - Voltage Sags and Interruptions*", IEEE Press.
5. J. Arrillaga, D.A Bradely and P.S. Bodger, *Power System Harmonics.* New York: Wiley.
6. Derek A. Paice, Power electronic converter harmonics.
7. N.G. Hingorani & L. Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press.
8. T.J.E Miller, *Reactive Power Control in Electric Systems*, John Wiley & Sons.
9. K. R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International, First Edition, Narosa Pub.

EEM-351 Project

L-T-P (0-0-16) Credit (8)

The Project is aimed at training the students to analyze any problem in the field of power systems independently. The project may be analytical, computational and experimental or combination of them based on the latest developments in relevant areas. It should consist of objectives of study, scope of work, critical literature review and preliminary work done pertaining to the seminar undertaken in Semester II. All the students are required to implement a research paper already published. During the project period, every student has to give a power point presentation of about 15 minutes duration of the progress of their works at least two times in a semester before the duly constituted committee of the Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

EEM-451 Dissertation

L-T-P (0-0-24) Credit (12)

Dissertation is a continuation of the project work done by the student during Semester III. The dissertation report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical computation and experimental aptitude of the students as applicable. During the dissertation period, every student has to give a power point presentation of about 15 minutes duration at least two times in a semester of the progress of their works before the duly constituted committee of the Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the dissertation in the form of hard copy must be submitted in the office at least two weeks before the final viva voce is conducted by the External Examiner.