Government College of Engineering, Aurangabad

Department of Electrical Engineering

NEP Compliant tentative B. Tech structure

& Curriculum of

T.Y. B. Tech. (Electrical) 2025-26 onwards as per NEP2020

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's)

1. Our graduates will excel in professional careers in technology and management with appropriate consideration for safety, culture, energy optimization and environment.
2. Our graduates will excel in higher studies, research and competitive examinations.
3. Our graduates will become successful entrepreneurs.
4. Our graduates will practice good human values, professional ethics and social responsibilities

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Program Outcomes

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design systems components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, social and environmental consideration. To use modern engineering IT tools to solve and model electrical engineering problems.
4. Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including predictions and modeling to complex engineering activities with an understanding of the limitations
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and consequent responsibility relevant to the professional engineering practice.
7. Environment and sustainability: Understands the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and multidisciplinary settings.
10. Communications: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentations, make effective presentations and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects multidisciplinary environments.
12. Life-long learning: Recognize the need for and have preparation and ability to engage in independent and life-long learning in the broadest context of technological changes.

Program Specific Outcomes

1. Identify, formulate problems in power system domain and apply subject knowledge to provide solutions
2. Classify, make use of various electrical machines, power electronics circuits and electrical drives for engineering applications and investigate for suitability and troubleshooting
3. Analyze and apply concepts of electronics, control systems and instrumentation for engineering applications

Total Credits for the completion of B. Tech. in Electrical Engineering:

The total number of credits proposed for the four-year B. Tech Electrical Engineering with 1 Multidisciplinary minor (Compulsory) degree is **170** as per the structure given below**:** Structure of B. Tech. in Electrical Engineering with multidisciplinary minor:

Semester		**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total Credits**
Basic Science Course	BSC	08	08		--	--	--	--	--	16
Engineering Science Course	ESC	07	07		--	--	--	--	--	14
Program Core Course (PCC)	Program Courses	--	02	14	12	08	10	04		50
Program Elective Course (PEC)	Program Elective	--	--	--	--	07	07	06	-	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses		-	04	03	04	03			14
Open Elective (OE) Other than a particular program	OE	--	--	03	02	03	--	--	--	08
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	--	02	--	02	--	--	08
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)		02	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)		02			--	--	--	--	--	02
Value Education Course (VEC)		--	--	02	02	--	--	--	--	04
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--		02	02
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	02	--	--	--	-	-	02
Project		--	--	--	--	--	--	06	-	06
Internship/ OJT		--	---			--	--		12	12
Co-curricular Courses (CC)	Liberal Learning Courses	02	02		--	--	--	--	-	04
Total Credits (Major)		**21**	**23**	**27**	**25**	**22**	**22**	**16**	**14**	**170**

Students can opt for any of the following as per the rules and regulations given by institute:

1. B. Tech with one Multidisciplinary Minor = Total 170 Credits

2. B Tech with two Multidisciplinary Minors = Total 184 Credits

3. B. Tech with one Multidisciplinary Minor and Honor = Total 188 Credits

4. B. Tech with one Multidisciplinary Minor and Honor by research = Total 188 credits

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MULTIDISCIPLINARY MINOR (MD M) and OPEN ELECTIVE (OE)

Other than particular Program

List of Multidisciplinary Minor Courses from other faculties: Total 14 Credits as per GR, Two courses of 4 credits and two courses of 3 credits. Open electives of 8 credits are offered, Two courses of 3 credits and 01 course of 02 credits.

Specialization	Dramatics	Film Making	Fine Art	Music
Multi-disciplinary Minor - 01	Dramatic Theory, Literature	Videography + Cinematography	Applied Art (Digital Art)	Theory of Indian Music
Multi-disciplinary Minor – 02	Acting	Video Editing and Lighting	Painting (Generative Art)	Ancient and Modern Poetry
Multi-disciplinary Minor – 03	Directing	Story telling Story Boarding	Sculpture (3D-Space)	The Evolution of music
Multi-disciplinary Minor – 04	Playwriting	UI/UX and Animation	Visual Communication (Evolutionary Art)	Music and Film
Multi-disciplinary Minor – 05	Applied Interactive Theatre	Art of Visual Communication	Graphics Art (Print & Printing Art)	Introduction to Electronic and Computer Music
Multi-disciplinary Minor - 06	Technical Theatre	Film & TV Directing	Art Culture	Analysis of Tonal Music

Specialization	Management & Finance	Law	Social Science	Journalism
Multi-disciplinary Minor - 01	Micro-economics	Constitutional Law	Indian Economics	Principles of Communication
Multi-disciplinary Minor – 02	Corporate Social Responsibility	Human Rights & International Law	Introduction to Sociology	Fundamentals of Journalism
Multi-disciplinary Minor – 03	Principles of Accounting	Environmental Law	Geo- Informatics	Cyber Journalism
Multi-disciplinary Minor – 04	Business Intelligence	Civil Procedure Code (CPC)	Introduction to Political Sciences	Basics of Design & Graphics
Multi-disciplinary Minor – 05	Marketing Research	Land Laws including ceiling and other local laws	Corporate sociology	Mass Communication: Concepts and Processes
Multi-disciplinary Minor - 06	Corporate Governance and Business Ethics	Cyber Law	Modern India-Political, Economic & Social Ethos	IT and Online Journalism

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In addition to above courses following Groups are offered as Multidisciplinary Minor by Electrical Engineering Department

Multidisciplinary Minor-I (Electrical Mobility)

Sr. No.	Course Code	Course Name	Pre-requisite	Credits L-T-P	Offered Semester	Suggested by dept
1	EEMDM2001	Electric Machines for EV Applications	No	3-0-0	III	Electrical Dept
2	EEMDM2010	Power Electronics & Electric Drives	No	3-0-0	IV	Electrical Dept
3	EEMDM2011	Lab-Electric Machines & Power Electronics drives	No	0-0-1	IV	Electrical Dept
4	EEMDM3001	Control & Instrumentation	No	3-0-0	V	Electrical Dept
5	EEMDM3010	Energy storage systems	No	3-0-0	VI	Electrical Dept
6	EEMDM3011	Lab-Control & Instrumentation, Energy Storage	No	0-0-1	VI	Electrical Dept

Multidisciplinary Minor-II (Renewable Energy Systems)

Sr. No.	Course Code	Course Name	Pre-requisite	Credits L-T-P	Offered Semester	Suggested by dept
1	EEMDM2002	Renewable Energy Technology	No	3-0-0	III	Electrical Dept
2	EEMDM2012	Grid Integration of Wind & Solar Systems	No	3-0-0	IV	Electrical Dept
3	EEMDM2013	Lab RET	No	0-0-1	IV	Electrical Dept
4	EEMDM3002	Energy Economics & Marketing	No	3-0-0	V	Electrical Dept
5	EEMDM3010	Energy Storage Systems	No	3-0-0	VI	Electrical Dept
6	EEMDM3012	Lab Energy Systems	No	0-0-1	VI	Electrical Dept

In addition to above courses following courses are offered as Open Elective Courses (OEC) by Electrical Engineering Department

List of Open Elective courses offered

Sr. No.	Course Code	Course Name	Pre-requisite	Credits L-T-P	Offered Semester	Suggested by dept
1	EEOEC2001	Music Engineering	No	3-0-0	III	Electrical Dept
2	EEOEC2010	Basic Engineering Economics	No	2-0-0	IV	Electrical Dept
3	EEOEC3001	Building Services and Maintenance	No	3-0-0	V	Electrical Dept

HONORS

Student has to choose One Honor program out of the Two Honor groups provided below

A) Electrical Engg with Honors- (Advanced Power Systems)

Sr. No.	Course Code	Course Name	Credits L-T-P	Offered Semester	Suggested by dept
1	#EEHNC4050	Power Quality & Mitigation	3-1-0	VII	Electrical Dept
2	EEHNC4051	Project	0-0-6	VII	Electrical Dept
3	#EEHNC4052	CAPSA	3-1-0	VIII	Electrical Dept
4	EEHNC4053	EHVAC & DC/or FACTs Controller	0-0-6	VIII	Electrical Dept

B) Electrical Engg with Honors- (Advanced Power Electronics and Drives)

Sr. No.	Course Code	Course Name	Credits L-T-P	Offered Semester	Suggested by dept
1	#EEHNC4060	Advanced Power Electronics	3-1-0	VII	Electrical Dept
2	EEHNC4061	Project	3-1-0	VII	Electrical Dept
3	EEHNC4062	Electrical Machine Analysis and Modeling	3-1-0	VIII	Electrical Dept
4	EEHNC4063	Control of Electric Drives	0-0-6	VIII	Electrical Dept

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Teaching and Evaluation Scheme from year 2023-24

First Year B. Tech. Program in Electrical Engineering

Semester I

Semester I Courses				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	BSC	MABSC1002	Mathematics I [For EE and E&TC]	3	1	-	4	15	15	10	60	100
2	BSC	PHBSC1001	Optics, Acoustics and Engineering Materials	3	-	-	3	15	15	10	60	100
3	ESC	MEESC1008	Basics of Mechanical Engineering and Graphics	3	-	-	3	15	15	10	60	100
4	ESC	CSESC1005	Programming for Problem Solving	2	-	-	2	10	10	-	30	50
5	BSC	PHBSC1003	LAB PHYSICS	-	-	2	1	-	-	25	-	25
6	ESC	MEESC1009	Basics of Mechanical Engineering and Graphics	-	-	2	1	-	-	25	-	25
7	ESC	CSESC1006	Lab Programming for Problem Solving	-	-	2	1	-	-	25	-	25
8	AEC-01	INAEC1001	Communication Skills	2	-		2	10	10	-	30	50
9	VSEC-01	ETVSE1002	Engineering Exploration	-	-	4	2	-	-	25	25	50
10	CC-01	INCCC1101	Yoga and Meditation	-	-	4	2	-	-	50	-	50
Total				**13**	**1**	**14**	**21**	**65**	**65**	**180**	**265**	**575**

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Semester II

Semester II Courses				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr. No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	BSC	MABSC1004	Mathematics II [For EE and E&TC]	3	1	-	4	15	15	10	60	100
2	BSC	CHBSC1002	Battery Science, Lubricants and Green Chemistry	3		-	3	15	15	10	60	100
3	ESC	EEESC1001	Fundamentals of Electrical Engineering	3		-	3	15	15	10	60	100
4	ESC	EEESC1002	Basics of Electronic Circuits	3		-	3	15	15	10	60	100
5	BSC	CHBSC1003	Lab Chemistry	-	-	2	1	-	-	25	-	25
6	PCC	EEPCC1001	Electrical Engineering Practice	1	-	-	1	-	15	10	-	25
7	PCC	EEPCC1002	Lab-Electrical Engineering Practice			2	1			25		25
8	ESC	EEESC1003	Lab Basics of Electronics Circuits	-	-	2	1	-	-	25	-	25
9	VSEC-02	EEVSE1005	Electrical Workshop			4	2	-	-	50		50
10	IKS-01	EEIKS1101	Vedic Mathematics	2			2	10	10	-	30	50
11	CC-02	INCCC 1002 INCCC 1003 INCCC 1004	NSS /Sports/ Club Activities	2			2	-	-	50	-	50
	Total			**17**	**1**	**10**	**23**	**70**	**85**	**225**	**270**	**650**

Exit Course

Exit option : Award of UG Certificate in Major with 44 credits and an additional 8 credits from following Exit Courses				
Sr. No	**Course Code**	**Course Title**	**Mode**	**Credits**
1	EEEXC1001	Electrification of building	Online/ Offline certification **courses** Work based vocational courses or internship or apprenticeship during summer vacation	4
		AND		
2	EEEXC1002	Electrical Panel Design and Implementation		4

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Second Year B. Tech. Program in Electrical Engineering
Semester III

Semester III Courses				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	PCC	EEPCC2000	Mathematics for Electrical Engineering	3	-	-	3	15	15	10	60	100
2	PCC	EEPCC 2001	Network Analysis	3		-	3	15	15	10	60	100
3	PCC	EEPCC2002	Electrical Machines- I	3		-	3	15	15	10	60	100
4	PCC	EEPCC 2004	Lab Network Analysis	-	-	2	1			25	25	50
5	PCC	EEPCC 2005	Lab Electrical Machines- I			2	1			25	25	50
6	PCC	EEPCC2003	Electrical Measurement & Instrumentation	2	-	-	2	10	10	-	30	50
7	PCC	EEPCC2006	Lab Electrical Measurement & Instrumentation	-	-	2	1		-	25	25	50
8	MD M-1			4			4	15	15	10	60	100
9	OE- I			3	-	-	3	15	15	10	60	100
10	EEM	EEEEM2001	Consumer Psychology	2			2	10	10	-	30	50
11	VEC-I	CEVEC0010	Environmental Studies	2			2	10	10	-	30	50
12	CEP	EECEP2001	Community Engg Project			4	2			50		50
Total				**22**	**-**	**10**	**27**	**105**	**105**	**175**	**465**	**850**

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Semester IV

Semester IV Courses				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr. No.	Category	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total
1	PCC	EEPCC2011	Electromagnetic Field	3	-	-	3	15	15	10	60	100
2	PCC	EEPCC2012	Electrical Machines- II	3	-	-	3	15	15	10	60	100
3	PCC	EEPCC2013	Power System-I	3	-	-	3	15	15	10	60	100
4	PCC	EEPCC2014	Digital Circuits	2	-	-	2	10	10	-	30	50
5	PCC	EEPCC2015	Lab Electrical Machines- II	-	-	2	1	-	-	25	25	50
6	AEC	EEAEC2010	Technical Communication	2			2	10	10	-	30	50
7	MD -2			3			3	15	15	10	60	100
8	OE- II	EEOEC2012		2	-	-	2	10	10		30	50
9	VSEC-I	EEVSE2010	Lab Digital Circuit	-	-	2	1	-	-	25	25	50
10	VSE	EEVSE2011	Lab Numerical Computational Techniques	-		2	1	-	-	25	25	50
11	VEC	INVEC1001	Universal Human Values	2			2	10	10		30	50
12	EEM	EEEEM2010	Electricity Market and Management	2			2	10	10		30	50
			Total	**22**	**-**	**06**	**25**	**110**	**110**	**115**	**435**	**800**

***Bridge course of Two credits is mandatory for Direct second year admitted students in IV th semester Exit Course**

Exit option : Award of UG Diploma in Major with 88 credits and an additional 8 credits from following Exit Courses				
Sr. No	Course Code	Course Title	Mode	Credits
1	EEEXC2001	Repairing and maintenance of Electrical Appliances	Online/ Offline certification courses Skill based courses, internship, mini projects etc. offered during summer vacation	4
		And		
2	EEEXC2002	Industrial Electrical systems installation and maintenance		4

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Third Year B. Tech. Program in Electrical Engineering
Semester V

Semester V Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	PCC	EEPCC3001	Control Systems	3	-	-	3	15	15	10	60	100
2	PCC	EEPCC3002	Power System -II	3		-	3	15	15	10	60	100
3	PEC-I			3	-	-	3	15	15	10	60	100
4	# PEC-II			3	-	-	3	15	15	10	60	100
5	**MD-M-3**			3	-	-	3	15	15	10	60	100
6	OE-III			3	-	-	3	15	15	10	60	100
7	PCC	EEPCC3003	Lab Control Systems	-	-	2	1	-	-	25	25	50
8	PCC	EPCC3004	Lab Power System-II	-	-	2	1	-	-	25	25	50
9	Lab PEC I			-	-	2	1	-	-	25	25	50
	Lab MDM 3			-	-	2	1	-	-	25	25	50
			Total	**18**	**-**	**08**	**22**	**90**	**90**	**160**	**460**	**800**

PEC II courses student can opt from NPTEL/ MOOCs/ SWAYAM

Professional Electives

PEC I	**Course Title**	**PEC II**	**Course Title**
EEPEC3001	Renewable Energy Technology	EEPEC3007	Electrical Machine Design
EEPEC 3002	Lab Renewable Energy Technology	EEPEC 3008	Smart Grid Technology
EEPEC 3003	High Voltage Engineering	EEPEC 3009	Energy storage Systems
EEPEC 3004	Lab High Voltage Engineering		
EEPEC 3005	Industrial Electrical Systems		
EEPEC 3006	Lab Industrial Electrical Systems		

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Semester VI

Semester VI Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	Category	Course Code	Course Name	TH	T	PR	Credits	ISE I	ISE II	ISE III	ESE	Total
1	PCC	EEPCC3010	Microcontrollers	3	-	-	3	15	15	10	60	100
2	PCC	EEPCC3011	Power System Protection	3	-	-	3	15	15	10	60	100
	PCC	EEPCC3012	Power Electronics	3	-	-	3	15	15	10	60	100
3	PCC	EEPCC3013	Lab-Power System Protection	-	-	2	1	-	-	25	25	50
4	PEC-III			3	-	-	3	15	15	10	60	100
5	Lab-PEC III					2	1	-	-	25	25	50
6	PEC-IV			3	-	-	3	15	15	10	60	100
7	MD M-4			3			3	15	15	10	60	100
8	VSEC	EEVSE3011	Lab Microcontrollers	-	-	2	1	-	-	25	25	50
9	VSEC	EEVSE3012	Lab Power Electronics	-	-	2	1	-	-	25	25	50
			Total	**21**	**-**	**06**	**22**	**90**	**90**	**160**	**400**	**800**

Professional Electives

PEC III	Course Title	PEC IV	Course Title
EEPEC3015	Advanced Control Systems	EEPEC3021	Energized Irrigation Systems
EEPEC 3016	Lab Advanced Control Systems	EEPEC 3022	Optimization Techniques
EEPEC 3017	Internet of Things	EEPEC 3023	Utilization of Electrical Energy
EEPEC 3018	Lab IoT	EEPEC 3024	Electrical and Hybrid Vehicles
EEPEC 3019	Machine Learning for Electrical Engineering		
EEPEC 3020	Lab Machine Learning for Electrical Engineering		

Exit courses

Exit option : Award of B. Vocational in Major with 132 credits and an additional 8 credits from following Exit Courses				
Sr. No	**Course Code**	**Course Title**	**Mode**	**Credits**
1	EEEXC3001	Installation of Transformer	Online/ Offline certification courses Skill based courses, internship, mini projects etc. offered during summer vacation	4
AND				
2	EEEXC3002	Industrial Electrical Systems		4

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Semester VII

Teaching and Evaluation Scheme from year 2026-27(With Single Minor)

(One semester long Internship **)

B Tech (Electrical with Single minor) Total Credits- 170

Semester VII Course				Teaching scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	RM		Research Methodology	2			2	10	10	-	30	50
2	**INT		Internship			24	12			200	200	400
			Total	**02**	**-**	**24**	**14**	**10**	**10**	**200**	**230**	**450**

Semester VII

Teaching and Evaluation Scheme from year 2026-27(With Honors/ Research and single Minor)

(One semester long Internship **)

B Tech (Electrical with Single minor) Total Credits- 170 +18=188

Semester VII Course				Teaching scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	RM		Research Methodology	2			2	10	10	-	30	50
2	**INT		Internship	-		24	12	-	-	200	200	400
3	#HNC-1			3	1	-	3	15	15	10	60	100
4	# HNC Project/ Research		Project		-	12	6	-	-	50	50	100
			Total	**05**	**1**	**36**	**23**	**25**	**25**	**260**	**340**	**650**

!For B Tech with single minor and Honors/ Honor Research, one theory course of 4 credits and Project of 6 credits added in this semester. . #HNC courses student can opt from NPTEL/ MOOCs/ SWAYAM

HNC-1EEHNC4050	Power Quality & Mitigation	HNC-2EEHNC4060	Advanced Power Electronics
HNC-1EEHNC4051	Project	HNC-2EEHNC4061	Project

Semester VII

Teaching and Evaluation Scheme from year 2026-27(2026-27(With Double Minor)

(One semester long Internship **)

B Tech (Electrical with Double Minor) Total Credits- 170 +14=184

Semester VII Course				Teaching scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	RM**		Research Methodology	2			2	10	10	-	30	50
2	INT		Internship	-		24	12	-	-	200	200	400
3	#MDM-2			3			3	15	15	10	60	100
4	#MDM-2			3			3	15	15	10	60	100
			Total	**08**	**1**	**24**	**20**	**40**	**40**	**220**	**350**	**650**

- For B Tech with Double minor , two theory courses each of 3 credits will be added in this semester.

To be completed online mode or allied courses from MOOCs/ NPTEL by the students who wish to go for one semester long internship in Industry/Research Organization. However, normal track students will complete these courses in offline mode in college

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Semester VIII

B Tech (Electrical with Single minor) Total Credits- 170)

Semester VIII Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	PCC	EEPCC4001	Electric Drives	3	-	-	3	15	15	10	60	100
2	** PEC-V			3	-	-	3	15	15	10	60	100
3	** PEC-VI			3			3	15	15	10	60	100
4	PCC	EPCC4002	Lab Electric Drives	-	-	2	1	-	-	25	25	50
6	Project		Project		-	12	6	-	-	75	75	150
			Total	**09**		**14**	**16**	**45**	**45**	**130**	**280**	**500**

**May be completed online mode or allied courses from MOOCs by the students who wish to go for one semester long internship in Industry/Research Organization. However, normal track students will complete these courses in offline mode in college.

PEC V	**Course Title**	**PEC VI**	**Course Title**
EEPEC4015	Power Systems Dynamics & Control	EEPEC3021	**Digital Signal Processing**
EEPEC 30162	**Restructured Power Systems**	EEPEC 3022	Energy Conservation & Management
EEPEC 3017	Power Systems Planning Operation & Control	EEPEC 3023	Reliability & Condition Monitoring
EEPEC 3018		**EEPEC3024**	Applications of Embedded Systems
Honor I-1 EEHNC 4052	**CAPSA**	**Honor II- EEHNC 4062**	**EMMA**
Honor I-1-EEHNC4053	**EHVAC or DC, FACTS Controller**	**Honor I-1-EEHNC4063**	**Control of Electrical Drives**

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Semester VIII

B Tech (Electrical with Single minor and with Honors/ Honors by research) Total Credits- 170 +18= 188)

Semester VIII Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	PCC	EEPCC4001	Electric Drives	3	-	-	3	15	15	10	60	100
2	** PEC-V			3	-	-	3	15	15	10	60	100
3	** PEC-VI			3			3	15	15	10	60	100
4	PCC	EPCC4002	Lab Electric Drives	-	-	2	1	-	-	25	25	50
5	Project		Project		-	12	6	-	-	75	75	150
6	#HNC-1/	EEHNC		3	1	-	4	15	15	10	60	100
7	#HNC-2/	EEHNC		3	1	-	4	15	15	10	60	100
			Total	**9+6**	**2**	**14**	**16+8**	**45+30**	**45+30**	**130+20**	**280+120**	**500+200**

**May be completed online mode or allied courses from MOOCs by the students who wish to go for one semester long internship in Industry/Research Organization. However, normal track students will complete these courses in offline mode in college.

Semester VIII

B Tech (Electrical with Double Minor) Total Credits- 170 +14= 184)

Semester VIII Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	PCC	EEPCC4001	Electric Drives	3	-	-	3	15	15	10	60	100
2	** PEC-V			3	-	-	3	15	15	10	60	100
3	** PEC-VI			3			3	15	15	10	60	100
4	PCC	EPCC4002	Lab Electric Drives	-	-	2	1	-	-	25	25	50
5	Project		Project		-	12	6	-	-	75	75	150
6	MDM-3			3	-	-	3	15	15	10	60	100
7	MDM-4			3	-	-	3	15	15	10	60	100
8	Lab-MDM-3			-	-	2	1	-	-	25	25	50
9	Lab MDM-4			-	-	2	1	-	-	25	25	50
			Total	**9+6**	**0**	**14+4**	**16+8**	**45+30**	**45+30**	**130+70**	**280+170**	**500+300**

**May be completed online mode or allied courses from MOOCs by the students who wish to go for one semester long internship in Industry/Research Organization. However, normal track students will complete these courses in offline mode in college.

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Course Category Wise credit distribution

Sr. No.	Course Category	Credits
1	Basic Science Courses (BSC)	16
2	Engineering Science Courses (ESC)	14
3	Program Core Course (PCC)	50
4	Program Elective Course (PEC)	20
5	Open Elective other than particular program (OE)	08
6	Minors (MDM)	14
6	Vocational and Skill Enhancement Course (VSEC)	8
7	Humanities Social Science and Management (HSSM) AEC EEM IKS VEC	 4 4 2 4
8	Experiential Learning (EL) RM CEP/FP Project Internship	- 2 2 6 12
9	Co-curricular And Extracurricular Activities(CCA)	4
10	**Total Credits**	**170**

List of Professional Electives Proposed

Courses	**1-Electric Mobility**	**2- Electrical Machines**	**3-Power Systems**	
PE I EEPEC	RET & Lab RET	HVE & Lab HVE	Industrial Electrical Systems & Its Lab	
PE II	Smart Grid	Electrical Machine Design	Energy Storage Systems	
PE III	Advanced Control & Lab ACS	Machine Learning & Lab ML	**IoT & Lab IoT**	
PE IV EEPEC	Optimization Techniques	Utilization of Electrical Energy	Energized Irrigation System	Electrical Vehicles
PE V MOOCs EEPEC 4001-4005	Power Systems Dynamics & Control	Restructured Power Systems	Power System Planning Operation & Control	
PE VI	Applications of Embedded Systems	Reliability & Condition Monitoring	Digital Signal Processing	Energy Conservation & Management

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Third Year B. Tech. Program in Electrical Engineering (NEP 2025-26)
Semester V

Semester V Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	PCC	EEPCC3001	Control Systems	3	-	-	3	15	15	10	60	100
2	PCC	EEPCC3002	Power System -II	3		-	3	15	15	10	60	100
3	PEC-I			3	-	-	3	15	15	10	60	100
4	# PEC-II			3	-	-	3	15	15	10	60	100
5	**MD-M-3**			3	-	-	3	15	15	10	60	100
6	OE-III			3	-	-	3	15	15	10	60	100
7	PCC	EEPCC3003	Lab Control Systems	-	-	2	1	-	-	25	25	50
8	PCC	EEPCC3004	Lab Power System-II	-	-	2	1	-	-	25	25	50
9	Lab PEC I			-	-	2	1	-	-	25	25	50
10	Lab-MDM3			-	-	2	1	-	-	25	25	50
	Total			**18**	**-**	**06**	**23**	**90**	**90**	**160**	**460**	**800**

PEC II can be taken by NPTEL

- For B Tech with single minor and Honors, one theory course of 4 credits will be added in this semester.

PEC I	**Course Title**	**PEC II**	**Course Title**
EEPEC3001	Renewable Energy Technology	EEPEC3007	Electrical Machine Design
EEPEC 3002	Lab Renewable Energy Technology	EEPEC 3008	Smart Grid Technology
EEPEC 3003	High Voltage Engineering	EEPEC 3009	Energy storage Systems
EEPEC 3004	Lab High Voltage Engineering		
EEPEC 3005	Industrial Electrical Systems		
EEPEC 3006	Lab Industrial Electrical Systems		

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EEPCC3001: Control Systems			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs./Week	ISE I	: 15 Marks
Tutorial	: Nil	ISE II	: 15 Marks
Total Credits	: 3	ISE III	: 10 Marks
		End Semester Exam	: 60 Marks

Course Description: This introduces the basic concepts of transfer function, signal flow graphs, block diagram reduction technique , control system components and performance of Control systems in Time domain, Frequency domain and stability analysis.

Course Objectives:

The objectives of the course is give to exposure to the students to

1. Transfer function of linear time invariant systems
2. Components used in Control Systems
3. Performance of system in Time domain
4. Stability of linear-time invariant systems
5. Performance of system in Frequency domain

Course Outcomes: After completing the course, students will able to:

CO1	calculate Transfer Function of linear-time-invariant systems
CO2	describe various control system components
CO3	analyze Linear Time Invariant system in time domain
CO4	calculate stability of Linear Time Invariant systems in time domain
CO5	analyze Linear Time Invariant systems in frequency domain

Detailed Syllabus:

Unit- I	**Transfer Functions and Block Diagrams:** Introduction to control problems. Industrial Control examples, Basic components and classifications of general control systems, physical, non physical, Linear/Nonlinear, Continuous/ On-off, Analog/ Digital, Mathematical models of physical systems, Electrical analogy of non-electrical systems, Force-current and force voltages analogies. Definition of transfer function, Block diagram representation of physical systems, Block diagram reduction techniques, Signal flow graphs and Mason's gain formula, Transfer function of electrical, Mechanical and electromechanical systems, Transfer function models of linear time-invariant systems. Feedback characteristics
Unit-II	**Control System Components:** Error detectors: Potentiometers, Synchros, Optical Encoders, DC and AC servomotors, AC and DC Tacho-generators
Unit-III	**Time-Domain Analysis:** Performance indices Standard test signals, Standard test signals, Type and order of a system, Transient response of second order systems, Time response of first and second order systems for standard test inputs, Performance specifications for first and second-order systems. Steady state error, static error constants, Dynamic-error-coefficients

Unit-IV	**Stability** Nature of system response from the location of roots in the s-plane of characteristic equation, Absolute and relative stability, Routh's-Hurwitz criterion and its applications in special cases. **Stability in Time domain:** Definition of root-locus, Rules for plotting root-loci, Root contours, Stability analysis using root locus, effect of addition of poles and zeros, Root locus for systems with transportation lag, Computer aided root locus. **Industrial Controllers:** PD, PI, PID controllers, tuning methods, pneumatic and hydraulic controllers, ISE, IATE
Unit-V	**Frequency-Domain Analysis** Frequency-domain specifications, Correlation between time-and frequency-domain responses, Polar plot, Bode plot, Determination of gain- and phase- margin from Bode plot, Effect of gain variation and addition of poles and zeros on Bode plot, Determination of transfer function from the given Bode plot, Bode plot for all-pass, minimum-phase, non-minimum phase systems. Computer aided Bode plot, Nyquist stability criterion, Determination of absolute and relative stability by the application of Nyquist Criterion, Effect of addition of poles & zeros on the shape of the Nyquist plot, Stability of linear control systems with time delay.

Self Study: Concepts of state variables, different forms of state space model, Transfer function from State Space model

Text Books:

1. I. J. Nagrath & M. Gopal, "Control System Engineering" New Age International.
2. Xavier," Control system Engineering", S. Chand Publication.
3. Norman Nice," Control System Engineering", John Wiley and Sons

Reference Books:

1. Katsuhiko Ogata, " Modern Control Engineering", Prentice Hall.
2. Benjamin Kuo, "Automatic Control System", Prentice Hall.
3. John J. D'Azzo, C.H. Houpis, "Linear Control System Analysis and Design", McGraw Hill

E resources (if any): https://nptel.ac.in/courses/107106081

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO 2	P O3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	P O1 1	PO 12	PS O 1	PS O 2	PSO 3
CO1	3	2	1	1		1	1	1	1	1	1	1		1	3
CO2	3	2	-			1		1	1	1	2	1		1	3
CO3	3	2	1	1		1	1	1	1	1	1	1		1	3
CO4	3	2	1	1		1		1		1	1	1		1	3
CO5	3	2	1	1		1	1	1	1	1	1	1		1	3

1 – Low 2 – Medium 3 – High

ISE I, II compulsory Tests

ISE III Assessment: It is of 10 marks is based on anyone / or combination of few of following,

1. Mini Project/ Model Assessment
2. Finding solutions of various problems on control systems using MATLAB
3. PPT Presentation on various applications of control systems in Industries etc
4. MCQ

Sample Assessment Table:

Sample Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III Assessment	End Semester Examination
K1	Remember	5	5	4	5
K2	Understand	5	5	2	10
K3	Apply	5	5	4	25
K4	Analyze				15
K5	Evaluate				5
Total Marks 100		15	15	10	60

Sample Assessment Pattern:

Assessment Tool	K1,K2, K3	K1,K2,K3	K1,K2, K3	K1,K2,K3	K1,K2,K3
	CO1	CO2	CO3	CO4	CO5
ISE I (15 Marks)	07	08	00	00	00
ISE II (15 Marks)	00	00	7	8	00
ISE III Assessment (10 Marks)	02	02	02	02	02
ESE Assessment (60 Marks)	12	12	12	12	12

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EEPCC3002: Power System-II	
Teaching Scheme	**Examination Scheme**
Lectures: : 03 Hrs./Week	ISE I : 15 Marks
Tutorial : 00	ISE II : 15 Marks
Total Credits : 03	ISE III : 10 Marks
	End Semester Exam : 60 Marks

Course Description: Electrical Power System is growing at a faster pace. An Electrical Engineer should be able to solve the power system network under normal & abnormal conditions. This course is aimed to cover from the fundamentals of Power System such as line constants, performance of transmission lines to the analysis part such as symmetrical & unsymmetrical fault analysis & different power flow methods.

Course Objectives:

The objectives of the course is to give exposure to students of

1. Power system components, modeling of transformer, synchronous machine and loads.
2. Symmetrical components of the transmission line
3. Symmetrical and unsymmetrical fault analysis.
4. Load flow studies.
5. Stability and transients in the power system..

Course Outcomes:

After completing the course, students will able to:

CO1	Calculate per unit values of components of the power system network.
CO2	Explain symmetrical components of unsymmetrical phasors.
CO3	Calculate current for symmetrical and unsymmetrical faults
CO4	Analyze power system networks using load flow studies.
CO5	Explain stability and transients in the power system.

Detailed Syllabus:

Unit- I	**Representation of power system components & Per unit calculation:** Representation of power system components in Single line diagram, Impedance diagram, Per Unit method and its advantages. **Modeling of Transformer, Synchronous Machine & Loads:** Steady state representation of power transformer: Three-phase connections and star delta phase-shifts. Single phase equivalent of three-phase transformers. Three-winding transformers, autotransformers, **Synchronous Machine:** equivalent circuit, operation when connected to infinite bus, power angle characteristics. **Load models :** constant power, constant current & constant impedance loads
Unit- II	**Symmetrical Components:** Unbalanced system Analysis using symmetrical components, Power in terms of symmetrical components, Sequence circuits of transmission lines, transformer and Synchronous Machines, Phase shift in star delta transformer, Formation of Sequence Networks
Unit- III	**Fault Analysis:** **Symmetrical Fault Analysis:** 3 phase fault on a transmission line, Short circuit MVA Capacity of a bus, 3 phase Short circuit of a synchronous machine - steady state, transient and sub-transient equivalent circuits. **Unsymmetrical Fault Analysis:** Fault analysis using symmetrical components, Single line to ground (SLG) fault, Line to line (LL) fault, Double line to ground (LLG) fault, Open conductor fault.

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Unit- IV	**Formation of Y-bus & Load Flow Studies:** Nodal admittance matrix, Network incidence matrix, Calculation of Bus Admittance Ybus and Impedance Matrices Zbus, Power Flow Problem, Gauss Seidel (GS) method, Newton Raphson (NR) method. Concepts of Decoupled & Fast Decoupled method, Backward/forward sweep method. Comparison of different load flow methods.
Unit- V	**Power system Stability:** Classification of stability, Dynamics of synchronous machine, power angle equation, swing equation, steady state stability- small disturbances, transient stability- Equal Area Criteria. **Power System Transients**: Switching transients, Travelling Wave Phenomena: Travelling wave equations (Telegraphic equations), reflection wave, refraction wave, typical cases of line termination, Bewley Lattice Diagram.

Text and Reference Books:

1. C. L. Wadhawa , "Electrical Power System", John Wiley & Sons
2. Hadi Saadat, " Power System Analysis", Tata McGraw-Hill
3. I. J. Nagrath & D. P. Kothari, "Modern Power System Analysis", Tata McGraw-Hill
4. W.D. Stevenson and J.J. Grainger, "Power System Analysis", McGraw-Hill
5. W.D. Stevenson, "Elements of Power System Analysis", McGraw-Hill
6. W.D. Stagg & A.H. El-Abiad, "Computer Methods in Power System Analysis", McGraw-Hill
7. Elgerd O. I., "Electrical Energy System Theory", McGraw-Hil

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	1	1				1	1		1	3		
CO2	3	2	1	1	1	1			1	1		1	3		
CO3	3	2	1	1	1				1	1		1	3		
CO4	3	2	1	1	1	1			1	1		1	3		
CO5	3	2	1	1	1	1			1	1		1	3		

1 – Low 2 – Medium 3 – High

ISE I, II Compulsory are tests

ISE III Assessment: Teachers Assessment of 10 marks is based on attendance of the student and any one / or combination of few of following. However, the course coordinator has to announce assessment components at the beginning of the course. Presentation on latest topics/Real life problems related with the subject-1. Problems based on GATE questions, 2.Simulations problems, 3.Quiz,4. Surprise test

Sample Assessment Pattern:

Sample Assessment Pattern Level No.	**Knowledge Level**	**ISE I**	**ISE II**	**ISE III Assessment**	**End Semester Examination**
K1	Remember	05	05	00	10
K2	Understand	05	05	05	20
K3	Apply	05	05	05	30
K4	Analyze	00	00	00	00
Total Marks 100		15	15	10	60

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Sample Assessment Table:

Assessment Tool	K1,K2, K3	K1,K2,K 3	K1,K2,K 3	K1,K2,K3	K1,K2,K3
	CO1	CO2	CO3	CO4	CO5
ISE I (15 Marks)	07	08	00	00	00
ISE II (15 Marks)	00	00	15	00	00
ISE III Assessment (10 Marks)	02	02	02	02	02
ESE Assessment (60 Marks)	12	12	12	12	12

Teaching Strategies:

The teaching strategy is planned through the lectures, tutorials and team based home Assignments.

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EEPCC3003: Lab Control Systems	
Teaching Scheme	**Examination Scheme**
Practical : 2 hrs/Week	ISE I : 25 marks
Tutorial : Nil	ESE : 25 marks
Total Credits : 01	

Laboratory Course Outcomes:

As an outcome of completing the Laboratory course, students will able to:

CO1	classify various control systems
CO2	explain various control system components
CO3	determine performance of linear second order system in Time domain
CO4	calculate performance of linear second order system in Frequency domain
CO5	describe operation of industrial controllers

List of Experiments:

Term-work shall consist of minimum 10 experiments from the following: Following is the list is guideline, other experiments can be performed based upon contents of syllabus

Sr. No.	Details
1	Study of potentiometers as an error detector for dc and ac signals.
2	Study of Synchros as an error detector.
3	Mathematical Modeling and Analysis of RLC Network, steady state and transient
4	To study the speed torque characteristics of a AC servo motor and derive its transfer function
5	To study the performance characteristics of a DC speed motor control system and find its transfer function.
6	To study time domain analysis of second order mechanical system
7	Computer aided simulation of second order linear control system.
8	To study time domain analysis of a second order system electrical circuit.
9	To study responses(Step and Impulse) of system for Type zero, Type one and Type two systems
10	Computer aided study of responses of PI,PD and PID controller
11	To study a continuous- time and/or digital position control system.
12	Computer aided plotting of root-locus and verify analytically.
13	Computer aided plotting of Bode- plots and verify analytically
14	Computer aided plotting of Nyquist plots and verify analytically

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O 2	PSO 3
CO1	3	1	1			1		1		1		1		1	3
CO2	3	2	2	1		1	1	1	1	1		1		1	3
CO3	3	2	2	1		1	1	1	1	1		1		1	3
CO4	3	2	2	1		1		1	1	1		1		1	3
CO5	3	1	1	1		1	1	1	1	1		1		1	3

1 -Low 2 – Medium 3 - High

Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination 25 Marks	05	05	05	05	05

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EEPCC3004: Lab Power System-II	
Teaching Scheme Practical : 2Hrs/Week Total Credits : 01	**Examination Scheme** ISE I : 25 Marks ESE :25 Marks

Course Objectives:

The objectives of the course are to-

1. Learn the power system software's such as MATLAB /MIPOWER/PSCAD
2. Acquire the skills of programming/modeling power system components.

Course Outcomes:

After completion of this course students will be able to

CO1.	simulate power system studies by MATLAB /MIPOWER/PSCAD
CO2.	develop the Y-bus matrix
CO3.	identify fault current under the symmetrical and unsymmetrical faults conditions
CO4.	perform load flow and interpret the results.

List of the Experiments:

The student shall perform minimum eight experiments of the following using MATLAB/ MIPOWER/PSCAD

Sr. No.	Name of the Experiments
1	Simulation of the effect of line parameters on performance of transmission lines.
2	Determination of ABCD constants of a given transmission line.
3	Formulation of Y-bus matrix using computer program.
4	Computer aided solution of power flow problem by Gauss Seidel.
5	Computer aided solution of power flow problem by Newton-Raphson method.
6	Computer aided solution of power flow problem fast decoupled method.
7	Simulation and analysis for a symmetrical three phase fault.
8	Simulation and analysis of unsymmetrical LL fault.
9	Simulation and analysis of unsymmetrical LG fault.
10	Simulation and analysis of an unsymmetrical LLG fault.
11	Determination of steady state power limit of a transmission line.
12	Visit to HV/EHV substation, power generating station.

Term Work:

The term work shall consist of submitting a file for minimum eight experiments performed with neatly written records of the study, programs & observations with results.

The term work will be assessed by the course coordinator.

Mapping of Course Outcome with Program Outcomes:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 315
CO1	3				3				2	2		1	2		
CO2	3				3				2	2		1	2		
CO3	3				3				2	2		1	2		
CO4	3				3				2	2		1	2		

1 – Low 2 – Medium 3 – High

Sample Assessment Table:

Assessment Tool	**S1,S2,S3**	**S1,S2,S3**	**S1,S2,S3**	**S1,S2,S3**
	C01	C02	CO3	CO4
Term Work (25 Marks)	10	05	05	05
ESE (25 Marks)	10	05	05	05

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Professional Electives I

PEC-I -EEPEC3001: Renewable Energy Technology	
Teaching Scheme	**Examination Scheme**
Lectures : 03 Hrs/Week	ISE I : 15 Marks
Tutorial : 0	ISE II : 15 Marks
Total Credits : 03	ISE III : 10 Marks
	End -Semester Exam : 60 Marks

Course Description:

In this curriculum, students will be explored in Renewable Energy Technologies such as Wind energy, Solar energy. They will be introduced to concepts of fuel cells and biomass energy.

Course Objectives:

The objectives of the course are to learn

1. Different types of energy sources
2. Various solar PV technologies and its characteristics
3. Various solar thermal technologies and its applications
4. Wind energy technologies and its operations
5. Grid integration of wind energy systems and its associated issues

Course Outcomes:

After completing the course, students will able to

CO1.	elaborate different types of energy sources
CO2	explain various solar PV technologies and its characteristics and solve numerical on it
CO3	describe various solar thermal technologies and its uses in various applications
CO4	discuss wind energy technologies and explain its operations
CO5	explain grid integration of wind energy systems and its associated issues

Detailed Syllabus:

Unit-I	**Basics of Energy:** Energy and Power, Hubert peak, Energy Scenario in India, Environmental impact of fossil fuels, Different types of energy sources - tidal, geothermal, wave energy, Introduction to fuel cells and Biomass
Unit-II	**Wind Power systems** History of wind power, Indian and Global statistics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions and related numerical based on it. Modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control
Unit-III	**The Solar Resource and Solar PV:** Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control. Design of stand-alone PV systems

Unit-IV	**Solar thermal power generation:** Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, Solar still elementary analysis.
Unit-V	**Network Integration Issues:** Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems

Text and Reference Books:

1. Thomas Ackermann, Editor, "Wind Power in Power Systems", John Willy and sons ltd., 2005,ISBN 0- 470-85508-8.

2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", John Willy and sons,2004,ISBN 0-471-28060-7.

3. S. P. Sukhatme, "Solar Energy", Tata McGrew Hill, second edition, 1996, ISBN 0-07-462453-9.

4. Chetan Singh Solanki, "Solar Photovoltaics", fundamental, technologies and applications, PHI-second edition, 2011.

5. Siegfried Heier, "Grid integration of wind energy conversion systems" John Willy and sons ltd.2006.

6. Mullic and G.N.Tiwari, "Renewable Energy Applications", Pearson Publications.

Mapping of Course Outcomes with Program Outcomes:

Corse outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3		1		2	1	2	1	1	1	1	1	1	1	
CO2	3	2	1	3	1	1	2	1	1	1	1	1	1	1	
CO3	3	2	1		1	1		1	1	1	1	1	1	1	
CO4	3	2	1	3	1	1	2	1	1	1	1	1	1	1	
CO5	3	2	1	3	1	1	2	1	1	1	1	1	1	1	

1- Low 2- Medium 3- High

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K2+K3	K4
Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I & ISE II 30 Marks	8	7	8	7	
ISE III 10 Marks	2	2	2	2	2
ESE Assessment 60 Marks	12	12	12	12	12

ISE III Assessment: It is based on one of the following.

1) Assignments ,2) Models/ Presentations

3) multiple choice questions test, 4).Quiz

Sample Assessment Pattern:

Level No.	Knowledge Level	Test		Teachers Assessment/ Assignment	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	5	5	2	20
K3	Apply	5	5	3	20
K4	Analyze			3	10
K5	Evaluate				
Total		15	15	10	60

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EEPEC3002 : Lab Renewable Energy Technology	
Teaching Scheme Practical : 2Hrs/Week Tutorial : NIL Total Credits : 01	**Examination Scheme** ISE III : 25 Marks Practical and Viva-Voce : 25 Marks

Laboratory Course Outcomes:

As an outcome of completing the Laboratory course, students will able to:

CO1	elaborate different types of energy sources
CO2	understand I-V and P-V Characteristics of Solar cell & Estimate the fill factor
CO3	analyze wind resources and energy production from wind turbines
CO4	plot electrical characteristics of fuel cell
CO5	explain Biogas plant

List of Experiments: Term-work shall consist of minimum ten experiments from the following:

Sr. No.	Details
1	Plot I-V and P-V characteristics of single Solar PV Module with radiation and temperature changing effects
2	Plot I-V and P-V characteristics with series and parallel combination of Solar PV modules
3	Study effect of shading on output power of Solar PV Module
4	Measure output power of solar PV system with effect of tilt angle
5	Plot charging and discharging characteristics of battery
6	Measure performance parameters of DC load system with and without battery (with variable rated capacity system) in Solar PV stand-alone system
7	Measure performance parameters of AC load system with and without battery in Solar stand-alone PV system.
8	Measure performance parameters of Combine AC and DC load system with and without battery in Solar stand-alone PV system
9	Identify and measure the parameters of a solar PV Module at Specific location
10	Measure the spectral response of a solar cell and Calculate quantum efficiency
11	Study of biogas plant
12	Study solar resource assessment station and record associated parameters
13	Simulate characteristics of fuel cell using electrical software
14	Simulate operation of wind turbine and measure associated parameters using electrical software
15	Study of Tri-brid system

Mapping of Course Outcome With Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PO 13	PO 14	PO 15
CO1	3	3			2	1		1		1		1	1	1	1
CO2	3	2		1	3	1	1	1	1	1		1	1	1	2
CO3	3	2		1	3	1	1	1	1	1		1	1	1	1
CO4	3	1		1	2	1		1	1	1		1	1	2	2
CO5	3			1	3	1	1	1	1	1		1		1	1

1- Low 2 – Medium 3 - High

Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination & Viva Voce	05	05	05	05	05

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EEPEC3003: High Voltage Engineering (Professional Elective I)	
Teaching Scheme Lectures : 03 Hrs/Week Tutorial : 00 Total Credits : 03	**Examination Scheme** ISE I : 15 Marks ISE II : 15 Marks ISE III Assessment : 10 Marks End -Semester Exam : 60 Marks

Course Description: This course introduces the concepts of High Voltage Engineering The course comprises the basic breakdown theories related to various insulating materials and covers the various aspects of over voltage generation and insulation coordination.

Course Objectives:
The objectives of the course are to

1. develop an understanding of breakdown phenomenon in case of solid, liquid and gaseous insulating medium
2. develop familiarity with various methods of generation of high voltages
3. develop familiarity with various methods of measurement of high voltages
4. develop an understanding of over voltage phenomenon & concepts of insulation coordination
5. develop an understanding of importance of testing of power apparatus

Course Outcomes:
After completing the course, students will able to:

CO1	calculate breakdown strength of various insulating materials for power system applications
CO2	describe the breakdown phenomenon in case of various insulating materials
CO3	explain the concepts of generation of high voltages & currents
CO4	explain the causes and protection from over voltages and of insulation coordination
CO5	explain the direct and indirect testing methods

Detailed Syllabus:

Unit -I	**Conduction & Breakdown in Gases:** Ionization Process & Current Growth, Townsend's Criterion for Breakdown, Determination of Alpha & Gamma, Streamer Theory of Break Down in Gases, Paschen's Law, Breakdown in Non-Uniform Field & Corona Discharge. Conduction & Break Down in Pure Liquid & Commercial Liquid--cavitations mechanism, suspended particle mechanism etc. Breakdown in Solid Dielectrics-intrinsic, electromechanical, thermal breakdown etc
Unit-II	**Generation of High Voltage & Currents:** Generation of High D. C. Voltages: voltage doubler, voltage multiplier, electrostatic machines etc.; Generation of High Alternating Voltages: cascade circuits, resonating circuits etc. Generation of transient voltages: Single stage and multistage impulse generator circuits, tripping and synchronization of impulse generator; Generation of switching surge voltages; Generation of Impulse Currents
Unit-III	**Measurement of High Voltages & Currents:** Measurement of High Direct Current Voltages, High Alternating Voltages & Impulse Voltages- use of potential dividers, gaps and other methods of measurement; Measurement of High Direct Currents, High Alternating Currents & High Impulse Currents

Unit -IV	**Over Voltage Phenomenon & Insulation Coordination:** Natural Causes for Over Voltages, Lightning Phenomenon, Over Voltages Due to Switching Surges, System Faults & Other Abnormal Conditions, Principles of Insulation Coordination on High Voltage & Extra High Voltage Power Systems, concept of statistical factor of safety, risk of failure
Unit -V	**High Voltage Testing of Power Apparatus:** High voltage testing of bushings, transformers, cables etc. Non-destructive insulation test techniques: High voltage dielectric loss measurements, discharge measurements

Text and Reference Books:

1. M. S. Naidu , V. Kamaraju, "High Voltage Engineering" , Tata McGraw –Hill publications
2. E. Kuffel, W.S. Zaengl, J. Kuffel, "High Voltage Engineering fundamentals", Butterworth – Heinemann publishers
3. D. Kind, K. Feser, "High Voltage Test Techniques", Vieweg/ SBA publications
4. M. Khalifa, "High Voltage Engineering- Theory & Practices", Dekker publications

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1				1						1	3	1	2
CO2	3	1				1	1					1	3	3	2
CO3	3	1	1			1	1					1	3	3	2
CO4	3	1				1						1	3	1	2
CO5	3	1				1						1	3	1	3

1- Low 2- Medium 3- High

ISE I, II are compulsory tests

ISE III Assessment: It is of 10 marks is based on attendance of the student and one of the / or combination of few of following. Assignments,2 MCQ, 3 Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	**Knowledge Level**	**Test**	**Teachers Assessment/ Assignment**	**End Semester Examination**
K1	Remember	10		25
K2	Understand	10	3	25
K3	Apply	10	2	10
K4	Analyze		3	
K5	Evaluate		2	
Total Marks 100		30	10	60

Sample Assessment table

Assessment Tool	K1+K2+ K3	K1+K2	K1+K2	K1+K2	K1+K2
	C01	C02	C03	CO4	CO5
Class Test (30 Marks)	10	10	10		
Teachers Assessment (10 Marks)	02	02	02	02	02
ESE Assessment (60 Marks)	12	12	12	12	12

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EEPEC3004: Lab High Voltage Engineering	
Teaching Scheme Practical : 2Hrs/Week Tutorial : NIL Total Credits : 01	Examination Scheme ISE I : 25 Marks ESE : 25 Marks

The High Voltage Lab in Electrical Engineering Department is a facility that has been created with a view to not only provide real time experience to learners about working on High Voltage phenomena including dielectric puncture, HV measurement techniques, protection aspects but also serve as a powerful platform for academic, industry and society linkages through testing for mutual benefit

Laboratory Course Outcomes: As an outcome of completing the Laboratory course, students will able to:

CO1	understand various ways of generation of high voltages
CO2	compare the quality of solid insulating material
CO3	measure the breakdown strength of liquid insulating material
CO4	understand the importance of appropriate clearances around high voltage equipment
CO5	understand the importance of calibration, detail specifications and various standards

List of Experiments: Term-work shall consist of record of *minimum eight* experiments of the following:

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Sr. No.	Details
1	Measurement of dielectric strength of transformer oil
2	Measurement of High A.C. Voltage using sphere gap
3	Measurement of breakdown strength of solid insulating material
4	Impulse voltage test on insulator
5	Power frequency test on insulator
6	Tan δ measurement of insulator
7	Study of Impulse Generator
8	Calibration of E. S. V. using sphere gap
9	Layout of High Voltage Laboratory
10	Study of voltage doubler principle
11	Measurement of insulation resistance of cable
12	Study of high voltage simulator
13,14	Record of-detailed specifications of *any two* with study of rating, manufacturing process (of any one of them) in case of following electrical equipment list- on the basis of survey conducted by the group of students List of the equipment: 1. Various types of circuit breakers ,2. Various lights/luminaries ,3. Distribution transformers ,4. Instrument transformers 5. Solar water heater ,6. All types of industrial fans, 7. D-G sets ,8. All Pumps
15,16	Study of any one of the 'Indian Standard' related to following electrical apparatus on the basis of corresponding IS No., important provisions in that IS, amendments(how many, when, why, comparison with older version) Porcelain bushings for alternating voltages up to and including 1000V b) Bushings for alternating voltages above 1000 volts c) Control Transformer for switchgear and control gear for Voltages not exceeding 1000V AC d) Dry type Transformer e) Outdoor Three Phase Distribution Transformer upto including 100 kVA,11 kV f) Power Transformers g) Transformer oil h) Insulation Coordination of highest voltages for equipments i) High voltage alternating current circuit breakers j) Porcelain insulators overhead power lines with nominal voltage greater than 1000V k) Voltage transformer , Insulation Coordination Record of any one of the following Comparison of specifications for Voltage transformer IS 3156 and IEC 186 Comparison of specifications for Insulation Coordination IS 2165 and IEC-171

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO1	3	1	1				1	3	2	1	1	2	3		
CO2	3	3	2	3		1	3	3	2	1	3	2	3		
CO3	3	3	2	2		3	3	3	2	1	3	2	3		
CO4	3	3	1	1		3	1	3	2	1	3		3		
CO5	3	2	3	1		3	3	3	3	1	3	1	3		

1- Low 2 – Medium 3 - High

Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination & Viva Voce	05	05	05	05	05

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EEPEC 3005 Industrial Electrical Systems (Professional Elective I)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	ISE I	: 15 Marks
Tutorial	: 00	ISE II	: 15 Marks
Total Credits	: 03	ISE III Assessment	: 10 Marks
		End -Semester Exam	: 60 Marks

Course Outcomes:

After completing the course, students will demonstrate the ability to

CO1	describe various components of industrial electrical systems
CO2	illustrate the electrical wiring systems for residential, commercial and industrial consumers with standard symbols and drawings
CO3	apply illumination schemes in residential and commercial premises
CO4	explain the industrial electrical systems used in Power Systems
CO5	discuss industrial electrical systems used in automation systems

Detailed Syllabus

Unit-I	**Electrical System Components** LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices
Unit -II	**Residential and Commercial Electrical Systems** Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.
Unit -III	**Illumination Systems** Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting
Unit -IV	**Industrial Systems in Power Systems** HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.
Unit -V	**Industrial Systems in Automation** Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Text/Reference Books

1. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
3. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
4. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008
5. Web site for IS Standards

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	1		2	1			1	1		1	3	1	2
CO2	3	1	1		2	1	1		1	1		1	3	3	2
CO3	3	1	1		2	1	1		1	1		1	3	3	2
CO4	3	1	1		2	1			1	1		1	3	1	2
CO5	3	1	1		2	1			1	1		1	3	1	3

1- Low 2- Medium 3- High

ISE I, II are compulsory tests

ISE III Assessment: It is of 10 marks is based on attendance of the student and one of the / or combination of few of following. Assignments,2 MCQ, 3 Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	**Knowledge Level**	**Test**	**Teachers Assessment/ Assignment**	**End Semester Examination**
K1	Remember	10		25
K2	Understand	10	3	25
K3	Apply	10	2	10
K4	Analyze		3	
K5	Evaluate		2	
Total Marks 100		30	10	60

Sample Assessment table

Assessment Tool	K1+K2+ K3	K1+K2	K1+K2	K1+K2	K1+K2
	C01	C02	C03	CO4	CO5
Class Test (30 Marks)	10	10	10		
Teachers Assessment (10 Marks)	02	02	02	02	02
ESE Assessment (60 Marks)	12	12	12	12	12

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Program Elective I

EEPEC 3006: Lab Industrial Electrical Systems	
Teaching Scheme	**Examination Scheme**
Practical : 2 hrs/Week	ISE I : 25 marks
Tutorial : Nil	ESE : 25 marks
Total Credits : 01	

Laboratory Course Outcomes:
After completing the laboratory course students will able to:

CO1	aware of National Electric Code
CO2	explain electrical installation of residential & commercial buildings
CO3	acquire knowledge of testing and installation, maintenance of transformers , circuit breakers and induction machines
CO4	explain various protective devices in power system for protecting equipment and personnel

List of Experiments: Term-work shall consist of minimum eight experiments of which at least minimum 2 from each of the following:

1. Study of National Electrical Code (NEC), 2011
2. Design electrical installation scheme for given 1BHK residential unit/ electrical laboratory
3. Design electrical installation scheme of a given factory/ small industrial unit.
4. Design public lighting installation scheme of given premises
5. Design H. T./L.T. line installation scheme for given HT (11kV) or LT (415 V) line
6. Visit to Grid substation/ switchyard.
7. Maintenance and installation of Power transformer
8. Maintenance and installation of Vacuum or SF6 circuit Breaker
9. Study of PLC and SCADA for distribution automation
10. Study/Design of industry standard 3 phase induction motor control panel
11. Earthling Design
12. Lightning protection
13. Estimation and drawing layout of Industrial zones as per industrial requirements

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1			1				1		1	3	1	1
CO2	3	2	1	1		1			1	1		1	3	1	1
CO3	3	1	1	1		1			1	1		1	3	1	1
CO4	3	1	1	1		1			1	1		1	3	1	1

1 -Low 2 – Medium 3 - High

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Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO 1	CO 2	CO 3	CO 4	CO5
ISE I (25 Marks)	05	05	05	05	05
Practical Examination & Viva Voce					

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Professional Elective II

EEPEC 3007 Electrical Machine Design	
Teaching Scheme	**Examination Scheme**
Lectures : 03 Hrs/Week	ISE I : 15 Marks
Tutorial : 00	ISE II : 15 Marks
Total Credits : 03	ISE III Assessment : 10 Marks
	End -Semester Exam : 60 Marks

Course Description:

Electrical Machine Design is an elective subject for all students of the Electrical Engineering Department. Course is aimed to introduce fundamental concepts regarding machine design with electrical aspects of all types of machines to undergraduate students. The goal of this course is to understand and apply fundamentals knowledge of design to design all machines including transformers.

Course Objectives:

The objectives of the course are to learn

- To study Selection proper commercial materials, their properties and selection criterions, IS standards used in electrical machine design.
- To study design of commercial induction motor and transformer

Course Outcomes:

After completing the course, students will able to

CO1	understand the basic considerations required for electrical machine design
CO2	design stator and rotor of induction machines as per the specifications
CO3	solve problems on performance parameters the Induction motor
CO4	design core, yoke, windings and cooling systems of transformers
CO5	apply computer-aided optimization techniques for the design of electrical machines and Design electrical machines using finite element-based software.

Detailed Syllabus:

Unit-I	**Major considerations in Electrical Machine Design** Electrical Engineering Materials- Space factor- Choice of Specific Electrical and Magnetic loadings- Thermal considerations- Heat flow, Temperature rise and Insulating Materials, Rating of machines, Standard specifications
Unit-II	**Design of Induction Motors -I** Constructional features, types of ac windings, Output equation of Induction motor , Main dimensions, specific electrical and magnetic loadings, ranges of specific loadings, turns per phase, number of stator slots. Length of air gap- Rules for selecting rotor slots of squirrel cage machines, Design of rotor bars & slots , Design of end rings, Harmonic field effect on the performance of three phase induction motor, Specifications of Induction motor

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Unit-III	**Design of Induction Motors -II** Magnetic leakage calculations-Leakage flux and leakage reactance: Slot leakage, tooth top leakage, zig-zag leakage, overhang leakage, leakage reactance calculation for three phase machines.MMF Calculation for air gap, stator teeth, stator core, rotor teeth and rotor core, effect of saturation, effects of ducts on calculations of magnetizing current, calculations of no-load current. Calculations of losses and efficiency
Unit-IV	**Design of Transformers** Types and constructional features of core and windings used in transformers. Transformer auxiliaries such as tap changer, pressure release valve, breather and conservator. Specifications of transformer. Output Equations, Design of Main Dimensions-KVA output for single and three phase transformers, Window space factor-Design of core and winding, Overall dimensions, Design of Tank, Methods of cooling of Transformers, Estimation of resistance and leakage reactance of transformer, No load current, losses, efficiency and regulation of transformers. Calculation of mechanical forces developed under short circuit conditions, measures to overcome this effect. Temperature rise in Transformers, Design of IVT, CVT,& Current Transformer
Unit-V	**Computer Aided Design (CAD) of Electrical Machines** Limitations and assumptions in traditional designs, need of CAD, analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. **Electrical Machine Design using FEA Software packages** Introduction to complex structures of modern machines- PMSMs, BLDCs, SRM, LSPMSMs, Claw pole machines etc., need of commercial FEA based software, analytical design modules, 2D and 3D machine models, analyzing steady state and transient performance of the designs.

Self study: The design of special machines like synchronous machine ,BLDC,PMSM etc

Text Books:

1. M.G. Say, Theory and Performance and Design of A.C. Machines, 3rd Edition, ELBS London

2. Sawhney A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, 1984.

Reference Books:

1..Indrajit Dasgupta,Design of Transformers, TMH

2. M.V.Deshpande "Design and Testing of Electrical Machine Design" Wheeler Publications, 2010.

3.A.Shanmuga Sundaram, G. Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.

4.R.K.Agarwal" Principles of Electrical Machine Design" Esskay Publications, Delhi, 2002.

5. K. G. Upadhyay, Design of Electrical Machines, New age publication.

6.Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programs, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.

7. Vishnu Murti, "Computer Aided Design for Electrical Machines", B.S. Publications.

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Mapping of Course Outcome with Program Outcomes:

Course outcome	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO0 8	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2													
CO2	3	2	3		1	1						1		3	
CO3	3	2	3		1	1						1		3	
CO4	3	2	3		1	1						1		3	
CO5	3	3	3		1	1						1		3	

1- Low 2- Medium 3-High

Sample Assessment Table:

Assessment Tool	K1,K2,K3	K2,K3,K4	K2,K3, K4	K1,K2,K3 K4	K2,K3,K4
Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I & II 30 Marks	7	8	15		
ISE III 10 Marks	02	02	02	02	02
ESE 60 Marks	12	12	12	12	12

Teaching Strategies: It is planned through the lectures and team based home works. Exercises are assigned weekly to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

ISE I, II are compulsory tests

ISE III Assessment: It is based on one of the /or combinations of the few of the following.

1.Home Assignments, 2.Power-point presentation on new concepts in design in any type of machine ,3. Develop working models using software, 4. Surprise written Test with multiple choice questions, 5. Quiz

*consider the design of all machines including special machines.

Sample Assessment Pattern

Assessment Pattern Level No.	**Knowledge Level**	**Test**	**Teachers Assessment /Assignment**	**End Semester Examination**
K1	Remember	10	03	10
K2	Understand	10	04	20
K3	Apply	10	03	20
K4	Analyze	00	00	10
Total		30	10	60

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Dean , Academics

Approved Updated Curriculum in XXIXth Academic Council Meeting
Dated: 25th March 2025

EEPEC 3008 Smart Grid Technology (Professional Elective II)	
Teaching Scheme Lectures : 3 Hrs/Week Tutorial : 0 Total Credits : 3	**Examination Scheme** ISE I : 15 Marks ISE II : 15 Marks ISE III : 10 Marks End-Semester Exam :60 Marks

Course Description: This course introduces the concepts of smart grid technology and covers the various aspects of smart grid.

Course Objectives: The objectives of the course are to

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understand concept of power quality issues in Smart grid
5. Appreciate problems associated with integration of distributed generation & its solution through smart grid.

Course Outcomes: After completing the course, students will able to:

CO1	explain fundamentals of smart grid
CO2	describe different smart grid technologies
CO3	understand the concept of micro grids and distributed energy resources
CO4	identify the power quality issues in Smart grid
CO5	compare different communication technologies for Smart Grid

Detailed Syllabus:

Unit-I	**Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid
Unit-II	**Smart Grid Technologies:** Part 1:Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers. Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit
Unit-III	**Micro grids and Distributed Energy Resources:** Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, Thin film solar Cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.

Unit-IV	**Power Quality Management in Smart Grid:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.
Unit-V	**Information and Communication Technology for Smart Grid:** Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing , Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

Text and Reference Books

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadiere, NouredineHadjsaid, "Smart Grids", Wiley Blackwell
5. Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc. (ISBN: 978-1-59749-570-7)

Mapping of Course outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O2	PS O3
CO1	3	1				2	2	3	2	2		2	3		
CO2	3	1				2	2	3	2	2		2	3	2	2
CO3	3	1				2	2	3	2	2		2	3	2	2
CO4	3	1				2	2	3	2	2		2	3	1	
CO5	3	1				2	2	3	2	2		2	3	2	2

1 – Low 2 – Medium 3 – High

ISE III Assessment: Teachers Assessment of 10 marks is based on attendance of the student and one of the / or combination of few of following. However, the course coordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. MCQ
3. Simulations problems
4. Quiz

Designed by Dr. S. P. Ghanegaonkar

Dr. Nitin Phadkule
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EEPEC3009 : Energy Storage Systems (Professional Elective II)	
Teaching Scheme Lectures : 03 Hrs/Week Tutorial : 00 Total Credits : 3	**Examination Scheme** ISE I : 15 Marks ISE II : 15 Marks ISE III : 10 Marks End-Semester Exam : 60 Marks

Course Description: Coverage of energy storage techniques involving electrochemical, mechanical and emerging options. Integration of the energy storage media, its effects on the bulk power system, and design tradeoffs to understand environmental impacts, cost, reliabilities, and efficiencies for commercialization of bulk energy storage.

Course Objectives: The objectives of the course are to
1. Understand energy storage needs
2. Study and compare different methods of Electro-chemical energy storages
3. Understand superconducting magnetic energy storage systems
4. Get knowledge of mechanical and thermal energy storage systems
5. Study various energy storage applications and management of storage systems

Course Outcomes: After completing the course, students will able to

CO1	describe the need of energy storage systems-present and future
CO2	explain working principles of various Electrochemical Energy Storage systems
CO3	explain superconducting magnetic energy storage systems
CO4	describe mechanical energy storage and Thermal energy storage systems
CO5	select appropriate energy storage systems for various applications and demonstrate management of energy storage systems

Detailed Syllabus:

Unit-I	**Necessity of Energy Storage** Storage Needs - Variations in Energy Demand - Variations in Energy Supply - Interruptions in Energy Supply - Transmission Congestion - Demand for Portable Energy - Demand and scale requirements - Environmental and sustainability issues, future prospect of storage
Unit-II	**Electrochemical Energy Storage** Electrochemical storage system (11 Hours) (a) Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery & Metal hydride battery vs lead-acid battery. (b) Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors (c) Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems
Unit-III	**Superconducting Magnetic Energy Storage** Introduction to Superconducting Magnetic Energy Storage (SMES) operation, theory of usage and emergent research. Focus will primarily be on large utility scale energy storage facilities

Unit-IV	**Mechanical Energy Storage and Thermal Energy Storage** Flywheel, Pumped hydro storage, compressed gas storage technologies, models for compressed gas capacity, efficiency and availability Thermal Energy Storage- Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems
Unit-V	**Applications** Present status of applications, Utility use (Conventional power generation, Grid operation & Service), Consumer use (Uninterruptible power supply for large consumers), New trends in application, Renewable energy generation, Smart grid, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems

Text and Reference Books:

1. Ter-Gazarian, A.G. (2011) *Energy Storage for Power Systems, 2nd Edition*, IET Publications (ISBN: 978-1849192194)
2. Huggins, R.A. (2010) *Energy Storage*, Springer, (ISBN: ISBN 978-1441910240)
3. R. P. Deshpande, "Ultracapacitors", McGraw Hill Education Publication.
4. Robert A. Huggins, "Energy Storage", Springer Publication.
5. Fransisco Diaz," Energy storage in power systems", published by Wiley.

Mapping of Course outcome with program outcomes:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	1	1	1	1	1		1	1	1	1
CO2	3	2	2	1	1	1	1	1	1	1		1	1	1	1
CO3	3	2	1	1		1	1	1	1	1		1	1	1	1
CO4	3	2	1	1		1		1	1	1		1	1		
CO5	3	2	1	1		1	1	1	1	1		1	1	1	1

1- Low 2- Medium 3- High

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K1 to K6	K1 to K6
Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I, II 30 Marks	8	7	8	7	
ISE III Assessment 10 Marks	2	2	2	2	2
ESE Assessment 60 Marks	12	12	12	12	12

ISE I , II are compulsory tests

ISE III Assessment: Teacher's Assessment is based on one of the following.

1. Assignments, 2. Models/ Presentations, 3. multiple choice questions test, 4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	ISE I, II		ISE III Assessment	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	5	5	2	20
K3	Apply	5	5	3	20
K4	Analyze			3	10
Total		15	15	10	60

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Semester VI

Semester VI Course				Teaching Scheme			Continuous Evaluation in terms of Marks					
Sr No	**Category**	**Course Code**	**Course Name**	**TH**	**T**	**PR**	**Credits**	**ISE I**	**ISE II**	**ISE III**	**ESE**	**Total**
1	PCC	EEPCC3010	Microcontrollers	3	-	-	3	15	15	10	60	100
2	PCC	EEPCC3011	Power System Protection	3	-	-	3	15	15	10	60	100
	PCC	EEPCC3012	Power Electronics	3	-	-	3	15	15	10	60	100
3	PCC	EEPCC3013	Lab-Power System Protection	-	-	2	1	-	-	25	25	50
4	PEC-III			3	-	-	3	15	15	10	60	100
5	Lab-PEC III					2	1	-	-	25	25	50
6	PEC-IV			3	-	-	3	15	15	10	60	100
7	MD M-4			3			3	15	15	10	60	100
8	VSEC	EEVSE3011	Lab Microcontrollers	-	-	2	1	-	-	25	25	50
9	VSEC	EEVSE3012	Lab Power Electronics	-	-	2	1	-	-	25	25	50
			Total	**18**	**-**	**08**	**22**	**90**	**90**	**160**	**460**	**800**

Professional Electives

PEC III	**Course Title**	**PEC IV**	**Course Title**
EEPEC3015	Advanced Control Systems	EEPEC3021	Energized Irrigation Systems
EEPEC 3016	Lab Advanced Control Systems	EEPEC 3022	Optimization Techniques
EEPEC 3017	Internet of Things	EEPEC 3023	Utilization of Electrical Energy
EEPEC 3018	Lab IoT	EEPEC 3024	Electrical and Hybrid Vehicles
EEPEC 3019	Machine Learning For Electrical Engineering		
EEPEC 3020	Lab Machine Learning For Electrical Engineering		

EEPCC3010: Microcontrollers			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs./Week	ISE I	: 15 Marks
Tutorial	: NIL	ISE II	: 15 Marks
Total Credits	: 03	ISE III	: 10 Marks
		End Semester Exam	: 60 Marks

Course Description: This course introduces the fundamentals concepts of microcontrollers. The student will be able to apply these concepts in various microcontroller based systems.

Course Objectives:

The objectives of the course is to give exposure to the students to

1. Fundamental concepts of Microcontrollers
2. Debug the assembly language/ C Program of microcontrollers
3. Demonstrate use of timers, SFRs and IO devices
4. Interface peripherals like I/O, A/D, D/A, timer etc to microcontrollers
5. Identify real world applications of microcontrollers

Course Outcomes:

After completing the course, students will able to:

CO1	describe the architecture of microcontrollers
CO2	debug the assembly language or C programs of microcontroller
CO3	demonstrate assembly language programs using timers, SFRs etc of 8051
CO4	interface peripheral devices to microcontrollers
CO5	demonstrate applications of advanced microcontrollers to real world applications

Detailed syllabus

Unit- I	**Architecture of 8051 Microcontrollers** Concept and overview of Microcontrollers, CISC Vs RISC, Von-Neumann vs. Harvard architecture,. Classification and features of 8-bit/16-bit/31-bit microcontrollers. Architecture of 8051 Microcontroller, Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, Clock and RESET circuits, Program Counter, I/O ports, Memory organization, Data and Program Memory, Stack and stack pointer
Unit-II	**Instruction Set and Programming** 8051 Instruction set, Programming 8051 with single bit instructions. Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Addressing modes: Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing

Unit-III	**Programming with IO and Timers** I/O programming, interfacing with simple switch, LED. 8 bit and 16 bit Timers, various modes of operations of timers, counters, Interrupts, priority, PWM programming. SFR's and its programming, timing diagram Branch control instructions and its types, Subroutine instructions, Bit manipulation instruction. Assembly language programs, Programming and debugging tools, C language programs. Assemblers and compilers. RAM memory organization Memory and I/O expansion buses, control signals, memory wait states
Unit-IV	**I/O Port Programming and Interfacing and Applications** General Purpose IO, I/O port programming, Interfacing of peripheral devices such as, memory devices, LED interfacing, Relays, heater coil, LED, LCD and keyboard interfacing. ADC, DAC, timers, counters, DC Motor ,stepper motor interfacing, Serial mode communication, Synchronous and Asynchronous Communication Using RS232, sensor interfacing
Unit -V	**Advanced Microcontrollers** Embedded system and its characteristics, Role of microcontrollers in embedded Systems. 16-bit Microcontrollers overview, Selection of Microcontroller, Architecture of PIC and/ ATMEGA. SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee. Interfacing of peripheral devices such as, memory devices, LED, Relays, heater coil, LCD and keyboard interfacing. ADC, DAC, timers, counters, DC Motor, stepper motor, sensor, such as projects based on real time systems using microcontrollers

Self Study Real world applications using Raspberry or suitable controllers like PIC/ ATMEGA/ AVR/ low power feature of MSP 430, .etc 32-bit Digital Signal Processor applications in power electronics

Text / References:

1. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson Education, 2007.
2. Muhammad A. Mazidi, "The AVR Microcontroller and Embedded Systems: A System Approach", 1st Ed., PHI, 2013
3. Muhammad A. Mazidi, "AVR Microcontroller and Embedded Systems: Assembly and C", Pearson; 1st edition, 2015
4. Thomas Grace, "Programming & Interfacing Atmel Avr Microcontrollers", Cengage Learning, Inc, 2015.
5. Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 2nd edition, 2008.
6. Venkataramani, M. Bhaskar "Digital Signal Processors: Architecture, Programming and Applications", Second Edition, Tata McGraw Hill Education Private Limited, 2011.

e Learning Resource: Prof. Santanu Chattopadhyay, NPTEL course lectures on Microprocessors and Microcontroller https://nptel.ac.in/courses/108/105/108105102

Mapping of Course Outcome With Program Outcomes:

Course Outcome	PO1	PO2	PO 3	PO 4	PO 5	PO 6	P O 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PSO 3
CO1	3	3	1	1	2	1		1		1	1	1		2	2
CO2	3	1	1		2	1		1		1	1	1	1	2	2
CO3	3	2	1		2	1	1	1		1	1	1		2	2
CO4	3	3	1	1	1	1	1	1		1	1	1	1	1	1
CO5	3	3	1	1	2	1	1	1		1	1	1	1	2	2

1 – Low 2 – Medium 3 – High

ISE III Assessment: It is of 10 marks is based on one of the / or combination of few of following,

1. Mini projects, 2. PPT presentation, 3. Assignment based on programming of microprocessors for different applications.

Sample Assessment Pattern:

Level No.	**Knowledge Level**	**ISE I**	**ISE II**	**ISE III**	**End Semester Examination**
K1	Remember		5	4	5
K2	Understand				15
K3	Apply	5	5	2	20
K4	Analyze	5			20
K5	Evaluate	5	5	4	
K6	Create				
Total Marks 100		15	15	10	60

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K2+K3	K2+K3+K4	K2+K3+K4	K2+K3+K4
	C01	C02	C03	CO4	CO5
ISE I, (15 Marks)	7	8	-	-	-
ISE II(15Marks)	-	-	7	8	-
ISE III (10 Marks)	-	2	2	3	3
ESE Assessment (60 Marks)	12	12	12	12	12

Special Instructions If Any: NIL

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EEPCC 3011: Power System Protection	
Teaching Scheme Lectures : 3 Hrs/Week Tutorial : 0 Total Credits : 3	**Examination Scheme** ISE I : 15 Marks ISE II : 15 Marks ISE III : 10 Marks End-Semester Exam :60 Marks

Course description:
This is a one-semester course compulsory to all third year Electrical Engineering students. It is the fundamental course related to Power System Engineering.

Course Objective:

The objectives of the course are to introduce & explain

1. The philosophy & technology of protection
2. Construction & working of circuit breakers & fuses
3. Different protection schemes of generators & transformers
4. Different protection schemes of transmission lines & bus bars
5. Modern trends in protection

Course Outcomes:

After completing the course, students will be able to:

CO1	explain basics of fault clearing process
CO2	describe arc Interruption phenomenon and working of various circuit breakers & their applications
CO3	apply differential protection schemes to transformers & generators
CO4	identify protection schemes to transmission lines & bus bars against different faults
CO5	explain fundamentals of static & numerical relaying

Detailed Syllabus:

Unit-I	**Introduction** Importance of protection in power systems, Fault clearing process , Desirable qualities of protective relaying, Definitions of terms used in relaying, Protective zones , Primary & back up protection
Unit-II	**Principle of Circuit Interruption** Arc phenomenon, A.C. & D.C. circuit breaking, Arc interruption theories, Transient recovery voltage, Re-striking voltage, Factors affecting TRV, Rate of rise of restriking voltage, Resistance switching, Damping of TRV, Current chopping, Capacitive current breaking, Auto reclosing **Circuit Breakers** Construction, Working principle, Application & comparison of different types of circuit Breakers such as Air Break, Air blast, Minimum Oil Circuit breaker, SF6 & Vacuum Circuit breakers, H.V.D.C. Circuit breakers. Different contactors, Rewirable & H.R.C. fuses MCB's, ELCB's , Introduction to Gas Insulated Substations

Unit-III	**Protection of Transformers and Generators** **Transformer protection**: Percentage differential protection, magnetic inrush current phenomenon, percentage differential relay with harmonic restraint, restricted earth fault protection, incipient faults, Buchholz relay, protection against over-fluxing. **Generator protection**: Stator phase and ground fault protection, protection against unbalanced loading, loss of excitation, loss of prime mover and over speeding.
Unit-IV	**Transmission lines & Bus bar protection** Introduction to distance relaying, zones of protection, setting and coordination of distance relays, pilot protection with distance relays, Protection against lightning, insulation coordination, Busbar protection: Different bus bar arrangements, differential protection of busbar, high impedance differential relay
Unit-V	**Basics of Static & Numerical relaying** Comparison of static and electro-mechanical relays, two input amplitude and phase comparators and their duality, Numerical relaying fundamentals, sampling theorem, anti-aliasing filters, least square method for estimation of phasors, Fourier algorithms, Fourier analysis and discrete Fourier transform, estimation of phasors from discrete Fourier transform, Applications for implantation of various numerical relays

Text and Reference Books

1. C. Russul Mason, "Art & Science of Protective Relaying ", John Wiley & Sons
2. Sunil S. Rao, "Switchgear Protection & Power Systems", Khanna Publishers, Fifth edition
3. Y. G. Paithankar S. R. Bhide , "Fundamentals of Power Systems Protection", PHI of India
4. Madhav Rao, "Solid state protective relaying", Tata McGraw Hill
5. M. S. Naidu," Gas Insulated Substations"- IK International Publishing House.1

Mapping of Course outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2	1	1		1	1	2	1	2		2	3	1	1
CO2	3	2	1	1		1	1	2	1	2		2	3		
CO3	3	2	1	1		1	1	2	1	2		2	3		
CO4	3	2	1	1		1	1	2	1	2		2	3		
CO5	3	2	1	1		1	1	2	1	2		2	3	2	2

1 - Low 2 – Medium 3 – High

ISE III Assessment: Teachers Assessment of 10 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course coordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

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Sample Assessment Pattern

Assessment Pattern Level No.	Knowledge Level	ISE I	ISE II	ISE III Assignment	End Semester Examination
K1	Remember	5	5		10
K2	Understand	5	5	5	20
K3	Apply	5	5	5	30
K4	Analyze				
K5	Evaluate				
K6	Create				
Total Marks 100		15	15	10	60

Sample Assessment table:

Assessment Tool	K1+K2+ K3	K1+K2+ K3	K1+ K2	K1+K3	K2
	CO1	CO2	CO3	CO4	CO5
ISE I (15 Marks)	7.5	7.5			
ISE II (15 Marks)			7.5	7.5	
ISE III (10 Marks)				5	5
ESE Assessment (60 Marks)	10	20	10	10	10

Teaching Strategies:

The teaching strategy is planned through the lectures, tutorials and team based home Assignments.

Designed by
Dr. S. P. Ghanegaonkar

EEPCC 3012: Power Electronics	
Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hrs./Week	ISE I : 15 Marks
Total Credits : 03	ISE II : 15 Marks
	ISE III : 10 Marks
	End Semester Exam : 60 Marks

Course Description:
The objective of this course is to give exposure to the students of various power semiconductor devices. Also to expose to applications of different types of power converter configurations and their control techniques.

Course Objectives:

The objective of the course is to give exposure to the students of
1. Power semiconductor devices
2. Triggering methods, commutation methods and various characteristics of power semiconductor devices
3. Operations of AC-DC converters and dual converters
4. Operations of DC-DC converters and their control techniques
5. Operations of DC-AC converters and its various control techniques

Course Outcomes:
After completing the course, students will able to:

CO1	Describe structure, characteristics, and applications of power semiconductor devices
CO2	Explain different triggering methods, commutation methods and various characteristics of switching devices
CO3	Analyze single and three phase AC-DC converters
CO4	Analyze operation of DC-DC converters
CO5	Analyze operation of DC-AC converters

Detailed Syllabus:

Unit-I	**Power Semiconductor Devices:** Structure, Principle of operation, V/I characteristics of power semiconductor devices such as SCR,TRIAC, DIAC, GTO, Power Transistor, Power MOSFET, IGBT, SiC, GaN
Unit-II	**Performance of Power Semiconductor Devices:** Gate triggering methods, Turn on-Turn off characteristics of SCR, Gate driving circuits for SCR, IGBT, GTO, Types of commutation, Ratings, protection, Series & parallel operation
Unit-III	**AC-DC Converters:** Principle & operation of single phase half wave and full wave converters with different types of load, Three phase half and full wave converters, Use of freewheeling diode, Effect of source inductance, Single phase and Three phase dual converters
Unit-IV	**DC-DC Converters:** Principle of operation of chopper, Basic principles of step-down and step-up operation, various control techniques, chopper classification, Buck, Boost, Buck-Boost converters.
Unit-V	**DC-AC Converters:** Principle of operation of series and parallel inverters, Single phase center tapped and bridge inverter with R, RL load, Three-phase bridge inverters, PWM techniques, Voltage Source Inverter, Current source inverters, Concepts of multilevel inverters and their types.

Text and Reference Books:

1. M.H. Rashid, “Power Electronics”, Third Edition, Prentice-Hall of India Pvt. Ltd. 2005
2. Mohan, Undel and, Robbins, "Power Electronics”, Second Edition, John Willey & Sons, 1995
3. B. K. Bose, “Modern Power Electronics and AC Drives”, Prentice-Hall of India Pvt. Ltd. 2006
4. C. W. Lander, “Power Electronics”, Tata McGraw-Hill Publications India 1993
5. P.C. Sen, “Power Electronics", Tata McGraw-Hill Publications India
6. G. K. Dubey, S. R. Doradla, A. Joshi, M. K. Sinha, “Thyristorised Power Controllers", Wiley Eastern Ltd.1987
7. M. Ramamoorthy, ”An Introduction to Thyristor & Their Applications”, East-West Press Pvt. Ltd., New Delhi

Mapping of Course outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	3	2	-		-	1		2	-	-		2		-	-
CO2	3	2	-		-	1		2	2	2		2		-	-
CO3	3	3	1		1	1		2	2	2		2		2	2
CO4	3	3	1		1	1		2	2	2		2		2	2
CO5	3	3	1		1	1		2	2	2		2		2	2

1 – Low 2 – Medium 3 – High

ISE III will be based on **any ONE** of the following:
1. Multiple Choice Question Test
2. Assignments/PPT presentation on allotted topics
3.Written Test on numerical
4. Quiz

Sample Assessment Pattern:

Level No.	Knowledge Level	ISE I	ISE II	ISE III	End Semester Examination
K1	Remember	05	05		15
K2	Understand	05	05		15
K3	Apply	05	05	05	15
K4	Analyze			05	15
Total Marks: 100		**15**	**15**	**10**	**60**

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K1+K2+K3	K1+K2+K3	K1+K2+K3+K4
	C01	C02	C03	CO4	CO5
ISE I (15 Marks)	7.5	7.5	-	-	-
ISE II (15 Marks)	-	-	7.5	7.5	-
ISE III (10 Marks)			04	04	02
ESE Assessment (60 Marks)	12	12	12	12	12

Designed by Dr. N. R. Bhasme

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EEPCC 3013: Lab Power System Protection	
Teaching Scheme Practical : 2 Hrs/Week Total Credits : 1	**Examination Scheme** Term Work : 25 Marks Practical Examination : 25 Marks

Course Objectives

The objectives of the course are to-

1. Learn fundamentals of relay operation
2. Learn working & application of different switchgears
3. Learn different protection schemes for the protection of power system equipments
4. Learn recent developments in relaying

Course Outcomes:

After completion of this course students will be able to

CO 1. Do the relay settings & plot the characteristics of relay
CO 2. Explain working of circuit breakers
CO 3. Apply different protection schemes
CO 4. Know basics of static and numerical relay

List of the Experiments:

Term work shall consist of minimum eight experiments from the following:

Sr. No.	Name of the Experiments
1	Study & use switchgear testing kit.
2	Plot Characteristics of rewirable HRC fuse.
3	Plot Characteristics of over current relay.
4	Study Distance protection of transmission lines.
5	Study Biased & Unbiased differential protection of transformer
6	Study Differential protection of alternators.
7	Study of vacuum circuit breakers.
8	Study of Numerical Relay.
9	Study of Air Circuit Breakers.
10	Study of Bucholz, Relay
11	Study of MCB.
12	Study of static relay.
13	Study of protection of 3-phase Induction Motor against various faults.
14	Simulation of sine and cosine type comparators in MATLAB/Simulink.
15	Visit report on protection schemes in substation.

Term work:

The term work shall consist of submitting a file for minimum eight experiments performed with neatly written records of the study, programs & observations with results.

The term work will be assessed by the course coordinator

Mapping of Course outcome with Program Outcomes:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2	1	2	1	3	2	2	1	2	2	2	3	2	
CO2	3	2	1	2	1	3	2	2	1	2	2	2	3	2	
CO3	3	2	1	2	1	3	2	2	1	2	2	2	3	2	
CO4	3	2	1	2	2	3	2	2	1	2	2	2	3	2	1

1 - Low 2 – Medium 3– High

Assessment Pattern:

Assessment Pattern Level No.	**Skill Level**	**Term Work**	**Practical Examination & viva voce**
S1	Imitation	10	10
S2	Manipulation	05	05
S3	Precision	10	10
S4	Articulation		
55	Naturalization		
Total		25	25

Assessment Table :

Assessment Tool	**S1+S2+S3**	**S1+S2+S3**	**S1+S2+S3**	**S1+S2+S3**
	C01	C02	CO3	CO4
Term Work (25 Marks)	05	05	05	05
ESE (25 Marks)	05	05	05	05

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EEVSE3011 : Lab Microcontrollers	
Teaching Scheme	**Examination Scheme**
Practical : 2Hrs/Week	ISE III : 25 Marks
Tutorial : NIL	Practical and Viva-Voce : 25 Marks
Total Credits : 01	

Laboratory Course Outcomes:

As an outcome of completing the Laboratory course, students will able to:

CO1	get the hands on experience with the software-tools like assembler, simulator, C Compiler
CO2	demonstrate assembly language programs on 16 bit data on 8051
CO3	execute assembly language programs using interrupts on 8051 microcontroller
CO4	interface microcontroller with commonly used devices.
CO5	use microcontroller for specific applications such as speed control of stepper and DC motor

List of Experiments:

Term-work shall consist of minimum ten experiments from the following:

Sr. No.	Details
1	Assembly language programming using cross-assembler
2	Execution of simple programs based on data transfer instructions for 8051/PIC etc
3	Execution of simple programs based on arithmetic and logical instructions(8 bit) for 8051/PIC etc
4	Execution of programs using bit addressable memory for microcontroller 8051/PIC etc
5	Execution of programs using any hardware/ software interrupts for 8051/PIC etc
6	Interfacing serial ports/communication to microcontroller
7	Write an Assembly language program to implement LED blinking programs using Delay function and Timers.
8	Interfacing of Push buttons, Key matrix, LCDs, ADC with Microcontroller
9	Interfacing of DC Motor with microcontroller
10	Write an Assembly language program to generate PWM waveform and display it on the DSO.
11	Interfacing of DAC to 8051 to generate various signals like square, triangular, saw tooth *etc.*/PIC
12	Open loop speed control of DC motor.
13	Interfacing of stepper motor to 8051/PIC
14	Write a C language program to implement LED blinking program using DSP
15	Write a C language program to generate PWM waveform using DSP.

Mapping of Course Outcome With Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PS O 1	PS O2	PSO3
CO1	3	3	1		2	1		1		1		1	1	1	2
CO2	3	2	1	1	3	1	1	1	1	1		1	1	1	2
CO3	3	2	1	1	3	1	1	1	1	1		1	1	1	2
CO4	3	1	1	1	2	1		1	1	1		1	1	2	2
CO5	3		1	1	3	1	1	1	1	1		1		1	2

1- Low 2 – Medium 3 - High

Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination & Viva Voce					

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EEVSE3012: Lab Power Electronics	
Teaching Scheme	**Examination Scheme**
Practical : 2Hrs/Week	ISE II :25 Marks
Tutorial : NIL	ESE :25 Marks
Total Credits : 01	

Laboratory Course Outcomes:

After completing the course, students will able to:

CO1	Explain various triggering method of SCR and measure the load voltages for varying firing angles
CO2	Explain commutation techniques and measure various parameters related to it
CO3	Explain single phase half wave, full wave/ three phase converters with various loads and measure the load voltages by changing firing angles
CO4	Explain the operations of Inverters and plot associated waveforms
CO5	Explain the operation of Chopper and plot associated waveform

List of Experiments:

Term work shall consist of minimum eight experiments from the following:
(Software based simulation can be used for some experiments)
Perform an experiment/simulate/study

Sr. No.	Details
1	Triggering circuits of SCR/IGBT/GTO/MOSFET
2	dv/dt protection of SCR
3	Commutation circuits of SCR
4	Single phase half wave and full wave controlled rectifier
5	Three phase half wave and full wave controlled rectifier
6	Dual converter
7	Choppers
8	Buck converter
9	Boost Converter
10	Buck-Boost Converter
11	Single phase/three phase inverter
12	Applications of power semiconductor devices

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2	1		2			2	2	2		2		2	
CO2	3	2	1		2			2	2	2		2		2	
CO3	3	2	1		2			2	2	2		2		2	
CO4	3	2	1		2			2	2	2		2		2	
CO5	3	2	1		2			2	2	2		2		2	

1 – Low 2 – Medium 3 - High

Sample Assessment Table:

Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination & Viva Voce (25 marks)	05	05	05	05	05

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Professional Electives III and IV

PEC III	Course Title	PEC IV	Course Title
EEPEC3015	Advanced Control Systems	EEPEC3021	Energized Irrigation Systems
EEPEC 3016	Lab Advanced Control Systems	EEPEC 3022	Optimization Techniques
EEPEC 3017	Internet of Things	EEPEC 3023	Utilization of Electrical Energy
EEPEC 3018	Lab IoT	EEPEC 3024	Electrical and Hybrid Vehicles
EEPEC 3019	Machine Learning For Electrical Engineering		
EEPEC 3020	Lab Machine Learning For Electrical Engineering		

EEPEC3015: Advanced Control System	
Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./Week	ISE I : 15 Marks
Tutorial : 00	ISE II : 15 Marks
Total Credits : 03	ISE III : 10 Marks
	End Semester Exam : 60 Marks

Course Description: This introduces the basic concepts of compensator design in frequency domain, state space analysis, digital control, nonlinear control and intelligent controllers

Course Objectives: The objectives of the course are to give exposure to students of

1. Compensator design in frequency domain
2. Analysis of systems using state space technique
3. Stability of digital systems
4. Explain stability of nonlinear control systems.
5. Advanced Controllers

Course Outcomes:

After completing the course, students will able to:

CO1	analyze compensators in frequency domain
CO2	analyze State space various forms, observability and controllability
CO3	determine stability of digital systems
CO4	explain various methods of nonlinear control systems.
CO5	describe various advanced controllers

Detailed Syllabus:

Unit-I	**Design of Classical Control System in frequency domain** Introduction to compensator. Design of Lead ,Lag, lag-lead compensator in frequency domain: lead, Lag and lag-lead compensator using Bode diagram.
Unit-II	**State Variable Analysis** State space representation of continuous systems indifferent forms like physical model, phase variable model, canonical form, Jordan Canonical form, Solving the time-invariant state equation, Transfer function from state space model, State transition matrix, Modal matrix, Diagonalization, Eigenvalues and Eigenvectors, Controllability and Observability criteria for time invariant systems, Pole placement using state variable feedback, Design of state observers
Unit-III	**Digital control and Stability** Introduction to digital control, concepts of sampling, reconstruction of signals, sample data control, Z and inverse Z transform. Stability using Jury criteria, Bilinear transformation. Digital PID control, Use of PID controllers for various Industrial applications
Unit -IV	**Nonlinear Control Systems:** Common physical nonlinearities, characteristics of nonlinear systems, linearize techniques, construction of phase trajectory, Non-linear control system using describing function concepts and phase plane techniques and Liapunov's stability criterion.

Unit-V	**Advanced Controllers** Comparison of feedback and Feed forward control, Ratio, Cascade control. Direct digital control (DDC), supervisory control Programmable Logic Controllers: Introduction to PLC, Constructional features, Fuzzy logic controller and its applications.

Text Books:

1. I .J. Nagrath & M. Gopal, "Control Systems Engineering",New Age Publishers 4th edition.
2. M. Gopal. , "Digital Control Systems", New Age Publishers 4th Edition.

Reference Books:

1. Benjamin Kuo, "Digital Control system", Oxford.
2. K. Ogata, "Modern Control System", Prentice Hall.
3. Lee Stoline,"Applied Non –Linear System", Prentice Hall.
4. Norman Nice, "Control System Engineering", New Age Publishers

Mapping Of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2		1	1	1		1	1		1		1	1	2
CO2	3	2		1	1	1		1	1		1		1	1	2
CO3	3	2		1	1	1		1	1		1		1	1	2
CO4	3	2	1	1	1	1		1	1		1		1	1	2
CO5	3	2		2	1			1	1		1		1	1	2

1 –Low 2 – Medium 3 –High

ISE III Assessment: It is of 10 marks based on one of the / or combination of few of following,

1. Assignment , 2. MCQ

Sample Assessment Pattern:

Level No.	**Knowledge Level**	**ISE I**	**ISE II**	**ISE III**	**End Semester Examination**
K1	Remember	5	5	4	14
K2	Understand	5	5	2	12
K3	Apply	5	5	4	14
K4	Analyze				
K5	Evaluate				
Total Marks 100		15	15	10	60

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K2+k3+K4	K2+k3+K4
	C01	C02	C03	CO4	CO5
ISE I, ISE II (30 Marks)	06	06	06	06	06
ISE III (10 Marks)	2	2	2	2	2
ESE Assessment (60 Marks)	12	12	12	12	12

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EEPEC3016: Lab Advanced Control System	
Teaching Scheme	**Examination Scheme**
Practical : 2 hrs/Week	ISE I : 25 marks
Tutorial : Nil	ESE : 25 marks
Total Credits : 01	

Laboratory Course Outcomes:

As an outcome of completing the Laboratory course, students will able to:

CO1	Differentiate various compensators
CO2	design various compensators in frequency domain using software or hardware
CO3	develop state space models for physical systems
CO4	design observer for state space model
CO5	describe PLC, PI/PID for industrial applications

List of Experiments:

Term-work shall consist of minimum 06 experiments from the following:

Sr. No.	Details
1	Analyze Lead compensator and realize using any software tool
2	Analyze Lag compensator and realize using any software tool
3	Analyze Lead- Lag compensator and realize using any software tool
4	Demonstrate any one compensator using hardware and compare results with any software tool
5	Demonstrate state model for any one Electrical/physical system
6	Determine observer for state space model
7	Explain digital PID controller
8	Simulate any one non linear device like(diode, transistor, zener diode etc)
9	Explain of PLC in motor control circuit

course coordinator can add the new practicals based on contents of theory course to give exposure to industrial applications

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O 2	PSO 3
CO1	3	1	1			1		1		1		1		1	1
CO2	3	2	2	1		1	1	1	1	1		1		1	2
CO3	3	2	2	1		1	1	1	1	1		1		1	2
CO4	3	2	2	1		1		1	1	1		1		1	2
CO5	3	1	1	1		1	1	1	1	1		1		1	1

1 -Low 2 – Medium 3 - High

Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination 25 Marks	05	05	05	05	05

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PE III

EEPEC3017: Internet of Things	
Teaching Scheme Lectures : 3 Hrs./Week Tutorial : 00 Total Credits : 03	**Examination Scheme** ISE I : 15 Marks ISE II : 15 Marks ISE III : 10 Marks End Semester Exam : 60 Marks

Course Description: This is the course in Electrical Engineering which introduces the basic concepts and techniques for processing signals on a computer and being familiar with filter design, transform-domain processing and importance of Signal Processors.

Course Outcomes:

After completing the course, students will able to:

CO1	understand concepts of IoT basics with its different components
CO2	describe various connectivity technologies and network protocols
CO3	implement Python programming with Raspbian OS to interface various devices
CO4	analysis of acquired logged data database handling
CO5	do IoT based projects

Detailed Syllabus:

Unit I	**Introduction to IoT**: Concepts and Features of IoT, Applications of IoT, Challenges in IoT IoT Components: Raspberry Pi, Arduino, different Sensors, Actuators, Connectors.
Unit II	**Basics of IoT Networking protocols:** Various connectivity technologies, Raspbian OS, Networking Protocols, Bluetooth, WSN, Sensor Web Connections with IoT components: Connections with different Sensors (like ultrasonic, temperature, vibration, physical etc), Actuators, output devices (LED, Serial Monitor,Screen, Buzzer, serial etc), MQTT, CoAP, XMPP and similar protocols
Unit III	**Python Programming with RPi:** Basics of python programming, Python sensor libraries, python with Raspbian OS, Read data from Sensor, store data to Server, data logging using python, micro python and GPIO programming
Unit IV	**Network Programming in IoT:** Server connections, Database Handling, Runtime Data upload to Server, File Read-Write operations, acquisition of real time data, processing of real time data in cloud
UNIT V	**Case Study:** 1) Smart Cities and Homes with IoT, Applications of IoT in Agricultural , utility sectors etc 2) Applications of IoT in EV, HEV, Industry, Power, Automation , Smart Grid,etc

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Text Books:

1. Getting Started with the Internet of Things, By CunoPfister
2 IoT fundamentals , Author: David Hanes, Gonzalo Sangueiro

Reference Books:

1 Internet of Things: A Hands-On Approach, Author: By ArshdeepBahga, Vijay Madisetti
2 Internet of Things with Raspberry Pi 3: By ByManeeshRao, Packtpub Location
3 Raspberry Pi IoT Projects: Prototyping Experiments for Makers,By John C. Shovic,, Apress Publication.
4. NPTEL online course: Introduction to Internet of Things, By IIT Kharagpur.

Mapping Of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3				1	1			1						
CO2	3	2			1	1			1						
CO3	3	2			1	1			1						
CO4	3	2	1		1	1			1						
CO5	3	2		2	1				1						

1 –Low 2 – Medium 3 –High

ISE III Assessment: It is of 10 marks based on one of the / or combination of few of following,
1. Assignment , 2. MCQ

Sample Assessment Pattern:

Level No.	**Knowledge Level**	**ISE I**	**ISE II**	**ISE III**	**End Semester Examination**
K1	Remember	5	5	4	14
K2	Understand	5	5	2	12
K3	Apply	5	5	4	14
K4	Analyze				
K5	Evaluate				
Total Marks 100		15	15	10	60

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K2+k3+K4	K2+k3+K4
	C01	C02	C03	CO4	CO5
ISE I, ISE II (30 Marks)	06	06	06	06	06
ISE III (10 Marks)	2	2	2	2	2
ESE Assessment (60 Marks)	12	12	12	12	12

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EEPEC3018: Lab Internet of Things	
Teaching Scheme Practical : 2 hrs/Week Total Credits : 01	Examination Scheme ISE I : 25 marks ESE : 25 marks

Laboratory Course Outcomes:

Course Outcomes- After studying this course, students will be able to:

CO1	use different components in IoT to make a complete system.
CO2	write python programs with RPi to work with different sensors.
CO3	work with files, database and cloud data logging with IoT and interpret analog and digital communications with arduino
CO4	write arduino programming for connecting sensors and actuators to control the applications
CO5	develop IoT based application project

Following is the list of experiments which is a guideline, any other experiments can be taken based on syllabus. Minimum eight experiments are to be carried out

List of Experiments

1. Introduction of Arduino IDE
2 Study RaspberryPi and Raspbian OS.
2 Study of different Sensors , Actuators, Connectors, LED with RPi
3 Write Python program in RPi to Glow LED with specific time interval.
4 Write a Python program in RPi to Glow LED if Buzzer sound.
5 Create IoT circuit with python program to maintain Temperature data log.
6 Database connection with IoT using RaspberryPi
7 File read/Write operations with IoT using RaspberryPi
8 Using IoT system, send runtime data log to the cloud.
9 Case Study : Smart City or Smart Vehicle
10 Case study : Smart grid
11. Write an arduino program to demonstrate constants
12. Write an program to demonstrate light an LED
13. Write an program to demonstrate the 7-segment display, button,switch with or without interrupt
14. Write a program to demonstrate I2C communication protocol , interface potentiometer, temperature sensors, PIR sensor, any physical sensor,
15 Write an arduino program for interfacing PWM pattern, servo motor, DC motor, AC motors

Mapping of Course Outcome With Program Outcomes

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PS O 1	PS O2	PSO3
CO1	3	3				1		1		1		1			1
CO2	3	2		1		1	1	1	1	1		1			1
CO3	3	2		1		1	1	1	1	1		1			1
CO4	3	1		1		1		1	1	1		1			1
CO5	3			1		1	1	1	1	1		1			1

1- Low 2 – Medium 3 - High

Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination & Viva Voce	05	05	05	05	05

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EEEPEC 3019: Machine Learning for Electrical Engineering			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs./Week	ISE I	: 15 Marks
Tutorial	: Nil	ISE II	: 15 Marks
Total Credits	: 3	ISE III	: 10 Marks
		End Semester Exam	: 60 Marks

The Course Objectives are to explore the students to:

1. Fundamental concepts, types, and applications of machine learning in the field of electrical engineering.
2. Supervised learning techniques for regression and classification problems.
3. Unsupervised learning methods such as clustering and dimensionality reduction, and their applications.
4. Evaluation and optimization of machine learning models using appropriate performance metrics and validation techniques.
5. Machine learning algorithms for solving real-world electrical engineering problems.

Course Outcomes: After successful completion of this course, students will be able to:

CO1	explain fundamental concepts of machine learning and its applications in electrical engineering
CO2	use supervised learning techniques in regression and classification problems
CO3	implement unsupervised learning algorithms for clustering and dimensionality reduction
CO4	execute performance evaluation metrics and optimize ML models
CO5	demonstrate the application of machine learning techniques to real-world electrical engineering problems

Detailed Syllabus:

Unit-I	Introduction to Machine Learning (6 Periods) ● Definition and Importance: Basics of machine learning, types (supervised, unsupervised, reinforcement learning). ● Applications in Electrical Engineering: Fault detection, load forecasting, predictive maintenance. ● ML Workflow: Data collection, preprocessing, model building, and evaluation. ● Tools and Libraries: Python libraries (NumPy, Pandas, Scikit-Learn).
Unit-II	Supervised Learning – Regression and Classification ● Regression Models: ○ Linear Regression ○ Multiple Linear Regression ○ Polynomial Regression ● Classification Models: ○ k-Nearest Neighbors (kNN) ○ Decision Trees ○ Support Vector Machine (SVM) • Applications in Electrical Engineering: **:** (To be covered in the practicals) ○ Power consumption prediction (regression) ○ Fault classification in power systems (classification)

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Unit-III	Unsupervised Learning – Clustering and Dimensionality Reduction ● Clustering Algorithms: ○ k-means clustering ○ Hierarchical clustering ● Dimensionality Reduction: ○ Principal Component Analysis (PCA) ○ Feature scaling and normalization ○ Applications in Electrical Engineering(Will be covered in practicals) ○ Customer segmentation in power distribution ○ Fault clustering in smart grids
Unit-IV	Reinforcement Learning (RL) ● Introduction to RL: ○ Definition and key concepts (agent, environment, state, action, reward). ○ Difference between RL and supervised/unsupervised learning. ● Basic RL Algorithms: ○ Q-Learning ○ Deep Q-Network (DQN) ○ Applications in Electrical Engineering(Will be covered in practicals) ○ DC Motor Control: Using RL to optimize motor speed control. ○ Power System Optimization: RL for energy management.
Unit-V	Model Evaluation and Optimization ● Performance Metrics: ○ Accuracy, Precision, Recall, F1-score ○ Confusion Matrix ● Model Optimization: ○ Cross-validation ○ Hyperparameter tuning (Grid Search, Random Search) • Real-World Applications in Electrical Engineering(Will be covered in practicals) ○ Improving accuracy of fault detection models ○ Optimizing parameters for power forecasting models ○ Load forecasting using regression models ○ Anomaly detection in power systems ○ Predictive maintenance of electrical equipment

NPTEL/SWAYAM Course:

1. NPTEL Course Name- Introduction to Machine Learning, Instructor-Prof. Balaraman Ravindran, Host Institute-IIT Madras
2. NPTEL Course Name- Machine Learning Instructor-Prof. Carl Gustaf Jansson, Host Institute-KTH, The Royal Institute of Technology

Text Books/Suggested References:

1. Introduction to Machine Learning, By Jeeva Jose, Khanna Book Publishing Co., 2020.
2. Machine Learning for Dummies, By John Paul Mueller and Luca Massaron, For Dummies, 2016.
3. Machine Learning, By Rajeev Chopra, Khanna Book Publishing Co., 2021.
4. Machine Learning: The New AI, By Ethem Alpaydin, The MIT Press, 2016.
5. Machine Learning, Tom M. Mitchell, McGraw Hill Education, 2017.

6. https://www.udacity.com/course/intro-to-machine-learning--ud120

7. https://www.coursera.org/learn/machine-learning-duke

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1		2	1	1	1	1	1		2		1	3
CO2	3	2	-		2	1		1	1	1		2		1	3
CO3	3	2	1		2	1	1	1	1	1		2		1	3
CO4	3	2	1		2	1		1	1	1		2		1	3
CO5	3	2	1		2	1	1	1	1	1		2		1	3

1 – Low 2 – Medium 3 – High

Sample Assessment Table:

Assessment Tool	K1+ K3+K4	K1+K2+K3	K1+K3+K4+K5	K1+K3+K4	K1+K2
Unit wise Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I 15 Marks	10	5			
ISE II 15 Marks		5	10		
ISE III 10 Marks	2	3	5	5	5
End Semester Exam 60 Marks	12	12	12	12	12

Teaching Strategies: The teaching strategy is planed through the lectures, tutorials, NPTEL lectures and home Assignments

ISE III Assessment: Is based on

Class Participation:25%

Class Attendance:25%

In-class Problems:25%

Class Test performance:25%

Sample Assessment Pattern:

Level No.	Knowledge Level	ISE I1	ISE II	ISE III Assessment	End Semester Examination
K1	Remember	5	5	2	**10**
K2	Understand	5	5	4	20
K3	Apply	5	5	4	30
K4	Analyze				
K5	Evaluate				
Total		15	15	Given above	60

Designed by Dr. N. J. Phadkule

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Dr. Anil Karwankar
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Approved Updated Curriculum in XXIXth Academic Council Meeting
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EEPC3020:Lab Machine Learning for Electrical Engineering	
Teaching Scheme Practical : 2 hrs/Week Tutorial : Nil Total Credits : 01	**Examination Scheme** ISE I : 25 marks ESE : 25 marks

Laboratory Course Outcomes:

As an outcome of completing the Laboratory course, students will able to:

CO1	Understand fundamental concepts, types, and applications of machine learning in electrical engineering.
CO2	Apply supervised learning techniques (regression and classification) for solving electrical engineering problems.
CO3	Implement unsupervised learning algorithms (clustering and dimensionality reduction) for data analysis.
CO4	Utilize **reinforcement learning** techniques for control and optimization in electrical systems.
CO5	Evaluate the performance of ML models using appropriate metrics and apply model optimization techniques.

List of Experiments:

Term-work shall consist of minimum eight experiments based on the following concept:

1. Linear Regression for Load Forecasting
2. k-Nearest Neighbors (kNN) for Fault Classification
3. Support Vector Machine (SVM) for Power Quality Disturbance Detection
4. k-means Clustering for Customer Segmentation in Power Distribution
5. Principal Component Analysis (PCA) for Feature Reduction
6. Decision Tree for Transformer Fault Classification
7. Reinforcement Learning for DC Motor Control
8. Hyper parameter Tuning and Cross-Validation

Students need to submit homework and projects via Google classroom.

Each submission must be an outcome of individual effort.

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
CO1	3	1			2	1		1		1		1		1	1
CO2	3	2		1	3	1	1	1	1	1		1		1	1
CO3	3	2		1	3	1	1	1	1	1		1		1	1
CO4	3	1		1	2	1		1	1	1		1		1	1
CO5	3			1	3	1	1	1	1	1		1		1	1

1 -Low 2 – Medium 3 - High

Sample Assessment Table:

Assessment Tool	S1	S1	S3	S2	S3
Course Outcomes	CO1	CO2	CO3	CO4	CO5
Term Work (25 Marks)	05	05	05	05	05
Practical Examination & Viva Voce					

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EEPEC3021 : Energized Irrigation Systems (Professional Elective IV)	
Teaching Scheme Lectures : 03 Hrs/Week Tutorial : 00 Total Credits : 3	**Examination Scheme** ISE I : 15 Marks ISE II : 15 Marks ISE III : 10 Marks End-Semester Exam : 60 Marks

Course Description: This course is designed to provide an in-depth understanding and analysis of various methodologies used in energized irrigation systems. It emphasizes the study of electrical distribution systems for agricultural power. Students will learn to manually calculate voltage regulation and losses for basic distribution systems, as well as utilize computerized analysis tools for practical applications. Additionally, the course will cover the calculations of water and energy requirements for different types of irrigation systems and crop patterns.

Course Objectives: The objectives of the course are to

1. Understand different methods of energized irrigation systems.
2. Analyze distribution system by manual calculations.
3. Use of computerized analysis tools for distribution systems.
4. Understanding the working of centrifugal pumps and various parameters related to it.
5. Analysis of water and energy requirements as per irrigation method and crop pattern.

Course Outcomes: After completing the course, students will able to

CO1.	Students shall be able to decide irrigation system requirements using field data.
CO2	Calculate voltage regulation and losses for the distribution system manually.
CO3	Create various scenarios of the distribution system and to use computerized tools for analysis of these distribution system scenarios.
CO4	Understand the working of centrifugal pumps and to perform calculations for pressure and friction head.
CO5	Workout energy and water requirement for an area of interest.

Detailed Syllabus:

Unit-I	**Introduction to Energized Irrigation Systems:** Different types of energized irrigation systems. Field utilization of these irrigation systems.
Unit-II	**Electrical Distribution Systems for Agriculture** Draw the SLD of the HV and LV distribution system for agricultural power. Calculate voltage regulation and losses of the distribution system. GPS plotting of the distribution system.
Unit-III	**Computerized Tools for analysis of distribution system:** Use of computerized tools for analysis of distribution systems. Creating different scenarios of the distribution system and use of these analyzing tools.
Unit-IV	**Centrifugal pumps:** Different types of centrifugal pumps and its working. Calculating static and friction head and discharge of the pump. Calculating pump efficiency.

Unit-V	**Energy and water requirement:** Irrigation systems used for different crops and water requirements. Calculating energy requirement as per crop pattern.

Text and Reference Books:

Notes provided by IIT-B

Mapping of Course outcome with program outcomes:

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1		1	1	1	1
CO2	3	2	2	1	1	1	1	1	1	1		1	1	1	1
CO3	3	2	1	1		1	1	1	1	1		1	1	1	1
CO4	3	2	1	1		1		1	1	1		1	1		
CO5	3	2	1	1		1	1	1	1	1		1	1	1	1

1- Low 2- Medium 3- High

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K1 to K6	K1 toK6
Course outcomes	CO1	CO2	CO3	CO4	CO5
ISE I 15 Marks	10	5	10	05	
ISE III Assessment 15 Marks			5	5	
ESE Assessment 60 Marks	12	12	12	12	12

ISE I , II are compulsory tests

ISE III Assessment: Teacher's Assessment is based on one of the following.1. Assignments, 2. Models/ Presentations, 3. multiple choice questions test, 4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	Test		Teachers Assessment /Assignment	End Semester Examination
K1	Remember	5			5
K2	Understand	5	5		5
K3	Apply		5		10
K4	Analyze				10
Total		10	10		30

Designed by Shri S. P. Vasekar and Dr. S. M. Shinde

EEPEC 3022 :Optimization Techniques (Professional Elective IV)	
Teaching Scheme Lectures : 03 Hrs/Week Tutorial : 00 Total Credits : 03	**Examination Scheme** ISE I : 15 Marks ISE II : 15 Marks ISE III : 10 Marks End -Semester Exam : 60 Marks

Course Description: Electrical Power Systems is growing at a faster pace. An Electrical Engineer should be able to solve the optimization problems in electrical engineering. This course is aimed to cover the fundamentals of LPP and NLPP optimization techniques for solving engineering problems.

Course Objectives: The objectives of the course are to

1. Introduce the fundamental concepts of Optimization Techniques;
2. Make the learners aware of the importance of optimizations in real scenarios;
3. Provide the concepts of various classical and modern methods for constrained and unconstrained problems in both single and multivariable.

Course Outcomes : After completing the course, students will able to:

CO1	Formulate optimization problems as mathematical programming problems
CO2	Solve various constrained and unconstrained problems in single variable as well as multivariable
CO3	Choose a suitable technique to solve a particular type of optimization problem.
CO4	Analyze and apply Evolutionary algorithms to find global optimum of linear and nonlinear optimization problems in real life situation
CO5	Analyze and apply the suitable optimization techniques for solving problems in Electrical engineering

Detailed Syllabus:

Unit 1	Introduction: Concept of optimization and classification of optimization techniques, formation of optimization problems Linear Programming : Standard form of LPP Simplex Method of solving LPP, duality, decomposition principle, transportation problem and application of LPP to Electrical Engineering
Unit 2	Non-Linear Problem (NLP) : One dimensional methods, Elimination methods, Interpolation methods, Unconstrained optimization techniques-Direct search and Descent methods, constrained optimization techniques, direct and indirect methods
Unit 3	Dynamic Programming: Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem.
Unit 4	Introduction to Multi objective Optimization, Evolutionary algorithms for optimization and search such as Genetic Algorithm, Swarm based Optimization techniques

Unit 5	Applications in Electrical Engineering.: Economic Load Dispatch in thermal and Hydro-thermal systems Unit commitment problem, reactive power optimization. Optimal power flow, applications in control systems etc.

Text and Reference Books

1. S.S.Rao, "Optimization - Theory and Applications", Wiley-Eastern Limited.
2. David G. Luenberger, "Introduction of Linear and Nonlinear Programming ", Wesley Publishing Company
1. Polak, "Computational methods in Optimization", Academic Press. Pierre D.A, "Optimization Theory with Applications", Wiley Publications.
4 .Kalyanmoy deb, "Optimization for Engineering Design: Algorithms and Examples", Kalyanmoy deb, PHI Publication.
5. .D.E. Goldberg & Addision, "Genetic Algorithm in Search Optimization and Machine Learning ", Wesley Publication, 1989
6. L.P. Singh, "Advanced Power System Analysis and Dynamics", Wiley Eastern Limited.
7. Hadi Saadat "Power System Analysis ", TMH Publication.
8. Olle I.Elewgerd " Electrical Energy System : An Introduction", TMH Publication, New Delhi.

ISE III Assessment: It is based on attendance of the student and one of the / or combination of few of following. However, the course coordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulation problems
4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	Test	Teachers Assessment/ Assignment	End Semester Examination
K1	Remember	5	10	10
K2	Understand	10	10	20
K3	Apply	5		30
Total Marks 100		20	20	60

Sample Assessment table :

Assessment Tool	K1+K2+ K3	K1+K2+ K3	K1+ K2	K2	K1+K3
	CO1	CO2	CO3	CO4	CO5
ISE I, II (30 Marks)	10	5	5		
ISE III Assessment (10 Marks)				10	10
ESE Assessment (60 Marks)	10	20	10	10	10

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EEPEC 3023 :Utilization of Electrical Energy (Professional Elective IV)			
Teaching Scheme		**Examination Scheme**	
Lectures	: 03 Hrs/Week	ISE I	: 15 Marks
Tutorial	: 00	ISE II	: 15 Marks
Total Credits	: 03	ISE III	: 10 Marks
		End -Semester Exam	: 60 Marks

Course Objectives:

The objectives of the course are to

1. Understand laws of illumination and different lighting schemes
2. Understand different heating methods employed in various industries such as steel, wood and plastic, different types welding methods used in industries, at construction sites and domestic purposes as well
3. Define Electrolytic processes
4. Understand existing traction systems in India
5. Understand different services such as urban, sub-urban and mainline rail traffic

Course Outcomes:

After completing the course, students will able to

CO1	Explain laws of illumination for different lighting schemes
CO2	describe different heating methods employed in various industries and domestic purposes as well
CO3	explain Electrolytic processes
CO4	describe existing traction systems in India
CO5	evaluate different traction specifications like specific energy consumption etc

Detailed Syllabus

Unit-I	**Illumination:** Introduction, Definition, Laws of illumination, coefficient of utilization and depreciation, Polar curves, Photometry, Artificial sources of light ,Incandescent lamps, Arc lamps, Discharge lamps, filament lamps, fluorescent tubes, comparison between filament lamps and fluorescent tube, Compact fluorescent lamps, LED lamps, Principles of light control, Types and design of lighting schemes, lighting calculations, factory lighting, street lighting and flood lighting.
Unit-II	**Electrical Heating & Welding:** Electrical Heating**:** Introduction, Advantages, Modes of transfer of heat, Methods of electrical heating, Resistance heating, Induction heating, Dielectric heating, High frequency heating, Causes of feeler of heating elements. Electric Welding: Introduction, Advantages, Disadvantages of welding, Resistance welding, Electric arc welding, Choice of welding time, Submerged arc welding, Electron beam welding, Laser beam welding, Types of welding electrodes, Comparison between resistance & arc welding, Electrical welding equipment, comparison between AC & DC welding. Problems on heating and welding

Unit-III	**Electrolytic Process and Air conditioning and refrigeration:** Electrolytic Process: Introduction, Principle of electrolysis, Laws of electrolysis, Application of electrolytic process- electroplating, metal extraction and metal processing, electromagnetic stirs, Power supply for electrolysis process. Air conditioning and refrigeration: function of complete air conditioning system - types of compressor motor. Cool storage - estimation of tonnage capacity and motor power. Water Coolers- Control of temperature. simple heat load calculations.
Unit-IV	**Electrical Traction I :** Introduction, Heavy of existing electrical traction system in India, System of traction, System of track electrification, Comparison between DC & AC traction, Special features of traction motors, Different type of traction motor, Braking, Overhead & auxiliary equipment.
Unit-V	**Electrical Traction II :** Introduction, Types of services, Speed time & speed distance curves for different services, Definition crest speed, Average speed, Schedule time, Dead weight, Accelerating weight, Adhesive weight, Coefficient of adhesion. Factors affecting schedule speed of train, Traction efforts, and specific energy conservation.

Text and Reference Books:

1. Jack L. Lindsey, "Applied Illumination Engineering", Second Edition, The Fairmont Press Publishers
2. C. L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", 10th Edition, New Academic Science Publishers
3. S.V.Suryanarayana, "Utilization of Electric Power Electric Traction", New Age International
4. R. K. Rajput, “Utilization of Electrical Power”, Laxmi Publications
5. E. O. Taylor, "Utilization of Electric Energy", SI Edition, Orient Longman PVT Ltd,2006

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2				1						1	1		
CO2	3	2				2						1	1	1	
CO3	3	2				2						1	1	1	
CO4	3	2				2						1	1	1	
CO5	3	2				2						1	1	1	

Mapping of Course Outcome with Program Outcomes :

1- Low 2- Medium 3- High

Sample Assessment Table:

Assessment Tool	K1+K2+K3	K1+K2+K3	K2+K3	K1 to K6	K1 to K6
Course outcomes	CO1	CO2	CO3	CO4	CO5
Class Test 30 Marks	8	7	8	7	
Teachers Assessment 10 Marks	2	2	2	2	2
ESE Assessment 60 Marks	12	12	12	12	12

ISE III **Assessment:** Teacher’s Assessment is based on one of the following.

1. Assignments, 2 Models/ Presentations, 3. Multiple choice questions test, 4. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	Test		Teachers Assessment /Assignment	End Semester Examination
K1	Remember	5	5	2	10
K2	Understand	5	5	2	20
K3	Apply	5	5	3	20
K4	Analyze			3	10
K5	Evaluate				
Total		15	15	10	60

Designed by
Dr. Sunanda Ghanegaonkar

EEPEC 3024: Electrical and Hybrid Vehicles (Professional Elective IV)	
Teaching Scheme Lectures : 03 Hrs/Week Tutorial : 00 Total Credits : 03	Examination Scheme ISE I : 15 Marks ISE II : 15 Marks ISE III : 10 Marks End -Semester Exam : 60 Marks

Course Description: This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. Various aspects of hybrid and electric vehicles such as their configuration, types of electric machines that can be used, energy storage devices, etc. will be covered in this course.

Course Objectives:

The objectives of the course are to introduce and explain:

1. The concepts of electrical vehicles and their operation.
2. The basic components of the EV and their design.
3. Power converters & energy storage devices for electrical vehicles

Course Outcomes:

After completing the course, students will able to:

CO1	List the need, components of conventional, electrical vehicles and HEV.
CO2	Calculate the different forces acting on vehicles
CO3	Analyze the various converters used in Electrical and hybrid vehicles
CO4	Identify the different machines used in Electrical and hybrid vehicles
CO5	Explain different Energy Storage options for the Electric and hybrid vehicles

Detailed Syllabus:

Unit 1	History of Conventional and electric vehicle, Components of conventional Internal combustion engine and Electric Vehicle, Energy Scenario of world and India, world market of EV, Environmental impact of vehicle, , General Layout of EV, EV classification, Technology, Advantages & Disadvantages of EV, Overview of Tesla car. Concept of Hybrid electric vehicle (HEV), Components and General Layout of Hybrid EV, Advantages & Disadvantages of Hybrid EV, Introduction to various hybrid drive-train concept, power flow control in hybrid drive-train topologies and their classifications
Unit-II	Dynamics of Vehicles: Forces acting on Vehicle: Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag vehicle performance, Calculating The Acceleration Force, maximum speed, Finding The Total Tractive Effort, Torque Required On The Drive Wheel, Transmission: Differential, clutch & gear box, Braking performance.
Unit-III	Power Converters- DC-DC converters for EV and HEV applications, DC-AC converters in EV & HEV

Unit-IV	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switched Reluctance Motor drives, drive system efficiency.
Unit-IV	Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Text and Reference Books

1. C.C. Chan and K.T. Chau, *Modern Electric Vehicle Technology*, Oxford University Press.
2. James Larminie, John Lowry, "Electric Vehicle Technology Explained", WIELY USA, 2012.
3. Electric Cars The Future is Now!: Your Guide to the Cars You Can Buy Now and What the Future Holds, by ArvidsLinde, Veloce Publishing,2010.
4. Mehrdad Ehsani, YiminGao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", Second Edition (Power Electronics and Applications Series) by CRC Press, 2009
5. Iqbal Husain, "Electric and Hybrid Vehicles – Design Fundamentals," CRC Press, 2010
6. https://www.niti.gov.in/sites/default/files/202108/HandbookforEVChargingInfrastructure Implementation081221.pdf
7. https://e-amrit.niti.gov.in/reports-and-articles **Brookes University, Oxford, UK, 2003**

Mapping of Course outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO 13	PO 14	PO 15
CO1	3	1	2			2	3	2	2	2		2	2		
CO2	3	1	2			2	3	2	2	2		2		3	2
CO3	3	1	2			2	3	2	2	2		2		3	
CO4	3	2	2			2	3	2	2	2		2			
CO5	3	1	2			2	3	2	2	2		2	2	2	1

1 – Low 2 – Medium 3 – High

ISE III Assessment: Teachers Assessment of 10 marks is based on attendance of the student and one of the / or combination of few of following. However, the course coordinator has announced assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. MCQ
3. Simulations problems
1. Quiz

Sample Assessment Pattern:

Assessment Pattern Level No.	Knowledge Level	Class Test I	Class Test II	Teachers Assessment/ Assignment	End Semester Examination
K1	Remember	05	05	05	20
K2	Understand	10	10	05	40
K3	Apply				
K4	Analyze	-	-		-
	Total Marks: 100	15	15	10	60

Sample Assessment Table:

Assessment Tool	K1+K2	K1+K2	K1+ K2	K1+K2	K1+K2
	CO1	CO2	CO3	CO4	CO5
ISE I (15 Marks)	7.5	7.5	-	-	-
ISE II (15 Marks)	-	-	7.5	7.5	-
ISE III Assessment (10 Marks)	02	02	02	02	02
ESE Assessment (60 Marks)	12	12	12	12	12

Designed by Prof. M S Morey