PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF SCIENCE& TECHNOLOGY

NEP 2020 Complaint Curriculum for Electrical Engineering
With effect from 2023-24

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Engineering & Technology
B. Tech (Electrical Engineering)
PROGRAMME: BACHELOR OF ELECTRICAL ENGINEERING
PROGRAMME OBJECTIVES

A. PROGRAM EDUCATIONAL OBJECTIVES

1. Deliver fundamental as well as advanced knowledge with research initiatives in the field of electrical engineering with emphasis on state-of-the-art technology.
2. Graduates will demonstrate measurable progress in the fields they choose to pursue.
3. Design and develop technically feasible solutions for real world applications which are economically viable leading to societal benefits.
4. To nurture Graduates to be sensitive for ethical, societal and environmental issues while conducting their professional work.

B. PROGRAMME OUTCOMES

Students attain the following 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 system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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 prediction 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 the consequent responsibilities relevant to the professional engineering practice.

7 **Environment and sustainability:** Understand the impact of the 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 in multidisciplinary settings.

10 **Communication:** 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 documentation, 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 and in multidisciplinary environments.

12 **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

C. PROGRAMME SPECIFIC OUTCOMES

1 An ability to specify, design and analyze Power System, Electrical Machinery, Electronic Circuits, Drive Systems, Lightning Systems and deliver technological solution by adapting advances in allied disciplines.

2 Apply knowledge of electrical engineering to meet the desired needs within realistic constraints viz. economical, ethical, and environmental and safety.

3 Apply modern software tools for design, simulation and analysis of electrical systems to successfully adapt in multi-disciplinary environments.

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NEP 2020 Compliant Curriculum

With effect from 2023-2024

Semester I (Common for All Engineering Branches)

Course Type	*Course Code*	*Name of the Course*	*Engagement Hours*		*Credits*	*FA*	*SA*		*Total*
			L	*P*		*ESE*	*ISE*	*ICA*	
BSC	BS-01/ BS-02	Engineering Physics / Engineering Chemistry $	3	2	4	70	30	25	125
	BS-03	Engineering Mathematics-I	3	2	4	70	30	25	125
ESC	ES-01/ ES-02	Basics of Civil and Mechanical Engineering /Basic Electrical & Electronics Engineering $	3	2	4	70	30	25	125
	ES-03	Engineering Mechanics	3	2	4	70	30	25	125
AEC	AE-01	Communication Skills	1	2	2		25	25	50
CC	CC-01	Sports and Yoga or NSS/NCC/UBA (Liberal Learning Course-I)	1	2	2			25	25
SEC	SE-01	Workshop Practices		2	1			25	25
		Total	**14**	**14**	**21**	**280**	**145**	**175**	**600**
		Student Induction Program**							

Semester II (Common for All Engineering Branches)

Course Type	*Course Code*	*Name of the Course*	*Engagement Hours*		*Credits*	*FA*	*SA*		*Total*
			L	*P*		*ESE*	*ISE*	*ICA*	
BSC	BS-01/ BS-02	Engineering Physics / Engineering Chemistry $	3	2	4	70	30	25	125
	BS-04	Engineering Mathematics – II	3	2	4	70	30	25	125
ESC	ES-01/ ES-02	Basics of Civil and Mechanical Engineering / Basic Electrical & Electronics Engineering $	3	2	4	70	30	25	125
		Engineering Graphics and CAD		4	2		25	50	75
SEC	SE-02	Data Analysis and Programming Skills	1	2	2		25	25	50
CC	CC-02	Professional Personality Development (Liberal Learning Course-II)	1	2	2		25	25	50
IKS	IKS-01	Introduction to Indian Knowledge System	2		2		25	25*	50
		Total	**13**	**14**	**20**	**210**	**190**	**200**	**600**
		Democracy, Elections and Good Governance *	**1**			**50**			

***For IKS activity report should be submitted**

BSC- Basic Science Course, ESC- Engineering Science Course, PCC- Programme Core Course ,

AEC- Ability Enhancement Course, IKS- Indian Knowledge System, CC- Co-curricular Courses ,

VSEC-Vocational and Skill Enhancement Course

- Legends used–

L	Lecture	FA	Formative Assessment
T	Tutorial	SA	Summative Assessment
P	Lab Session	ESE	End Semester Examination
		ISE	In Semester Evaluation
		ICA	Internal Continuous Assessment

- **Notes-**

1. $ - Indicates approximately half of the total students at F. Y. will enroll under Group A and the remaining will enroll under Group B.

   Group A will take up the course of Engineering Physics (theory & laboratory) in Semester I and will take up the course of Engineering Chemistry (theory & laboratory) in semester II.

   Group B will take up the course of Engineering Chemistry (theory & laboratory) in Semester I and will take up the course of Engineering Physics (theory & laboratory) in semester II.

2. # - For the Course (C113) Basic Electrical & Electronics Engineering, Practical's of Basic Electrical Engineering and Basic Electronics Engineering will be conducted in alternate weeks.

3. @ - For the Course (C113) Basics of Civil and Mechanical Engineering, Practical's of Basics of Civil Engineering and Basics of Mechanical Engineering will be conducted in alternate weeks.

4. In Semester Evaluation (ISE) marks shall be based upon the student's performance in a minimum of two tests & mid-term written test conducted & evaluated at the institute level.

   Internal Continuous Assessment Marks (ICA) are calculated based on student's performance during laboratory sessions/tutorial sessions.

5. *- Democracy, Elections & Good Governance is a mandatory course. The marks earned by students in this course shall not be considered for the calculation of SGPA/CGPA. However, the student must complete the End Semester Examination (ESE) of 50 marks (as prescribed by the university) for fulfillment of this course. This course is not considered a passing head for counting passing heads for ATKT. However, students must pass this subject for the award of the degree.
6. Students must complete an induction program of a minimum of five days before the commencement of the regular academic schedule in the first semester.

** GUIDELINES FOR INDUCTION PROGRAM (C119)

New entrants into an Engineering program come with diverse thoughts, mind set and different social, economic, regional and cultural backgrounds. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose.

An induction program for the new UG entrant students is proposed at the commencement of the first semester. It is expected to complete this induction program before commencement of the regular academic schedule.
Its purpose is to make new entrants comfortable in their new environment, open them up, set a healthy daily routine for them, create bonding amongst the peers as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.
The Induction Program shall encompass (but not limited to) below activity –

1. Physical Activities
2. Creative Arts
3. Exposure to Universal Human Values
4. Literary Activities
5. Proficiency Modules
6. Lectures by Experts / Eminent Persons
7. Visit to Local Establishments like Hospital /Orphanage
8. Familiarization to Department

Induction Program Course do not have any marks or credits however performance of students for Induction Program is assessed at institute level using below mandatory criteria –

1. Attendance and active participation
2. Report writing

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W.E.F. 2024-25 ***Semester III***

Distribution	***Course Code***	***Theory Course Name***	***Hrs./week***			***Credits***	***Examination Scheme***				
			L	***T***	***P***		***ESE***	***ISE***	***ICA***	***OE/POE***	***Total***
PCC	EEPCC-01	Analog Electronics	3			03	70	30			100
PCC	EEPCC-02	Power Plant Engineering and Elements of Power System	3			03	70	30			100
PCC	EEPCC-03	DC Machines and Transformer	3		2	04	70	30	25	25	150
CEP/FP	EEFP-01	Laboratory on Power Plant Engineering and Elements of Power System			2	01			25	25	50
CEP/FP	EEFP-02	Electrical Workshop			2	01			25	25	50
Entrepreneurship	EM-01	Product Development & Entrepreneurship	1	1		02		50	25		75
OE	OE-01	Open Elective -I	2		2	03	70	30	25		**125**
MDM	MDM-01	Multidisciplinary Minor -I	2		2	03	70	30	25		**125**
VEC	VEC-01	Universal Human Values	1		2	02	50*		25		**75**
	Total		**15**	**1**	**12**	**22**	**400**	**200**	**175**	**75**	**850**
	VEC-01	**Environmental Science**	**1**								

***For VEC-01(Universal Human Values) MCQ-based examination to be conducted. The red colour indicates activities that are connected with other programs**

PCC- Programme Core Course, PEC-Programme Elective Course, AEC - Ability Enhancement Course, IKS- Indian Knowledge System, CC- Co-curricular Courses, VSEC-Vocational and Skill Enhancement Course, FP- Field Project/ CEP – Community Engagement Program MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme.

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W.E.F. 2024-25 ***Semester IV***

Distribution	***Course Code***	***Theory Course Name***	***Hrs./week***			***Credits***		***Examination Scheme***			
			L	***T***	***P***		***ESE***	***ISE***	***ICA***	***OE/POE***	***Total***
PCC	EEPCC-04	Electrical Transmission and Distribution	3			03	70	30			100
PCC	EEPCC-05	Network Analysis	2		2	03	70	30	25		125
PCC	EEPCC-06	AC Machines	3		2	04	70	30	25	25	150
SEC	EESEC-01	Computer Aided Design and Simulation	1		2	02			25	25	50
Economics/ Managements	EM-02	Project management economics	2			02		25	25		50
OE	OE-02	Open Elective -II	**2**		**2**	**03**	**70**	**30**	**25**		**125**
MDM	MDM-02	Multidisciplinary Minor -II	**2**		**2**	**03**	**70**	**30**	**25**		**125**
VEC	VEC-02	Professional Ethics	**1**		**2**	**02**	**50***		**25**		**75**
	Total		**16**		**12**	**22**	**400**	**175**	**175**	**50**	**800**
	Environmental Science		**1**				**40**	**10**			**50**

VEC-02 (Professional Ethics) Examination will be MCQ based

SEC- Skill Enhancement Course, PCC- Programme Core Course, VSEC-Vocational and Skill Enhancement Course

AEC- Ability Enhancement Course, EM Economice/ Managements, CC- Co-curricular Courses,

MDM-Multidisciplinary Minor: It should from other UG Engineering Minor Programme..

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W.E.F. 2025-26 ***Semester V***

Distribution	***Course Code***	***Name of the Course***	***Engagement Hours***			***Credits***	***FA***	***SA***			***Total***
			L	***T***	***P***		***ESE***	***ISE***	***ICA***	***OE/ POE***	
PCC	EEPCC-07	Electromagnetic Engineering	3			03	70	30			100
PCC	EEPCC-08	Power System Analysis	3		2	04	70	30	25		125
PCC	EEPCC-09	Linear Control System	3		2	04	70	30	25	25	150
PEC	EEPEC-01	Programme Elective Course-I	3		2	04	70	30	25		125
AEC	AEC-02	Creativity and Design Thinking	1		2	02	50*		25		75
OE	OE-03	Interdisciplinary Mini Project	**1**		**2**	**02**			**25**	**25**	**50**
MD M	MDM-03	MD Minor-III	**2**		**2**	**03**	**70**	**30**	**25**		**125**
		Total	**16**		**12**	**22**	**400**	**150**	**150**	**50**	**750**

* MCQ examinations
PEC- Program Elective Course, PCC- Programme Core Course, VSEC-Vocational and Skill Enhancement Course
AEC- Ability Enhancement Course, IKS- Indian Knowledge System, CC- Co-curricular Courses,
MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme.

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W.E.F. 2025-26 ***Semester VI***

Distribution	***Course Code***	***Name of the Course***	***Engagement Hours***			***Credits***	***FA***	***SA***			***Total***
			L	***T***	***P***		***ESE***	***ISE***	***ICA***	***OE/POE***	
PCC	EEPCC-10	Electric Traction & Utilization	2			02	70	30			100
PCC	EEPCC-11	Power Electronics & Industrial Drives	3		2	04	70	30	25	25	150
PCC	EEPCC-12	Advanced Control System	2		2	03	70	30	25		125
PEC	EEPEC-02	Program Elective Course-II	3		2	04	70	30	25	25	150
PEC	EEPEC-03	Program Elective Course-III	3	01		04	70	30	25		125
SEC	SEC-04	Mini Project on Industrial Applications			**4**	**02**			**25**	**50**	**75**
MDM	MDM-04	Multidisciplinary Minor-IV	**2**		**2**	**03**	**70**	**30**	**25**		**125**
		Total	**15**	**01**	**12**	**22**	**420**	**180**	**150**	**100**	**850**

PEC- Program Elective Course, PCC- Programme Core Course, SEC- Skill Enhancement Course
AEC- Ability Enhancement Course, IKS- Indian Knowledge System, CC- Co-curricular Courses,
MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme.

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Faculty of Engineering & Technology

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W.E.F. 2026-27 ***Semester VII***

Distribution	***Course Code***	***Name of the Course***	***Engagement Hours***			***Credits***	***FA***	***SA***			***Total***
			L	***T***	***P***		***ESE***	***ISE***	***ICA***	***OE/POE***	
PCC	EEPCC-13	Power Quality & FACTS	3			03	70	30			100
PCC	EEPCC-14	Switchgear & Protection	2		2	03	70	30	25		125
PEC	EEPEC-04	Programme Elective Course – IV or MOOCS	##4			04	100				100
Project	Project	Capstone Project			8*	04			100	100	200
RM	RM	Research Methodology and IPR	**3**		**2**	**04**	**70**	**30**	**25**		**125**
MD M	MDM-05	Multidisciplinary Minor-V	**2**			**02**	**70**	**30**			**100**
		Total	**14**		**12**	**20**	**350**	**150**	**175**	**125**	**800**

Students should attend MOOCS in that 4 Hrs. * Academic Load based on project groups
PEC- Program Elective Course, PCC- Programme Core Course, SEC- Skill Enhancement Course
AEC- Ability Enhancement Course, IKS- Indian Knowledge System, CC- Co-curricular Courses,
MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme.

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Faculty of Engineering & Technology
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W.E.F. 2026-27 ***Semester VIII***

Distribution	***Course Code***	***Name of the Course***	***Engagement Hours***			***Credits***	***FA***	***SA***			***Total***
			L	***T***	***P***		***ESE***	***ISE***	***ICA***	***OE/POE***	
PCC	PCC-15	Electrical Energy Audit and Management	4#			04	100				100
PEC	PEC-05	Programme Elective Course –V or MOOCS	4#			04	100				100
OJT	OJT	On-Job Training			**24**	**12**			**200**	**100**	**300**
		Total	**8**		**24**	**20**	**200**		**200**	**100**	**500**

Self-learning Technical # Students will practice or attend in Self-Learning mode. *List of mooc Courses related to Electrical PEC-04 & 05will be provided by BOS time to time

BSC- Basic Science Course ESC- Engineering Science Course, PCC- Programme Core Course,
AEC- Ability Enhancement Course, IKS- Indian Knowledge System, CC- Co-curricular Courses,
VSEC-Vocational and Skill Enhancement Course

Basket of Programme Elective Course (PEC)

PEC/Sem	Course code and name
EEPEC - 01/ V	EEPEC – 01A: Advanced Microcontroller Systems EEPEC – 01B: Advanced Electrical Machines EEPEC – 01C: Hybrid Electrical Vehicle Design
EEPEC - 02/ VI	EEPEC – 02A: Power System Operation and Control EEPEC – 02B: Electrical Machine Design EEPEC – 02C: Programmable Logic Control and SCADA
EEPEC - 03/ VI	EEPEC – 03A: Smart Grid Technology EEPEC – 03B Extra High Voltage AC Transmission EEPEC – 03C Energy Storage System EEPEC – 03D: Signal & System
EEPEC - 04/ VII OR	EEPEC – 04A: Electrical Estimation, Installation, and Testing EEPEC – 04B Mechatronics EEPEC – 04C: Neural Networks & Fuzzy Logic Control EEPEC – 04D: Digital Signal Processing
EEPEC - 04/ VII	MOOC Courses (As per the list provided by BOS)
EEPEC - 05/ VIII OR	EEPEC – 05A: High Voltage Engineering EEPEC – 05B: Instrumentation Process Control & Robotics EEPEC – 05C: Advanced Applications in Solar Energy Technology
EEPEC - 05/ VIII	MOOC Courses

Please identify two to three course baskets as above which students will opt for semester-wise PECs to develop expertise in the specific area.

A) Multidisciplinary Minor (MDM) in "Sustainable Energy System "

Semester	Course Code	Course Title
III	EEMDM-01A	Electrical Technology
IV	EEMDM-02A	Advanced Application in renewable Energy
V	EEMDM-03A	Electrical Installation and Utilization
VI	EEMDM-04A	Energy Audit, Conservation Economics and Policy
VII	EEMDM-05A	Energy Storage Systems

Multidisciplinary Minors are for the students of Other Program

B) Multidisciplinary Minor (MDM) in "Electric Vehicle Systems"

Semester	Course Code	Course Title
III	EEMDM-01B	Basics of Electric Vehicle
IV	EEMDM-02B	Electrical Vehicle Motors
V	EEMDM-03B	Electric Vehicle Controls
VI	EEMDM-04B	Electric Vehicle Battery Systems
VII	EEMDM-05B	AI & Cloud Computing in Electric Vehicle

Multidisciplinary Minors are for the students of Other Program

A. Honors in **Electrical Vehicle**

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*		*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	
III	EEHn-01A	Electric Vehicle Technology	3		2	4	70	30	25	125
IV	EEHn-02A	Electric Motors and Controls for Electric Vehicle	3	1		4	70	30	25	125
V	EEHn-03A	Energy Management System for Electric Vehicle	3		2	4	70	30	25	125
VI	EEHn-04A	Testing And Certification of Electric And Hybrid Vehicles	3		2	4	70	30	25	125
VII	EEHn-05A	Mini Project			4*	2			50	50
		Total	**12**	**1**	**10**	**18**	**280**	**120**	**150**	**550**

* Indicates Contact Hours

Honors Course will be for the students of same Program

B. Honors in **Sustainable Power System**

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*		*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	
III	EEHn-01B	Advanced and Sustainable Energy Sources	3		2	4	70	30	25	125
IV	EEHn-02B	Smart Energy Management System	3	1		4	70	30	25	125
V	EEHn-03B	Distributed Energy Integration	3		2	4	70	30	25	125
VI	EEHn-04B	AI Applications To Power Systems Management	3		2	4	70	30	25	125
VII	EEHn-05B	Mini Project			4*	2			50	50
		Total	**12**	**1**	**10**	**18**	**280**	**120**	**150**	**550**

*Indicates Contact Hours

Honors Course will be for the students of same Program

Honors with Research

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*	*Credits*	*SA*		*Total*
			P		***ICA***	***OE***	
VII	EERES-01	Research Project Phase-01	9 #	9	100	100	200
VIII	EERES-01	Research Project Phase-02	9 ##	9	100	100	200
		Total	18	18	200	200	400

Along with 9 hours of engagement hours, 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc.

Along with 9 hours of engagement hours 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc. and independent reading during Project Phase 2 and preferably related to Project Phase 2 activities.

These Courses are open for students of all the UG Engineering Program. However, Paper setting and evaluation responsibilities are assigned as follows:

Sr. No.	List of Open Electives	Responsible BOS	
1.	OE-01A: Advanced Mathematics and Statistics	General Engineering	**Semester III**
2.	OE-01B Digital Marketing and E-Commerce	Mechanical Engineering	
3.	OE-01C Humanities and Social Sciences	General Engineering	
4.	OE-01D Industrial and Quality Management	Mechanical Engineering	
5.	OE-01E Mathematics for Software and Hardware Applications	Electrical Engineering	
6.	OE-01F Soft Skills and Personality Development	General Engineering	

Sr. No.	List of Open Electives	Responsible BOS	
1.	OE-02A Entrepreneurship and Innovation	Civil Engineering	
2.	OE-02B Environmental Sustainability	Civil Engineering	
3.	OE-02C Renewable Energy	Civil Engineering	
4.	OE-02D Measurement, Instrumentation & Sensors	Electrical Engineering	
5.	OE-02 E Operation Research	Mechanical Engineering	**Semester IV**
6.	OE-02F Computational Mathematics	General Engineering	
7.	OE-02 G Professional Business Communication	General Engineering	

List of Open Electives 01 (Semester –III)

1. **OE-01A: Advanced Mathematics and Statistics**
2. **OE-01B Digital Marketing and E-Commerce**
3. **OE-01C Humanities and Social Sciences**
4. **OE-01D Industrial and Quality Management**
5. **OE-01E Mathematics for Software and Hardware Applications**
6. **OE-01F Soft Skills and Personality Development**

List of Open Electives 02 (Semester –IV)

1. **OE-02A Entrepreneurship and Innovation**
2. **OE-02B Environmental Sustainability**
3. **OE-02C Renewable Energy**
4. **OE-02D Measurement, Instrumentation and Sensors**
5. **OE-02E Operation Research**
6. **OE-02F Computational Mathematics**
7. **OE-02G Professional Business Communication**

Open Electives 03 (Semester –V)

1. **Interdisciplinary Mini Project**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Subject: Electrical Engineering

Name of the Course: S.Y. B. Tech

(Syllabus to be implemented from w. e. f. June 2024)

SEMESTER -I

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
S. Y. B. Tech. Electrical Engineering
Semester-I
(EEPCC-01) Analog Electronics

Teaching Scheme
Theory– 3 Hrs. /Week, 3 Credits

Examination Scheme
ESE-70 Marks
ISE- 30 Marks

This course introduces the diodes, transistors and Operational Amplifier (Op-amp), its application.

Course Prerequisite:

Basics of diodes, BJT amplifier, Frequency response of amplifier, differential amplifiers and Op Amp.

Course Objectives:

- To develop conceptual understanding of diode and Bipolar Junction Transistor (BJT)
- To Course analyze the frequency response of BJT
- To develop conceptual understanding of Field effect transistors
- To define the specification and parameters of Op-amp
- To analyze configurations of operational amplifier
- To make student understand the op-amps applications

Course Outcome:

After successful completion of this course-

- Students will be able to develop conceptual understanding of diode and Bipolar Junction Transistor (BJT)
- Students will be able to analyze the frequency response of BJT
- Students will be able to develop conceptual understanding of Field effect transistors
- Students will be able to define the specification and parameters of Op-amp
- Students will be able to analyze configurations of operational amplifier
- Students will be able to use op-amp for different electronic applications

SECTION-I

Unit 1 Semiconductor Devices and their applications (08 Hrs.)

- **Prerequisite:**

Semiconductor diodes, BJT, KVL-KCL

- **Objective:**

To develop conceptual understanding of diodes and Bipolar Junction Transistor (BJT)

- **Outcomes:**

After completing this unit-
Students will be able to understand diode and transistor-based circuits

- **Unit Content:**

Semiconductor Diodes- Zener diode, LED (construction, operation, V-I Characteristics and applications), Applications of diodes as clippers and clampers.

Bipolar Junction Transistor (BJT) – BJT as an Amplifiers-BJT Configurations CB, CE and CC,

DC analysis-load line, thermal runaway, stability factor (no derivation), biasing circuits and their types (fixed, collector to base, self-bias).

- **Content Delivery Methods:**

Chalk and talk, Power point presentation, Video lectures

- **Assessment Methods:**

Theoretical questions

Unit 2 Frequency response of BJT amplifier: (**06** Hrs.)

- **Prerequisite:**

Basics of Capacitance

- **Objective:**

To analyze the frequency response of BJT

- **Outcomes:**

After completing this unit-

Students will be able to analyze the performance of BJT at different frequency

- **Unit Content:**

Frequency response of CE amplifier, effect of C_e, C_c & C_i on frequency response of RC coupled CE amplifier, Design of driver circuits- design of single stage RC coupled BJT amplifier

- **Content Delivery Methods:**

Chalk and talk, Power point presentation, Video lectures

- **Assessment Methods:**

Design, Numerical and Theoretical questions

Unit 3 Field Effect Transistor: (06 Hrs.)

- **Prerequisite:** Semiconductors materials and transistor knowledge
- **Objective:**

To develop conceptual & analytical understanding of Field effect transistors

- **Outcomes:**

After completing this unit-

Students will be able to analyze Field effect transistors circuits

- **Unit Content:**

Junction Field Effect Transistor (JFET)-Types, construction and operations, characteristics, small signal JFET parameters, Metal Oxide Semiconductor Field Effect Transistor (MOSFET)-construction, operations and characteristics of depletion type & Enhancement type

- **Content Delivery Methods:**

Chalk and talk, Power point presentation, Video lectures

- **Assessment Methods:**

Derivation and Theoretical questions

SECTION- II

Unit- 4 Operational Amplifier (**07** Hrs.)

- **Prerequisite:** Differential Amplifiers
- **Objective:**

To define the specification and parameters of Op-amp

- **Outcomes:**

After completing this unit

Students will be able to define specification and parameters of Op-amp

- **Unit Content:**

Introduction of differential amplifier and their types, Block diagram of typical op-amp, Ideal characteristics of op-amp & practical characteristics of op-amp (IC741) - input offset voltage, input offset current, input bias current, differential input resistance, offset voltage adjustment range, input voltage range, common mode rejection ratio, supply voltage rejection ratio, large signal voltage gain, output voltage swing, output resistance, slew rate, gain bandwidth product, Equivalent circuit of op-amp, ideal voltage transfer curve

- **Content Delivery Methods:**

Chalk and talk, Power point presentation, Video lectures

- **Assessment Methods:**

Derivations and Theoretical questions

Unit- 5 Configurations of Operational Amplifier (**07** Hrs.)

- **Prerequisite:** Feedback Amplifiers
- **Objective:**

To analyze open loop as well as closed loop circuit configurations of operational amplifier

- **Outcomes:**

After completing this unit-

Students will be able to analyze open loop and closed loop circuit configurations of anoperational amplifier

- **Unit Content:**

Open loop configurations of op-amp (differential, inverting &non-inverting), block diagram of closed loop configurations of op-amp: voltage series, voltage shunt, current series, current shunt feedback Derivation of various parameters for voltage series & voltage shunt feedback op-amp (closed loop voltage gain, input resistance with feedback, output resistance with feedback, bandwidth with feedback, total output offset voltage with feedback), concept of virtual ground condition

- **Content Delivery Methods:**

Chalk and talk, Power point presentation, Video lectures

- **Assessment Methods:**

Derivation and Theoretical questions

Unit -6 Applications of Operational Amplifier (**07** Hrs.)

- **Prerequisite:** Basics of op-amp

- **Objective:**

  To make student understand the op-amps applications

- **Outcomes:**

After completing this unit –

Students will be able to use op-amp for different electronic applications

- **Unit Content:**

Voltage follower, Current to Voltage converter, Voltage to Current converter with floating & grounded load, Adder circuit (by using inverting, non-inverting & differential configuration of op-amp), Subtractor (by using differential configuration of op-amp), instrumentation amplifier, Integrator & Differentiator

- **Content Delivery Methods:**

Chalk and talk, Power point presentation, Video lectures

- **Assessment Methods:**

Derivations and Theoretical questions

Text books:

1. OP _AMP' sand Linear IC's , Gayakwad Ramakant A, Prentice Hall of India
2. Robert L. Boylestad and Louis Nashelsky, "Electronic devices and circuit theory", 11th edition, Prentice Hall India Ltd, 2015.
3. Ramakant A. Gayakwad, "Op-Amps and linear integrated Circuits" 4th edition, Pearson Education, 2015.
4. Electronic Devices and Circuits, Allen Mottershead , PHI Publication
5. Electronic Devices & Circuit Theory, Robert Boylestad, Louis Nashelsky, Pearson Education

Reference books:

1. Electronic Devices and circuits , J B Gupta, Katson Publication
2. Thomas L. Floyed, "Electronic Devices", 10th edition, Pearson Education, 2018. • James M. Fiore, "Op Amps and Linear Integrated Circuits-Concepts and Applications", 3rd edition, Cengage Learning, 2018. •
3. David A. Bell, "Electronic Devices and Circuits", 5th edition, Oxford University Press, 2008
4. Analog Integrated Circuit ,Wiley India, Second edition, Tony chan carusone, Davidlohns, Kenneth Martin
5. Electronic Devices, Floyd, Pearson Education
6. Electronic Devices and circuits , S Salivahan, N Sureshkumar, Avallavraj, Tata Mc- Graw Hill Publication
7. Electronic Devices and circuits, Mantri and Jain
8. Electronic Devices and circuits, Wiley India ,Anil K Maini & Varsha Agrawal

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
S. Y. B. Tech. Electrical Engineering
Semester-I
(EEPCC-02) POWER PLANT ENGINEERING & ELEMENTS POWER SYSTEM

Teaching Scheme	Examination Scheme
Theory: - 3 Hrs/Week, 3 Credits	**ESE – 70 Marks**
	ISE- 30 Marks

This course introduces power plant which deals with generation of electrical energy The course also introduces economic aspects of different power plants

Course Prerequisite:
Knowledge of Basic Electrical Engineering, simple mathematical calculations Student shall have knowledge of energy conversion Student shall also have basic knowledge types of energy sources

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Course Objectives:

1. To develop conceptual understanding of operation of different power plants
2. To learn economic aspects of power system.
3. To study necessity and types of non-conventional energy sources.
4. To make students understand overhead structure of power system.

Course Outcomes:

After successful completion of this course:

1. Student will be able to understand operation of different power plants.
2. Student will be able to analyze economic aspects of power system.
3. Student will be able to investigate need and areas of application for non-conventional energy sources.
4. Students will be able to understand overhead structure of power system.

SECTION-I

Unit 1: Base Load Power Plants **No of lectures-07**

Prerequisite:

Energy sources, Energy conversion methods

Objectives:
1. Revision of Energy Sources.
2. To introduce student to different Conventional & non-Conventional Energy sources.
3. To make student understand different base load power plants.

Outcomes:

After completing this unit, students -
1. Can define conventional & non-conventional sources.

2. Can compare different base load power plants

Unit Content:

Different types of conventional and non-conventional energy sources, Structure of power industry,

a. **Hydro Power Plant:** Typical layout, Site selection, Classification, Hydrograph, Flow duration curves, Hydrology, Types of turbines.
b. **Thermal Power Plant:** Typical layout, Site selection, Fuels & their handling, Combustion process, Ash handling, Dust collection.
c. **Nuclear Power Plant:** Typical layout, Site selection, nuclear reaction, Classification of nuclear reactor (AGR, PWR, BWR), Nuclear waste disposal, Environmental Aspects

Content Delivery Methods:

Chalk and talk, Power point presentations on Energy Sources

Assessment Methods:
Theory questions related to above content.

Unit 2: Peak Load Power Plants **No of lectures-06**

Prerequisite:

Knowledge of Basic Electrical Engineering & nuclear reaction

Objectives:

1. To introduce student to Diesel & Gas Turbine Power Plants.
2. To introduce student to solar & Wind Power Plants.
3. To make student analyze typical layout of solar & Wind Power Plants

Outcomes:

After completing this unit, students –

1. Can apply the operation of Diesel & Gas Turbine Power Plants.
2. Can apply the operation of solar & Wind Power Plants

Unit Content:

a. Review of Diesel Plants (advantages & disadvantages), Typical layout of power plant, site selection
b. Review of Gas Turbine Plants (advantages & disadvantages), Typical layout of power plant, Site selection
c. Review of Solar Energy (advantages & disadvantages), Typical layout of solar thermal power plant, Site selection
d. Review of wind energy (advantages & disadvantages), Typical layout of wind power plant, Site selection

Content Delivery Methods:

Chalk and talk, power point presentation

Assessment Methods:

Theory questions related to above content

Unit 3: Economic Aspects of Power Generation **No of lectures-07**

Prerequisite:
Knowledge of Basic Electrical Engineering, simple mathematical calculations

Objectives:

1. To introduce to student basic terms used in power system operation.
2. To make student understand load curve.
3. To introduce student to types of loads.
4. To familiarize the students with the tariff methods for electrical energy consumptions

Outcomes:

After completing this unit, students –

1. Can define different terms in power system operation.
2. Can analyze selection of generating units.
3. Can calculate usage of electrical power & tariff

Unit Content:

Review of terms commonly used in system operations, Variable load on power station, Peak load, Base load, Diversity factor, Plant utility factor, Maximum demand, Load curves, load duration curves, Types of loads, Selection of generation units, Economics in Plant Selection, factors affecting economics of power generation, economic load sharing, Interconnected grid systems, Cost of electrical energy, Tariff & different types of tariffs

Content Delivery Methods:
Chalk and talk, power point presentation

Assessment Methods:
Numerical problems related to cost of electrical energy and tariff, Theory questions related to above content

SECTION - II

Unit 4: – General Electric Power Systems and Economics **No of lectures – 08**

Prerequisite:

DC system, single phase & three phase systems, ohms law

Objectives:

1. To learn basic structure of power systems.
2. To make student understand different transmission systems

Outcomes:

After completing this unit, students -

1. Can distinguish between different supply systems.
2. Can compare between AC and DC transmission System.

3. Can compare between overhead and underground System.

Unit Content:
Review of Electrical supply system, typical AC power supply scheme, Comparison DC and AC transmission system, advantages of high transmission voltage, comparison between overhead and underground system against volume of conductor material, choice of transmission voltage, conductor size and kelvins law

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions related to above content

Unit 5– Mechanical design of overhead lines **No of lectures – 08**

Prerequisites:

Electrical Material**s** & their properties**,** Capacitance

Objectives:
1. To introduce concept of overhead transmission line.
2. To introduce different conducting material & their application.
3. To introduce different insulators & their application.
4. To make student understand string efficiency & methods to improve it

Outcomes:

After completing this unit, students -

1. Can describe construction and use of different insulators, conductor, line supports.
2. Can calculate string efficiency of given string insulators

Unit Content:

Review of overhead transmission line, main components, conductor materials, line supports, overhead line insulators, types- pin type, suspension type, strain type insulators, string efficiency, methods of improving string efficiency

Content Delivery Methods:

Chalk and talk, power point presentations, videos lectures on insulators, line supports

Assessment Methods:

Numerical problems and derivation related to string efficiency; Theory questions related to above content

Unit 6– Substations and Grounding **No of lectures – 04**

Prerequisite:

Transformer, bus bar, generator, Earthing, electrical safety measures

Objectives:

1. To introduce student to substation and its types
2. To make student understand substation equipment
3. To make student understand Grounding & its types
4. To make student understand about importance of Grounding

Outcomes:

After completing this unit, students –

1. Can describe different equipment used in substation
2. Can describe different types of Grounding

Unit Content:

Substations: classification, symbols for equipment in substations, equipment's in substation Grounding: Introduction, Grounding of transformer neutral, resistance grounding, reactance grounding, solid grounding

Content Delivery Methods:

Chalk and talk, power point presentations, videos on Substations installation & working

Assessment Methods:

Theory questions related to Substation, Grounding

Internal Continuous Assessment (ICA):

ICA shall consist of Minimum **FOUR** drawing Sheets on above syllabus and **report on visit** to any one of the generating power plants

Text Books:

1. "A course in Electrical Power", S K Kataria & Sons, J B Gupta
2. "Generation of Electrical Energy", S Chand Publication, B R Gupta
3. "Power System Engineering", Laxmi Publications, R K Rajput
4. "Power Plant Engineering", New Age International Publication, A K Raja

Reference Books:

1. "Power Plant Technology", Tata Mc Graw Hill, MMEI-Wakil
2. "Power Plant Engineering", S Chand Publications, Samsher Gautam

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S. Y. B. Tech. Electrical Engineering

Semester-I

(EEPCC-03) DC MACHINES AND TRANSFORMER

Teaching Scheme
Theory: - 3 Hrs/Week,3 Credits
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA-25Marks
ISE- 30Marks
POE: 25Marks

This course introduces Electrical machines like DC Machines and Transformer including theirtheoretical and analytical performance

Course Prerequisite:

Student shall have knowledge of Magnetic Circuit, DC Circuit, AC Fundamentals and ACCircuit

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Course Objectives:

- To get detailed knowledge of construction, operating principles of DC machines andtransformer
- To find equivalent circuit parameters and performance parameters for transformer and DCmachines
- To understand different testing methods of DC Machines

Course Outcomes:

Upon successful completion of this course:

- Student will be able to analyze performance of DC generators and motors
- Student will be able to examine performance of single phase and three phase transformers
- Students will be able to identify applications of DC machines & transformer in power sector

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SECTION-I

Unit 1: DC Generators: **No of lectures – 08**

- **Prerequisite:**
  Concepts of magnetic flux and basics of AC circuit
- **Objectives:**
  1) To make students understand operation of dc generator
  2) To make students analyze operating parameters of dc generator
- **Outcomes:**
  After completing this unit, student -
  1. Can apply operation of DC generator
  2. Can find different operating parameters of DC generator
- **Unit Content:**

Construction, Basic Principle of working, EMF equation, Types of Armature windings, Characteristics and applications of different types of DC Generators, EMF built up

process in DC Shunt Generator, Armature reaction- Demagnetizing and Cross magnetizing MMFs and theirestimations, Remedies to overcome the armature reaction, Commutation Process

Delivery Methods:
Chalk and talk, Video lectures

- **Assessment Methods:**

Numerical problems and derivation related to Armature reaction, EMF equation and Types of DCgenerator.

Unit 2: DC Motors: **No of lectures – 08**

- **Prerequisite:**
Concepts of magnetic flux and basics of AC circuit

- **Objectives:**

1. To make students understand operation of DC motor
2. To make students analyze operating parameters of DC motor

- **Outcomes:**
After completing this unit,students –

1. Can apply operation of DC motor
2. Can find different operating parameters of DC motor

- **Unit Content:**

Principles of working, Significance of Back EMF, Torque Equation, Types of DC motors, Losses and efficiency, Condition for maximum efficiency, Characteristics and selection of DC motors for various applications, Starting of DC motors (3-point, 4-point starters), Speed control of DC shunt and series Motors

- **Content Delivery Methods:**

Chalk and talk, Video lectures, Animations

- **Assessment Methods:**
Numerical problems and derivations related to torque equation, losses and efficiency

Unit 3: Testing of DC Machines: **No of lectures – 04**

- **Prerequisite:**
Necessity of testing

- **Objectives:**
1) To make student understand concepts and operation of various testing methods
2) To make student analyze various testing methods

- **Outcomes:**
After completing this unit,
students –Can analyze
various testing methods

- **Unit Content:**
Direct and indirect methods of testing, brake test, Swinburne's test, Hopkinson's test

- **Content Delivery Methods:** Chalk and talk

- **Assessment Methods:**
  Numerical problems on brake test and Swinburne's test

SECTION- II

Unit 4: Special Purpose Machines: **No of lectures – 04**

- **Prerequisite:**
  Concepts of magnetic flux, de motor and basics of AC circuit

- **Objectives:**

1. To make students understand operation, characteristics and applications of BLDC and stepper motor

- **Outcomes:**
  After completing this unit,students –

1. Can apply knowledge operation of BLDC and stepper motor

- **Unit Content:**

  Construction, working principle, types, characteristics and applications of BLDC and Stepper motor.

Unit 5: Single Phase Transformer: **No of lectures – 08**

- **Prerequisite:**
  Basics of magnetic flux and AC circuit

- **Objectives:**
  1. To make students understand operation of single-phase transformer
  2. To make students analyze operating parameters of single-phase transformer

- **Outcomes:**
  After completing this unit, students –
  - Can understand operation of single-phase transformer
  - Can find different operating parameters of single-phase transformer
- **Unit Content:**

  Transformer construction and types, EMF equation, Voltage ratio, KVA rating, Transformer on no-load and on-load condition with phasor diagrams, Losses and Efficiency, Condition formaximum efficiency, Transformer equivalent circuits, Effect of load on power factor, Testing- Polarity test, Open Circuit Test (OC), Short Circuit Test (SC), Parallel operation, Auto- Transformer

- **Content Delivery Methods:**
  Chalk and talk, Video lectures, Animations

- **Assessment Methods:**
  Numerical problems on losses, efficiency and regulation, equivalent circuit parameters, Auto-Transformer

Unit 6: Three Phase Transformers: **No of lectures – 08**

- **Prerequisite:**
  Basics of magnetic flux and ac circuit

- **Objectives:**
  1. To make students understand operation of three phase transformer
  2. To make students analyze operating parameters of three phase transformer
- **Outcomes:**
  After completing this unit, students -
1. Can understand operation of three phase transformer
2. Can find different operating parameters of three phase transformer

- **Unit Content:**

  Special constructional features, Three phase transformer connections, Labeling of transformer terminals, Star/Star connection, Delta/Delta Connection, Star/Delta, Delta/Star connection, Delta/Zigzag Star, Star/Zigzag Star, Vector groups, Choice of transformers connections, Magnetizing inrush current, Three winding transformers and its equivalent circuits, Open delta connection, Three/Two phase conversion (Scott connection), On-Off Load tap changing transformers.

- **Content Delivery Methods:**
  Chalk and talk, Video lectures, Animations

- **Assessment Methods:**
  Numerical problems on transformer connections, Parallel operation of transformers

- **Internal Continuous Assessment (ICA):**

  ICA shall consist of minimum **eight** experiments from following list
  1. Determination of magnetization, external and internal characteristics of DC Generator
  2. Determination of efficiency and voltage regulation of DC Shunt generator by direct loading
  3. Speed control of D C shunt motor by armature and field control
  4. Determination of efficiency and speed regulation of DC shunt motor by direct loading
  5. Determination of efficiency and speed regulation of DC Shunt motor by indirect loading
  6. Determination of efficiency of a DC series motor by load test
  7. Determination of efficiency of a DC machine by performing Swinburne's test
  8. Determination of efficiency of a DC machine by performing Hopkinson's test
  9. Determination of efficiency of single-phase transformer by Back to Back test
  10. Parallel operation of Single-phase transformer
  11. Determination of equivalent circuit parameters of single-phase transformer
  12. Scott connection of three phase transformers
  13. Direct load test on three phase transformers for various connections

- **Text Books:**
1. Electric Machines, Third Edition, Tata McGraw Hill Publication, I J Nagrath, D P Kothari
2. Electrical Machines, Third Edition, Tata McGraw Hill Publication, S K Bhattacharya Theoryand Performance of Electrical Machines, S K Kataria& Sons , J

B Gupta
3. A Text Book of Electrical Technology Volume II, S Chand, B L Theraja

- **Reference Books:**

1. Electrical Machinery, Sixth Edition 2002, Tata McGraw Hill, AEFitzgerald, CKingsleySDUmans
2. Electrical Machinery, Khanna Publishers, P S Bhimbhra
3. Electrical Machines, Dhanpat Rai & Sons, Ashfaq Hussain
4. Theory and Performance of Electrical Machines, S K Kataria and sons, J B Gupta
5. Principles of electronic machines & Power electronics, Wiley India,P.C.Sen

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Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S. Y. B. Tech. Electrical Engineering

Semester- I

(Field Project) (EEFP-01) LABORATORY ON POWER PLANT ENGINEERING AND ELEMENTS OF POWER SYSTEM

Teaching Scheme
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ICA-25Marks
POE: 25Marks

Internal Continuous Assessment (ICA):

ICA shall consist of a Minimum of **FOUR drawing Sheets and ONE Power Plant Prototype Models per group (maximum Three Students/group)** based on the above syllabus and Students must **visit a generation station** and submit a **field project along with report based on their visit**.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
S. Y. B. Tech. Electrical Engineering
Semester-I
(EEFP-02) ELECTRICAL WORKSHOP

Teaching Scheme
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ICA-25Marks
POE: 25Marks

Course Objectives:

1. To develop practical workshop skills in the students.

2. To provide students a widespread knowledge and understanding of the workshop tools and other facilities. Course

Outcomes: At the end of the course student –

1. can apply workshop equipment, wiring accessories and print circuit boards

2. can prepare the PCB in the practical field.

3. can install the earthing for different equipment

4. can find the faults in the circuits by troubleshooting

Electrical workshop

To perform and record any six of following experiments

1. Understanding of different types of switches such as SPST, SPDT, DPST, DPDT, TPST, TPDT

2. Understanding of different types of switchgears such as MCCB, MCB, ELCB, Isolators, HRC fuses

3. Understanding Different types of meters such as analog multimeter, clamp meter, trivector meter, power quality analyser, RLC meters etc.

4. Measurement of insulation resistance and earth resistance.

5. Understanding Different types of power supply, function generator, DSO, CRO.

6. Study and performing of motor winding.

7. Installation of plate, pipe, and grid earthing.

8. Types of wiring, Industrial, domestic wiring and panel wiring etc.

9. PCB design and fabrication

10. Soldering and desoldering of components on PCB.

11. Troubleshooting in electronic circuits.

Carry out at least one activity of the following to give the students an insight to their practical approach in diverse electrical field.

1. Site visit to nearby apartments/industries to understand the electrical wiring.

2. Workshop on PCB design using any suitable and available software like ORCAD, eagle, Proteus etc.

3. Workshop on Solar panel installation.

4. Workshop on motor rewinding

A. Multidisciplinary Minor in "Sustainable Energy System"

Sem	Course Code	Title
III	EEMDM-01 A	Electrical Technology

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. B.Tech. Electrical Engineering Semester-I

ELECTRICAL TECHNOLOGY

Teaching Scheme	**Examination Scheme**
Theory: - 2 Hrs/Week, 2 Credits	**ESE -** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ISE –** 30 Marks
	ICA - 25Marks

Course Objectives:

- Understand the fundamentals of measuring instruments, including their types, working principles, and applications.
- Understand the construction, working principles, characteristics, and speed control methods of DC machines.
- Explore the construction and operation principles of AC machines.
- Investigate the construction and operating principles of special-purpose machines.

Course Outcome Statements:

On completion of the course, student will be able to-

- Identify and classify different types of measuring instruments.
- Demonstrate a comprehensive understanding of the construction, operation, and speed control methods of DC machines.
- Develop competency in the analysis of AC machines.
- The knowledge and skills necessary to evaluate the construction, operating principles, and applications of Special purpose machine.
- Explain the construction, operation, performance characteristics, and calculate the efficiency of transformers

SECTION I

Unit 01: Measuring Instruments (05 Hrs)

Basics of measuring instruments and their types, working principles and applications of moving coil, moving iron (ammeter & voltmeter) and Extension of their ranges, dynamometer- type Wattmeter, induction-type Energy Meter, Two-wattmeter method for the measurement of power in three phase circuits, Introduction to digital voltmeter, digital Multimeter and Electronic Energy Meter.

Unit 02: Electrical Machines (10 Hrs)

DC Machine: Construction, working, torque speed characteristic and speed control of separately excited dc motor.

AC Machine: Construction, Generation of rotating magnetic fields and working of a three-phase induction motor, Torque-slip characteristic, Brief idea about Single Phase Induction Motor and Synchronous generators

SECTION II

Unit 03: Special Purpose Machines (05 Hrs)

Construction and principle of operation of Stepper motors, Permanent magnet DC motors, Brushless DC motors, Permanent Magnet Synchronous Motors, Switched Reluctance Motors, Linear Induction motors and their Applications, Problems on all the above motors

Unit 04: Energy Efficient Machines (04 Hrs)

Construction, Basic Concepts, losses minimization and efficiency calculations of Energy efficient AC machines

Unit 05: Transformer (06 Hrs)

Transformers Single phase transformer: Core and shell type construction, ideal and practical transformer, EMF equation, no load and on load, operation, phasor diagram and equivalent circuit, losses of a transformer, open and short circuit tests, regulation and efficiency calculation, Auto-transformer.

ICA:

It should consist of a minimum 6 experiments based on the above syllabus but not restricted to the list of experiments given below.

1. Power measurement by using two wattmeter method.
2. To calculate energy consumption using energy meter.
3. Brake test on D.C. Shunt motor.
4. Speed control of D.C. Shunt motor and study of starters.
5. No load & blocked-rotor test on 3-phase induction motor.
6. O.C. and S.C. test on single phase Transformer.
7. Determination of equivalent circuit parameters from the test data.
8. Polarity test on single phase and three phase transformers.

Text Books:

1. S.N Singh, ―Basic Electrical Engineering‖ PHI India Ed 2012
2. Chakrabarti, Chanda,Nath ―Basic Electrical Engineering‖ TMH India‖, Ed 2012.
3. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
4. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition
5. Basic Electrical Engineering, Nath & Chakraborti 4. Electrical Technology, Vol-I,Vol-II, Surinder Pal Bali, Pearson Publication.
6. A Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand &Company

Reference Books:

1. E. Fitzgerald, C. Kingsley and Stepen D. Umans: Electric Machinery, Tata McGrawHill Pub., 7th Edition, 2020.
2. P.S. Bimbhra: Generalized Theory of Electrical Machines, Khanna Pub., 6th Edition, 2017.
3. D.P. Kothari and I J Nagarath: Electric Machines: Tata McGraw-Hill Pub., 5th Edition, 2017.
4. P.S. Kenjo and S.Nagamori: Permanent Magnet DC motors, Clarendon Press, Oxford, 1985.
5. J.B. Gupta: Theory and Performance of Electrical Machines, S. K. Kataria & Sons, 14th Edition, 2006.

B. Multidisciplinary Minor in "Electrical Vehicle System"

Sem	Course Code	Title
III	EEMDM-01 B	Basics of Electrical Vehicle

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. B.Tech. Electrical Engineering Semester-I

BASICS OF ELECTRIC VEHICLE

Teaching Scheme
Theory: - 2 Hrs/Week, 2 Credits
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ESE - 70 Marks
ISE – 30 Marks
ICA - 25Marks

- **Course Objective:**
  - To understand the basics of electric vehicle history and components.
  - To understand the properties of batteries.
  - To understand the electrical machine properties and classifications.
  - To understand the properties of electric vehicle drive systems.
  - To understand the concepts of hybrid electric vehicles.
- **Course Outcomes: Students' will be able to:**
  - Understand about basics of hybrid electric vehicle
  - Analyze the performance of electric vehicle.
  - Explain environmental aspects of solar powered charging system
  - Understand about mobility and connectors used in charging system.

SECTION I

UNIT I: Introduction to Electric vehicles: (05 Hrs)

Present scenario of electric vehicles, Need of Electric Vehicles, Economic and environmental impacts of using Electrical vehicles. Challenges faced by electric vehicles to replace ICE. Major requirements of electric vehicles.

UNIT II: Types of Electric Vehicle and their challenges: (05 Hrs)

Types of electric vehicle, Pure Electric Vehicle (PEV): Battery Electric vehicle, Fuel Cell electric vehicle (FCEV), Hybrid Electric vehicle (HEV). Challenges of Battery Electric vehicle, Hybrid Electric Vehicle and Fuel cell Electric vehicle.

UNIT III: Battery Electric Vehicle: (05 Hrs)

Components of BEV drive train, Battery pack & Battery Management System, Electric vehicle configurations, Power steering unit, Common parts between ICE drivetrain and EV drive train, Differences (modifications/parts to be removed/added) between ICE and EV drive train.

SECTION II

UNIT IV: Hybrid Electrical vehicle and Fuel cell electric vehicle: (05 Hrs)

Hybrid Electric Vehicle (HEV) -Basic architecture of hybrid drive trains, Components of HEV drivetrain system. Classification of HEV: Conventional HEV, Grid -Able HEV .Fuel efficiency in HEV.

UNIT V: Energy Storage: (05 Hrs)

Battery based energy storage, Overview of batteries, Battery Parameters, Battery Charging, regenerative braking, alternative novel energy sources-solar photovoltaic cells, fuel cells, super capacitors, and flywheels.

Reference books:

1. Electric & Hybrid Vehicles – A.K. Babu, Khanna Publishing House, New Delhi, 2018.

2. Electric & Hybrid Vehicles – Design Fundamentals – Iqbal Hussain, Second Edition, CRC Press, 2011.

3. Electric Vehicle Technology Explained - James Larminie, John Wiley & Sons, 2003.

4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals – Mehrdad Ehsani, Yimin Gao, Ali Emadi, CRC Press, 2010.

5. Electric Vehicle Battery Systems – Sandeep Dhameja, Newnes, 2000.

ICA:

It should consist of a minimum 6 experiments based on the above syllabus but not restricted to the list of experiments given below.

List of Experiments:

1) Conduct a case study related with Electric Vehicle Charging Infrastructure
2) Modeling and Simulation of DC Motor Characteristics.
3) Modeling and Simulation of Induction Motor Characteristics.
4) Modeling and Simulation of BLDC Motor Characteristics.
5) Modeling and Simulation of energy consumption and performance of electric vehicle.
6) Architecture development of Hybrid Electric Drive Trains.Development of performance analysis of Powertrain Component Sizing for various Electric vehicle configurations
7) Development of a mini solar powered charging system.
8) Conduct a case study related with Connected Mobility and Autonomous Mobility

SEMESTER -II

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
S. Y. B. Tech. Electrical Engineering
Semester-I
(EEPCC-O4) ELECTRICAL TRANSMISSION AND DISTRIBUTION

Teaching Scheme
Theory: - 3 Hrs/Week,3 Credits

Examination Scheme
ESE – 70 Marks
ISE- 30 Marks

This course introduces elements of power systems which deals with structure of power system & constants of Transmission lines The course also introduces theoretical and analytical aspects of overhead & underground transmission lines, DC & AC distribution systems and substation

Course Prerequisite:

Student shall have knowledge of circuit theory Student shall also have basic knowledge of Transformers, single phase & three phase systems

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Course Objectives:

1. To learn basic structure of power systems and mechanical design of overhead lines.
2. To study various effects related to overhead transmission lines.
3. To gain knowledge about need of power transmission using underground cables, types of underground cables.
4. To understand DC & AC distribution systems and substations

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Course Outcomes:

1. Students will be able to understand overall structure of power system.
2. Students will be able to understand mechanical design of transmission lines.
3. Students will be able to implement the knowledge to design underground power distribution system.
4. Students will be able to analyze various performance parameters of transmission lines

SECTION-I

Unit 1: Corona & Sag in overhead lines **No of lectures –07**

Prerequisites:
Electric field Intensity, phase addition rule, concept of moment & force

Objectives:
1. To introduce corona phenomenon and its effects.
2. To introduce concept of sag in design of transmission line.
3. To make student understand about corona & sag in overhead lines.

4. To introduce concept of stringing chart

Outcomes:

After completing this unit, students –

1. Can describe phenomenon of corona & sag
2. Can describe factor affecting corona & method's to reduce corona
3. Can calculate sag & different voltages related to corona.

Unit Content:

Corona-principle, terms- definitions and empirical formulae related corona, factor affecting corona, advantages and disadvantages of corona, methods of reducing corona effect Sag in overhead lines, calculation of sag

Content Delivery Methods:

Chalk and talk, power point presentations, animation on corona phenomenon

Assessment Methods:

Numerical problems and derivation related to sag & corona, Theory questions related to above content

Unit 2: Constants of transmission lines **No of lectures –07**

Prerequisite:

Resistance, inductance, capacitance, fundamental electrical concepts

Objectives:

1. To introduce constants of transmission lines.
2. To analyze transmission lines by its constants.
3. To introduce concept of GMR and GMD

Outcomes:

After completing this unit, students-

1. Can describe constants of transmission lines.
2. Can derive and calculate resistance, inductance, and capacitance of transmission lines

Unit Content:

Resistance of line, skin effect and proximity effect, inductance of single phase 2 wire line, GMR and GMD, inductance of three phase line with equilateral spacing, unsymmetrical spacing, effect of transposition, line capacitance, capacitance of 1ph and 3ph line, effect of earth on the capacitance of overhead lines

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Numerical problems and derivation related resistance, capacitance, and inductance of transmission lines, Theory questions related to skin effect and proximity effect

Unit 3: Underground cables **No of lectures –06**

Prerequisite:

Electrical Materials, resistance, capacitance

Objectives:

1. To introduce construction and classification of cable.

2. To make student understand effect of voltage on performance of cable.
3. To introduce economic size of conductor in cable.

Outcomes:

After completing this unit, students -

1. Can describe construction and classification of cable.
2. Can describe insulation resistance, capacitance & advantages of grading of cable.
3. Can derive and calculate resistance, capacitance, and potential gradient of cable

Unit Content:

General construction of cables, insulating materials for cables, classification of cables, insulation resistance of a single core cable, capacitance of a single core cable, dielectric stress in a single core cable, grading of cables, and capacitance of 3-phase cables

Content Delivery Methods:

Chalk and talk, power point presentations, video lectures on types of cable

Assessment Methods:

Numerical problems and derivation related resistance, capacitance, dielectric stress, grading of cables, Theory questions related to above content

SECTION-II

Unit 4: Performance of transmission lines **No of lectures –08**

Prerequisite:

AC circuits, Power Factor, complex notations, phasor representation

Objectives:

1. To analyze performance of transmission lines.
2. To make student understand types of transmission lines.
3. To make student understand power factor improvement

Outcomes:

After completing this unit, students –

1. Can describe performance of different transmission line.
2. Can describe generalized constants of different transmission line.
3. Can calculate parameters of different transmission lines

Unit Content:

Review of transmission line, classification of overhead transmission lines, important terms, performance of short transmission line, effect of load PF on regulation and efficiency, medium transmission lines-end condenser method, nominal T method, nominal π method, long transmission lines-rigorous solution, generalized circuit constants of a transmission line, Ferranti effect, derivations of generalized constants (A, B,C,D) of short, medium & long transmission lines

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:
Numerical problems and derivation related to different types transmission line, generalized Constants, power factor improvement

Unit 5: – Distribution systems **No of lectures –06**

Prerequisite:
DC circuits, Kirchhoff's laws, generator, transformer
Objectives:

1. To make student understand types of Distribution systems.
2. To analyze performance of Distribution systems

Outcomes:
After completing this unit, students -

1. Can describe performance of different Distribution systems.
2. Can calculate parameters of different Distribution systems

Unit Content:
Classification & types, connection schemes of distribution systems, DC distribution calculations-DC distributor fed at one end and both ends with concentrated load, Ring main distributor, AC distribution and its calculations, 3phase 3wire and 3 phase 4 wire connected loads

Content Delivery Methods:
Chalk and talk, power point presentations
Assessment Methods:
Numerical problems and derivation related to different types Distribution system**,** Theory questions related to above content

Unit 6: – Introduction to Extra High Voltage Transmission **No of lectures –06**

Prerequisite:
Power System, Laws of High Voltage
Objectives:

1. To make student understand the benefits of extra high voltage Transmission system.
2. To make student understand the benefits of High Voltage DC Transmission system.

Outcomes:
After completing this unit, students -

1. Can describe benefits of extra high voltage Transmission system.
2. Can understand types High Voltage DC Transmission system

Unit Content:
EHV AC Transmission System: Introduction, Advantages and Limitation
HV DC Transmission System: Classification, Advantages, limitation and application

Content Delivery Methods:
Chalk and talk, power point presentations

Assessment Methods:
Theory questions related to EHVAC and HVDC transmission system.

Text Books:

1. "A course in Electrical power", S K Kataria and sons, J B Gupta
2. "Principles of power system", S Chand Publication V K Mehta, Rohit Mehta
3. "Power system engineering", Dhanpat Rai and sons , M L Soni, P V Gupta, U S Bhatnagar
4. "*Power System Engineering"*, Laxmi Publications, R K Rajput
5. Fredrick T Morse, Power Plant Engineering, East-West Press Pvt Ltd
6. Mahesh Verma, Power Plant Engineering, Metrolitan Book Co Pvt Ltd
7. George W Sutton-(Editor), Direct Energy Conversion, Lathur University, Electronic Series Vol3 McGraw Hill
8. D. P. Kothari, I. J. Nagrath, Power System Engineering, 3 Edition, Mc Graw Hill
9. B.R. Gupta, Power System Analysis And Design, S.Chand

Reference Books:

1. "Electrical power system", New age international, C L Wadhwa
2. "Electrical power generation transmission and distribution", PHI New Delhi, S M Singh
3. "Elements of power system design", AH wheeler and Co, M V Deshpande
4. "Power System operation & Control", Wiley India, Dr. K. Uma Rao
5. Stevenson and Grainger, Modern Power System Analysis, 1 Edition, TMH publication
6. W. D. Stevenson, Elements of Power System, 4 Edition TMH
7. Hadi Saadat, Power System Analysis, TMH, 1st Edition, 2002

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
S. Y. B. Tech. Electrical Engineering Semester-II
(EEPCC-05) NETWORK ANALYSIS

Theory: - 2 Hrs/Week, 2 Credits
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA - 25Marks
ISE - 30Marks

This course introduces basic concepts of Electrical network and different network analysis techniques.

Course Prerequisite:
Student shall have knowledge of terminology of electrical networks, Laplace transforms and linear differential equations

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Course Objectives:
1. To develop the strong foundation for Electrical Networks
2. To develop analytical qualities in Electrical circuits by application of various theorems.
3. To understand the concepts of network topology
4. To understand the behavior of circuits by analyzing the transient response using classical methods and Laplace Transform approach
5. To apply knowledge of Network theory for analysis of 2-port networks

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Course Outcomes:
Upon successful completion of this course, the students will be able to:
1) Calculate current/voltage in electrical circuits using simplification techniques, Mesh, Nodal analysis
2) Analyze electric network using network theorems
3) Analyze electrical network using network topology
4) Analyze the response of RLC circuit with electrical supply in transient
5) Apply Laplace transform to analyze behavior of an electrical circuit.
6) Apply knowledge of Network theory for analysis of 2-port networks

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SECTION-I

Unit 1–Introduction to electrical network **(05 Hrs.)**

- **Prerequisite:**

Series and parallel connections, Ohm's law, Solution of linear equations, Kirchhoff's law

- **Objectives:**

1. To revise of basic concepts of electrical network
2. To introduce to student network reduction techniques
3. To make student understand Mesh and Node analysis method

- **Outcomes:**

After completing this unit, students -
1. Can apply network reduction techniques to solve numerical
2. Can apply loop and node analysis to solve numerical

- **Unit Content:**

Ideal and Practical sources, Source transformations, Network reduction techniques, Mesh and node analysis with linearly dependent and independent sources for DC and AC networks, Concepts of super node and super mesh, coupled circuits and dot conventions.

- **Content Delivery Methods:** Chalk and talk, Video lectures
- **Assessment Methods:** Numerical problems and derivation related to Star-Delta transformation, Source transformation, Loop and node analysis, Super node and super mesh, coupled circuits.

Unit 2–Network Theorems (05 Hrs.)

- **Prerequisite:**

Concept of open circuit and short circuit, equivalent resistance

- **Objectives:**

1. To make student understand different theorems to analyze electrical network
2. To make student analyze electric network using network theorems

- **Outcomes:**

After completing this unit, students –

Can able to analyze electrical network using network theorems

- **Unit Content:**

Superposition Theorem, Thevenin's Theorem, Norton's Theorems, Maximum Power Transfer Theorem Reciprocity Theorem, Compensation Theorem, applied to both ac and dc circuits.

- **Content Delivery Methods:** Chalk and talk, Video lectures
- **Assessment Methods:** Numerical problems and derivations related to network theorems

Unit 3–Network Topology (04 Hrs.)

- **Prerequisite:**

Concepts from linear algebra

- **Objectives:**

1. To make student understand concepts network topology
2. To make student understand dual of network

- **Outcomes:**

After completing this unit, students –

1. Can analyze electrical network using network topology
2. Can draw dual of given network

- **Unit Content:**

Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set matrix, cut-set matrix, Principle of duality.

- **Content Delivery Methods:** Chalk and talk, videos
- **Assessment Methods:** Numerical problems on Incidence matrix, cut set, tie set matrices and duality

SECTION-II

Unit 4-Analysis of Transient Response in Circuits: Classical Approach (05 Hrs.)

- **Prerequisite:**

Node and mesh analysis, Solution of linear differential equations

- **Objectives:**

To make student analyze behavior of circuit when transient occurs

- **Outcomes:**

After completing this unit, students –

Can find circuit response in transient state

- **Unit Content:**

Initial and Final Condition of network, General and Particular Solution, Transient response of R-L, R-C and R-L-C (DC Supply only) network in time domain

- **Content Delivery Methods:**

Chalk and talk, Video lectures, animations

- **Assessment Methods:** Numerical problems transient response of circuit, derivations of circuit response

Unit 5-Analysis of Transient Response in Circuits: Laplace Transform Approach (05 Hrs.)

- **Prerequisite:**

Loop and mesh analysis, Laplace transform

- **Objectives:**

To make student analyze behavior of circuit when transient occurs

- **Outcomes:**

After completing this unit, students –

Can find circuit response in transient state

- **Unit Content:**

Standard test inputs: Step, Ramp, Impulse and their Laplace transform, Representation of R, L, C in s-domain, transformed network, Application of Laplace transform to solve series and parallel R- L, R-C and R-L-C circuits

- **Content Delivery Methods:**

Chalk and talk, Video lectures, animations

- **Assessment Methods:**

Numerical problems on transient response of circuit, derivations of circuit response

Unit 6-Two port networks (05 Hrs.)

- **Prerequisite:**

Loop and mesh analysis techniques, Linear Algebra

- **Objectives:**

1) To make student understand two port network parameters
2) To make student understand relationship between parameters
3) To make student analyze interconnected networks

- **Outcomes:**

After completing this unit, students –

1. Can able to find two port network parameters
2. Can able to convert one parameter into other
3. Can able to analyze interconnected two port networks

- **Unit Content:**

Determination of Z, Y, H and Transmission parameters, relationship between parameters sets.

- **Content Delivery Methods:** Chalk and talk, Video lectures
- **Assessment Methods:** Numerical problems on two port network parameters, conversion of parameters, interconnected two port networks

Internal Continuous Assessment (ICA):

List of Experiments:

1. Verification of Superposition theorem.
2. Verification of Thevenin's theorem.
3. Verification of Norton's theorem.
4. Verification of Reciprocity theorem.
5. Determination of time response of R-C circuit to a step D.C. voltage input. (Charging and discharging of a capacitor through a resistor).
6. Determination of time response of R-L circuit to a step D.C. voltage input. (Rise and decay of current in an inductive circuit)
7. Determination of Z-parameter of Two Port Network.
8. Determination of Y-parameter of Two Port Network.
9. Determination of h-parameter of Two Port Network.

Guidelines for Student's Lab Journal

- Students are expected to write the journal in the following sequence:

➢ Aim

➢ Equipment

➢ Circuit diagram

➢ Theory

➢ Procedure

➢ Observation table

➢ Calculations

➢ Graphs

➢ Conclusion.

- Students are expected to draw the circuit diagrams.
- For plotting the characteristics, they must use 1mm graph papers.
- Students should write conclusion.
- Students should get the assignment and lab write up checked within 1 week after performing

The experiment.

Guidelines for Lab: Assessment should be on the basis of:

- Neatness of circuit diagram.
- The detail calculations to obtain results.
- Graph with title, scale, labeling of axes etc.
- Conclusion.
- Punctuality, discipline, attendance, understanding and neatness of the journal. Few questions on the basis of the experiment can be asked to verify the understanding of the students about that experiment.

- **Text Books:**

1. "Circuit Theory", Dhanpat Rai and Company, 7th Edition, Abhijit Chakroborty
2. "Network Analysis and Synthesis", McGraw Hill Education (India) Pvt Ltd, 3rd Edition 2015, Ravish Singh
3. "Circuits & Networks 4E", Tata McGraw-Hill Education (India) Pvt Ltd, Anant Sudhakar
4. "Network and Systems", New Age International Publishers, D Roy Choudhary
5. "Introduction to Electric Circuits" McGraw Hill, Alexander & Sadiku,

- **Reference Books:**

1. "Network Analysis", Prentice Hall of India Private Limited, Third Edition, M E Van Valkenburg
2. "Engineering Circuit Analysis" McGraw Hill Publication, William H. Hayt, Jr. Jack E. Kemmerly.
3. "Schaum's Outline of Electric Circuits", McGraw-Hill Education; 7th Edition
4. "Network analysis and Synthesis", Wiley International Edition Franklin F Kuo
5. "Analysis of Linear Systems", Narosa Publishing House, 11th reprint, 2002 David K Cheng
6. "Network Analysis and Synthesis", Khanna Publication, G K Mittal

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Punyashlok Ahilyadevi Holkar Solapur University,Solapur
S. Y. B. Tech. Electrical Engineering
Semester-II
(EEPCC-06) AC MACHINES

Teaching Scheme
Theory: - 3 Hrs/Week,3 Credits
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA-25 Marks
ISE- 30 Marks
POE: 25 Marks

This course introduces electrical machines, which works on AC supply including theoreticaland analytical aspects of both three phase and Single-phase types

Course Prerequisite:
Student shall have knowledge of Magnetic Circuit, AC Fundamentals and AC series Circuits He/She shall also have basic knowledge of complex Numbers and Vectors

Course Objectives:
- To get detailed knowledge of construction and operating principles of Electro MechanicalAC Machines
- To make student understand equivalent circuit parameters and performance parameters ofboth synchronous and asynchronous AC Machines
- To enable student to understand starting and control techniques of AC Motors

Course Outcomes:
After Successful completion of this course-
- Students will be able to analyze performance of three phase as well as single phaseInduction Motors
- Students will be able to identify applications of Induction Motors in industries & power sector
- Students will be able to analyze performance of synchronous machines
- Students will be able to identify applications of synchronous machines in industries &power sector

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SECTION-I

Unit 1– Introduction to AC Machines and Three Phase Induction Motor No of lectures – 07

- **Prerequisite:**

Concept of electromechanical energy conversion, mutual induction, concept of induced torqueand Basics of AC Circuit

- **Objectives:**

1. To make student understand Construction of different Induction Motors (cage and wound)
2. To make student analyze operation and characteristics of Induction Motor

- **Outcomes:**

After completing this unit, students –
1. Can analyze various parameters of Induction Motor
2. Can draw nature of torque slip characteristics at various conditions

- **Unit Content:**

Classification of AC Machines, Construction- Stator, Rotor (Squirrel cage, Wound Type), Concept of rotating magnetic field, Principle of operation, Concept of Slip, Rotor current frequency, Rotor current and Power factor, Power flow diagram, Losses and efficiency, Torque Equation, Condition for maximum torque, starting torque, full load torque and their ratios, Torque slip characteristics, Effect of rotor resistance on torque slip characteristics, Crawling and cogging effects

- **Content Delivery Methods:**

Chalk and talk, Analogy, Power point presentation

- **Assessment Methods:**

Numerical and derivations related to torque equation and their ratios, numerical related to lossesand efficiency, frequency, slip and rotor current and power factor.

Unit 2– Starting and Speed Control of Induction Motor **No of lectures – 06**

- **Prerequisite:** Concepts of circuit networks, Torque slip Characteristics

- **Objectives:**

1. To make student understand starting methods of Induction Motors
2. To make student understand speed control methods of Induction Motors

- **Outcomes:**

After completing this unit, students –

1. Can analyze various types of starters for Induction Motor
2. Can understand different speed control techniques of Induction Motor

Unit Content:

Necessity of starters, Types of starters (DOL, star delta, auto transformer, rotor resistance), Speed control of three phase *Induction Motor*-stator side control methods (applied voltage, frequency, pole changing), and Rotor side speed control methods (rotor resistance, slip power recovery)

- **Content Delivery Methods:** Chalk and talk

- **Assessment Methods:**

Numerical related to starters

Unit 3– Performance of Three Phase Induction Motor **No of lectures – 07**

- **Prerequisite:**

Concept of open circuit and short circuit**,** Equivalent circuit of transformer

- **Objectives:**

1. To make student understand circle diagram and impact of different tests on circle diagram
2. To make student understand analysis of *Induction Motor* through circle diagram

- **Outcomes:**

After completing this unit, students –

1. Can draw circle diagram of Induction Motor at different operating conditions

2. Can analyze Induction Motor performance through circle diagram

- **Unit Content:**

Equivalent circuit of Induction Motor, Stator resistance test, No load and blocked rotor test, construction of circle diagram, determination of performance parameters from circle diagram, Double cage Induction Motor and its equivalent circuit, Induction generator

- **Content Delivery Methods:**

Chalk and talk, Power point presentation

- **Assessment Methods:**

Numerical related to Circle Diagram and Double cage Induction Motor

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SECTION-II

Unit 4-Single Phase Induction Motor **No of lectures – 07**

- **Prerequisite:**

Principle of operation of three phase Induction Motor, Torque slip characteristics of three phaseInduction Motor

- **Objectives:**

1. To make student analyze behavior and operation of single-phase Induction Motor

- **Outcomes:**

After completing this unit, students –

Can find suitable application of various single-phase Induction Motor as per their torque speedrequirement

- **Unit Content:**

Principle of operation, Concept of double field revolving theory & cross field theory, Types of single-phase IM based on method of self-starting and their Torque-slip characteristics, Equivalent circuit, Determination of equivalent circuit parameters using OC & SC Tests

- **Content Delivery Methods:**

Chalk and talk, Video lectures, Animations

- **Assessment Methods:**

Numerical related to equivalent circuit of Single-phase Induction Motor

Unit 5-Synchronous Generator **No of lectures – 07**

- **Prerequisite:**

Construction of three phase Induction Motor, Concepts of vector diagrams

- **Objectives:**

1. To make student understand working operation of synchronous generator
2. To make student understand various performance analysis methods of synchronous generator

- **Outcomes:**

After completing this unit, students –

1. Can find performance parameters through various methods like EMF and MMF Method
2. Can analyze operation of synchronous generator under parallel operation

- **Unit Content:**

Construction (Salient and Non – Salient type), Principle of operation, Winding factors, EMF Equation, Armature reaction, Equivalent circuit and Vector diagram, Voltage regulation, determination of voltage regulation (EMF Method, MMF Method, ZPF Method), Paralleloperation of alternators, Methods of synchronization

- **Content Delivery Methods:**

Chalk and talk, Video lectures

- **Assessment Methods:**

Numerical related to EMF, MMF and ZPF Methods, EMF Equation, and Synchronizing Power

Unit 6-Synchronous Motor **No of lectures – 06**

- **Prerequisite:**

Operation and Construction of three phase Induction Motor, concepts of vector diagrams

- **Objectives:**

1. To make student understand working operation of synchronous Motor
2. To make student understand various performance analysis methods of synchronous Motor

- **Outcomes:**

After completing this unit, students –

1. Can find performance parameters through various methods like Equivalent circuit and vectorDiagrams at different excitations
2. Can analyze operation of synchronous Motor under different operating conditions

- **Unit Content:**

Principle of operation, Methods of starting, Equivalent circuit, Performance and vector diagram with different excitations, Losses and Efficiency, V and inverted V curves, Hunting- its causes and remedies

- **Content Delivery Methods:**

Chalk and talk, Video lectures, Analogies

- **Assessment Methods:**

Numerical related to equivalent circuit and performance under various excitations

Internal Continuous Assessment (ICA):

ICA shall consist of Minimum EIGHT experiments from following list

1. Determination of efficiency & speed regulation of 3 Phase IM by direct loading method
2. Determination of efficiency & speed regulation of 3 Phase IM by indirect loading method
3. Determination of equivalent circuit parameters of 3 Phase SCIM by conducting No Load &Blocked Rotor Test

4. Speed control methods of 3 Ph. SCIM
5. Speed control methods of 3 Ph. SRIM
6. Determination of efficiency & speed regulation of 1 phases Induction Motor
7. Determination of efficiency of alternator by direct loading
8. Determination of Voltage regulation of an alternator by EMF method
9. Determination of Voltage regulation of an alternator by MMF method
10. Parallel operation of alternators
11. Determination of V and Inverted V curves of a synchronous motor
12. Determination of efficiency of synchronous motor by indirect loading
13. Determination of efficiency of synchronous motor by direct loading

- **Text Books:**

1) Theory and Performance of Electrical Machines, J B Gupta, S K Kataria & Sons
2) A Text Book of Electrical Technology Vol 2, B L Theraja, S Chand
3) Principles of Electrical Machines, V K Mehta, Rohit Mehta, S Chand
4) Electrical machinery, PS Bhimbra, Khanna Publishers

- **Reference Books:**

1) Electrical Machinery, AE Fitzgerald, C Kingsley, S D Umans, Tata McGraw Hill
2) Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Sons
3) Performance and design of AC Machines, MG Say, ELBS Publication

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
S. Y. B. Tech. Electrical Engineering
Semester-II
(EESEC-01) COMPUTER AIDED DESIGN AND SIMULATION

Teaching Scheme	Examination Scheme
Theory: - 1 Hr./Week, 1 credit	**ICA-**25 Marks
Practical: - 2 Hrs/Week, 1 Credit	**POE:** 25 Marks

Course Prerequisite:
Student shall have adequate basic knowledge of software and programming using any language

Course Objectives
- To develop conceptual & analytical understanding of Electrical engineering through computer-based simulation.
- To develop design skills so that students become able to handle design software for different applications in electrical engineering.
- To make students familiar with simulation software for electrical engineering.
- To make students familiar with Design software for electrical engineering

Course Outcome
After successful completion of this course student will be able to:
- Handle Simulation software for different applications in electrical engineering.
- Understand steady state analysis of various electrical devices through simulation.
- Create Design of various devices used in electrical engineering.
- Handle design software for different applications in electrical engineering.

SECTION-I

Unit 1: Basics of Simulation software **No of lectures – 02**

- **Prerequisite:**

Software environment

- **Objectives:**

1. To learn Simulation environment.
2. To understand General commands used in simulation software

- **Outcomes:**

After completion of this unit,
1. Students will be able to create General commands used in simulation software

- **Unit Content:**

Introduction to simulation, Importance of simulation in Electrical Engineering, Organization of Simulink, Input-output, File types, General commands, Entering Matrix, indexing matrix, matrix manipulation, creating vectors, Matrix and array operations such as arithmetic operators, logical operators, Elementary math functions.

- **Content Delivery Methods:**

Chalk and talk, PPT

- **Assessment Methods:**

Apply programing software

Unit 2: Graphics and simulation toolbox **No of lectures – 02**

- **Prerequisite:**

Graphical user interface, Block diagram

- **Objectives:**

1. To learn 2D and 3D plots
2. To learn block diagram, Simulink simulation

- **Outcomes:**

After completion of this unit,

1. Students will be able to create 2D and 3D plots
2. Students will be able to construct block diagram, Simulink simulation

- **Content:**

Basic 2D plots: labels, title, legend, text objects, axis control, overlay plots, Introduction to 3D plots: Concepts of mesh & surface plots,Introduction to various block set in Simulink toolbox: (continuous, discrete, logic and bit operation, Math operation, Model verification, Port and subsystem, signal attributes, signal routing, sinks, sources).

- **Content Delivery Methods:**

Chalk and talk, Video lectures and PPT

- **Assessment Methods:**

Apply simulation modelling skill in simulation software.

Unit 3: Toolbox for electrical applications **No of lectures – 02**

- **Prerequisite:**

Electrical Machines, Machine Design, measurement.

- **Objectives:**

1. To learn Tool Box for electrical engineering

- **Outcomes:**

After completion of this unit,

1. Students will be able to apply toolbox for various electrical applications.

- **Content:**

Study and understanding of every block set of Toolbox: electrical sources block set, elements block set, Machines block set, Measurement block set, phasor elements block set.

- **Content Delivery Methods:**

Chalk and talk, Video lectures and PPT

- **Assessment Methods:**

Apply simulation modeling skill in simulation software.

SECTION-II

Unit 4: Basics of Design software **No of lectures – 02**

- **Prerequisite:**

Software environment

- **Objectives:**

1. To learn Design software environment
2. To understand General commands used in design software

- **Outcomes:**

After completion of this unit,

1. Students will be able to use general commands used in design software

- **Unit Content:**

Introduction to CAD software, opening an existing file, making changes, saving a file, closing the file, Basic commands for 2D drawing like: Line, Circle, Arc, and Ellipse etc.

- **Content Delivery Methods:**

Chalk and talk, PPT, Video lectures

- **Assessment Methods:**

Apply commands in software

Unit 5: Concept of Drawing **No of lectures – 02**

- **Prerequisite:**

Basics of CAD software

- **Objectives:**

1. To learn various concepts of CAD software

- **Outcomes:**

After completion of this unit,

1. Students will be able to describe various concepts of CAD software

- **Unit Content:**

Setting the drawing units, Setting the drawing limits, coloring of object, Grid and Snap, Ortho mode, Object snap, polar tracking, scale factors, line type, line weight, multiline, polylines, Rectangles, polygons etc.

- **Content Delivery Methods:**

Chalk and talk, PPT, Video lectures

- **Assessment Methods:**

Apply concepts in CAD software

Unit 6: Editing Object, Text and Unit **No of lectures – 02**

- **Prerequisite:**

Commands and concepts of CAD software

- **Objectives:**

1. To learn editing the object with text and units.

- **Outcomes:**

After completion of this unit,

1. Students will be able to edit the object with text and units.

- **Unit Content:**

Copying object, move, mirrors (mirroring object), offset, rotate, scale, stretch, lengthen, trim, extend, chamfer, fillet, break, array etc., creating single line text, paragraph text, multiple text editor options, text size and plotting/printing, creating .def. files.

- **Content Delivery Methods:**

Chalk and talk, PPT, Video lectures

- **Assessment Methods:** Apply concepts and commands in CAD software

Internal Continuous Assessment (ICA):

- **ICA shall consist of Minimum Eight Practical's on any simulation and Design Software**
- **Minimum Four simulation-based Experiment should be conducted but not restricted the following**

1.Simulation for verification of KCL and KVL.

2.Simulation for verification of Thevenins Theorem.

3.Simulation for verification of Superposition Theorem.

4.Steady state analysis of DC Machine using Simulation.

5.Steady state analysis of Induction Motor using Simulation.

6.Steady state analysis of Single-phase Transformer using Simulation.

7.Steady state analysis of Short Transmission Line using Simulation.

8.Steady state analysis of Medium Transmission Line using Simulation.

- **Minimum Four Design based Experiment should be conducted but not restricted thefollowing**

1.Design of construction of underground cables.

2.Design of sample single line diagram of power system.

3.Design of various bus bar arrangements in substation.

4.Design of distribution system network.

5.Design of typical layout of thermal power plant.

6.Design of typical layout of nuclear power plant.

7.Design of typical layout of solar power plant

8.Design of cross-sectional view of wind power plant.

Note: Use text books and reference books as per the simulation and design software used.

A. Multidisciplinary Minor in "Sustainable Energy System"

Sem	Course Code	Title
IV	EEMDM-02 A	Advanced Application in Renewable Energy

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. Electrical Engineering Semester-II

(EEMDM-02A) ADVANCED APPLICATION IN RENEWABLE ENERGY

Teaching Scheme	Examination Scheme
Theory: - 2 Hrs/Week, 2 Credits	**ESE -** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ISE –** 30 Marks
	ICA - 25Marks

Course Objectives:

- The distinction between renewable and non-renewable energy sources and evaluate their respective roles in meeting current and future energy demands.
- Analyze global and national energy scenarios to identify strategies for sustainable energy development.
- Explore the production, storage, transportation, and utilization of hydrogen gas as an alternative energy carrier, including its potential applications in vehicle propulsion systems.
- Examine the principles of passive and active solar building heating and cooling technologies, including the design and integration of solar thermal systems.
- Investigate the fundamentals of solar drying techniques and solar desalination processes

Course Outcome Statements:

On completion of the course, student will be able to-

- Differentiate between renewable and non-renewable energy sources and formulate strategies for sustainable energy development.
- Demonstrate proficiency in the production, storage, and utilization of hydrogen gas as an alternative fuel, and evaluate its potential applications.
- Design and implementing solar thermal systems for building heating, cooling, and refrigeration, integrating passive and active solar technologies.
- Design and operate solar drying systems for food preservation and solar desalination systems.
- Competent in the design, installation, and performance analysis of solar photovoltaic (PV) power systems for various applications

SECTION I

Unit 01: Introduction to Energy Sources (4 Hrs)

Renewable and non-renewable energy sources, strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. India's Production and reserves, energy alternatives.

Unit 02: Hydrogen Energy& chemical energy (5 Hrs)

Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles, Basic Battery theory, Definition of fundamental quantities and characteristics, different types of batteries, different types of battery arrangements. Comparative study of all renewable energy sources on economical base.

Unit 03: Solar Based Building Heating & Cooling (6 Hrs)

Passive Heating of Buildings: Direct Gain, Thermal storage wall, Sunspaces, Thermal storage roof, Convective loop. Passive cooling of buildings: Shading, ventilation, evaporation, radiation cooling, ground coupling, dehumidification. General aspects of Solar active heating of buildings, Components of solar heating system (solar collector, concentrating collectors, thermal storage system, Auxiliary heat supply system, and control systems). Solar air heaters and water heaters, solar cooker, Solar thermoelectric refrigeration and air-conditioning.

SECTION II

Unit 04: Solar Drying of Foods & Solar Desalination (07 Hrs)

Basics of solar drying. Types of solar dryers: Natural convection or Direct-type solar dryers. Forced circulation type dryers: Hybrid dryer, Hot air industrial process heat system. Solar Desalination: Simple solar still, Basics of solar still, material problems in solar still, Performance prediction of Basin-Type still. Wick-type solar still. Multi-stage solar still. Active solar still. Future material advancements.

Unit 05: Solar Photovoltaic Power Applications (08 Hrs)

Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, solar photovoltaic system, Standards of solar photovoltaic system, Rooftop Solar PV Systems: Introduction, system components, typical schematic diagram of rooftop solar PV systems, costing, net-metering of rooftop grid-connected system, system performance analysis (Performance Ratio and Levelized Cost of Electricity). Solar PV water pumping system. Solar PV battery charging system. Solar PV Street lighting system. Floating solar PV systems.

Textbooks:

1. Chetan S. Solanki., “Solar Photovoltaic: Fundamentals, Technologies and Application”.
2. S. P. Sukhatme and J. K. Nayak, “Solar Energy: Principles of Thermal Collection and Storage”.
3. J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Process”.
4. H. P. Garg and J. Prakash, “Solar Energy: Fundamentals and Applications”

References:

1. Twidell & Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis)
2. Ramesh & Kumar “Renewable Energy Technologies”, Narosa
3. G D Rai “Non-Conventional Energy Sources”, Khanna Publications
4. Tiwari and Ghosal “Renewable energy resources”, Narosa.

5. D.P. Kothari, K.C.Singhal, “Renewable energy sources and emerging technologies", P.H.I.

ICA: ICA Shall Consist of Minimum Six Experiments based on above syllabus but not restricted to the following list

1. To compare and contrast the characteristics and availability of renewable and non-renewable energy sources.
2. To demonstrate different methods of hydrogen production and storage and evaluate their efficiency
3. To measure and analyse the performance of a solar air heater in heating air for various applications.
4. To investigate the efficiency of a solar water heater system in heating water
5. To design and construct a simple solar still for desalinating water and evaluate its effectiveness.
6. To measure and compare the efficiency of different types of photovoltaic cells under varying conditions.
7. To understand series and parallel connection of solar cell
8. To design and simulate a rooftop solar PV system
9. Evaluate the performance of a solar PV battery charging system.

B. Multidisciplinary Minor in "Electrical Vehicle System"

Sem	Course Code	Title
IV	EEMDM-02 B	Electric Vehicle Motors

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. Electrical Engineering Semester-II

(EEMDM-02 B) ELECTRIC VEHICLE MOTORS

Teaching Scheme
Theory: - 2 Hrs/Week, 2 Credits
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ESE - 70 Marks
ISE – 30 Marks
ICA - 25Marks

- **Course Objective:**
  - Understand requirement of EV motors
  - Understand suitability of electric motors & their control.
  - Understand speed control of Induction motors.
- **Course Outcomes: Students' will be able to:**
  - Select the appropriate type of motor to be used in an electric vehicle.
  - Apply the required control strategy to the Electric Vehicle motors.

SECTION I

UNIT I: Fundamentals of Electric Motor (5 Hrs)

Overview of electric propulsion systems, Role of electric motors in EVs, Comparison of motor types (DC, induction, synchronous, permanent magnet), Principles of electromagnetism, Operating principles of electric motors (Faraday's law, Lorentz force, torque production), Construction and components of electric motors

UNIT II: DC Motor: (5 Hrs)

Types of DC motors. construction, operation, and control. Brushed DC motors: construction, operation, and control.

SECTION II

UNIT III: – Induction Motors:(5 Hrs)

Three phase induction motors, working principle, Design considerations for induction motors in EVs, Variable frequency drives (VFDs) and control strategies

UNIT IV: Starters (5 Hrs)

Need and types; stator resistance, auto transformer, star delta, rotor resistance and soft starters.

UNIT V: – Other Motors used in Electric Vehicles:(5 Hrs)

Construction and working of Permanent Magnet Synchronous Motor (PMSM), Switched

Reluctance Motors (SRM), Brushless DC Motor.

Textbook:

"Electric Motors and Drives: Fundamentals, Types, and Applications" by Austin Hughes and Bill Drury, 2013.

References:

"Electric Motor Control: Fundamentals of Electric Motor Drive Systems" by R. Krishnan, 2014.

"Advanced Electric Drive Vehicles" by Ali Emadi, 2014.

Journal papers and technical articles related to electric vehicle motors.

ICA:

ICA should consist of minimum Five assignments based on above syllabus and one mini project related to control of electric motors

A. Honors in Electrical Vehicle

Course Code	*Course Name*	*Hrs./week*			*Credits*	*Examination Scheme*			
		L	*T*	*P*		*ISE*	*ESE*	*ICA*	*Total*
SY Sem I									
EEHn-01A	Electric Vehicle Technology	3		2	4	30	70	25	125
SY Sem II									
EEHn-02A	Electric Motors and Controls for Electric Vehicle	3	1		4	30	70	25	125
TY Sem I									
EEHn-03A	Energy Management System for Electric Vehicle	3		2	4	30	70	25	125
TY Sem II									
EEHn-04A	Testing and Certification of Electric and Hybrid Vehicles	3		2	4	30	70	25	125
B. Tech Sem I									
EEHn-05A	Mini Project			4*	2			50	50
Sub Total		**12**	**1**	**10**	**18**	**120**	**280**	**150**	**550**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. B.Tech. Electrical Engineering Semester-I

(EEHn-01A) ELECTRIC VEHICLE TECHNOLOGY

Teaching Scheme	**Examination Scheme**
Theory: - 3 Hrs/Week, 3 Credits	**ESE -** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ISE –** 30 Marks
	ICA - 25Marks

- **Course Objective:**
  - To provide the basics of hybrid electric vehicle
  - To make the students aware of performance parameters of electric vehicle.
  - To elaborate the concepts & architecture of HEVs, PHEVs
  - Develop awareness for solar powered charging system
  - Make the student aware of mobility and connectors.
- **Course Outcomes: After the completion of this course, students will be able to:**
  - Understand the basics of electric vehicle.
  - Describe the Mechanics of electrical Electric Vehicle.
  - Analyze the performance & configurations of electric vehicles based on motor characteristics.
  - Elaborate the concepts & architecture of HEVs, PHEVs and classify it.
  - Explain Social, Environmental & Economic Aspects of Solar Powered Charging Systems.
  - Understand The Mobility & Connectivity used in the Charging System

SECTION I

UNIT I: INTRODUCTION TO ELECTRIC VEHICLE (6 Hrs)

History of electric vehicle, Electric vehicle components, Vehicle mass and performance, electric motor and engine ratings, fuel economy, Electric vehicle market.

UNIT II: VEHICLE MECHANICS (6 Hrs)

Laws of motion, vehicle kinetics, motion dynamics, propulsion power, velocity and acceleration, force mechanics.

UNIT III: CHARACTERISTICS AND PERFORMANCE OF ELECTRIC VEHICLE (9 Hrs)

Electric vehicle configurations, electric motor characteristics, tractive effort and transmission requirements, tractive effort in normal driving, energy consumption and vehicle performance.

SECTION II

UNIT IV: HYBRID ELECTRIC VEHICLE (7 Hrs)

Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Plug-In Hybrid Electric Vehicle,Powertrain Component Sizing, Mass Analysis and Packaging

UNIT V SOLAR POWERED CHARGING SYSTEM (5 Hrs)

Social Benefits of SPCSs, Environmental Benefits of SPCSs, Economic Benefits, Electric Vehicle Supply Equipment, Locations for SPCSs, Energy Storage, Life Cycle Analysis of SPCSs.

UNIT VI: MOBILITY AND CONNECTORS (9 Hrs)

Mobility - Connected Mobility and Autonomous Mobility, E-Mobility, Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs.

Connectors- Types of EV charging connector, North American EV Plug Standards, DC Fast Charge EV Plug Standards in North America, CCS (Combined Charging System), CHAdeMO, Tesla, European EV Plug Standards,

Reference books:

1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
3. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000
5. .http://nptel.ac.in/courses/108103009/

ICA:

It should consist of minimum 6 experiments based on above syllabus but not restricted to list ofexperiments given below.

List of Experiments:

1) Modeling and Simulation of DC Motor Characteristics.
2) Modeling and Simulation of Induction Motor Characteristics.
3) Modeling and Simulation of BLDC Motor Characteristics.
4) Modeling and Simulation of energy consumption and performance of electric vehicle.
5) Architecture development of Hybrid Electric Drive Trains.
6) Development of performance analysis of Powertrain Component Sizing for various Electric vehicle configurations
7) Development of mini solar powered charging system.
8) Conduct a case study related with Connected Mobility and Autonomous Mobility

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. Electrical Engineering Semester-II

(EEHn-02A) ELECTRIC MOTORS AND CONTROLS FOR ELECTRICVEHICLE

Teaching Scheme	Examination Scheme
Theory: - 3 Hrs/Week, 3 Credits	**ESE -** 70 Marks
Tutorial: - 1 Hrs/Week, 1 Credit	**ISE –** 30 Marks
	ICA - 25Marks

- **Course Objective:**
  - Provide the basics requirements of Electric Vehicle motors.
  - To understand the various control strategies applied to the motors used in electric vehicle.
- **Course Outcomes: After the completion of this course, students will be able to:**
  - Select appropriate type of motor to be used in electric vehicle.
  - Describe the drive System to be used in Electric Vehicle DC motors.
  - Describe the drive System to be used in Electric Vehicle AC motors.
  - Explain different field oriented control methods of Electric Vehicle motors.
  - Explain direct torque control methods of Electric Vehicle motors.
  - Apply the required control strategy to the Electric Vehicle motors.

SECTION I

UNIT I: ELECTRIC VEHICLE MOTORS (06 Hrs)

Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) –; Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Power flow in Hybrid Electric Drive Train System with different modes, Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor, Design.

UNIT II: CONVERTER AND CHOPPER CONTROL (08 Hrs)

Principle of phase control – Series and separately excited DC motor with single phase and three phase converters – waveforms, performance parameters, performance characteristics Operation with freewheeling diode schemes; Drive employing dual converter. Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor – performance analysis, multi-quadrant control.

UNIT III: VSI AND CSI FED INDUCTION MOTOR CONTROL (07 Hrs)

Stator Voltage Control of an induction Motor, VSI fed induction motor drives – V/f operation theory –Slip Power Recovery Theory, Closed loop speed control for VSI & Cyclo-Converter fed Induction motor drives. CSI fed induction machine Control – Closed loop Speed control of CSI Drive.

SECTION II

UNIT IV: FIELD ORIENTED CONTROL (7 Hrs)

Working Principle of Field oriented control of induction machines – Theory – DC drive analogy, – Direct or Feedback vector control - Indirect or Feed forward vector control — Flux Vector estimation- Principle of Space Vector Modulation control.

UNIT V: DIRECT TORQUE CONTROL (7 Hrs)

Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy – optimum switching vector selection –Torque ripple reduction methods in Induction motor drives.

UNIT VI: ELECTRIC VEHICLE CONTROL STRATEGY (7 Hrs)

Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy – optimum switching vector selection –Torque ripple reduction methods in Induction motor drives.

Reference Books:

1. Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw Hill,2000.
2. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice- Hall of India,Pvt. Ltd., New Delhi, 2003.
3. Austin Hughes, “Electric Motors and Drives – Fundamentals, Types and Applications”, Elsevier – a division of Reed Elsevier India private Limited, New Delhi, 2006.

ICA:

ICA should consist of minimum six assignments based on above syllabus

B. Honors in Sustainable Power System

	Course Name	*Hrs./week*			*Credits*	*Examination Scheme*			
		L	*T*	*P*		*ISE*	*ESE*	*ICA*	*Total*
SY Sem I									
EEHn-01B	Advanced and Sustainable Energy Sources	3	1		4	30	70	25	125
SY Sem II									
EEHn-02B	Smart Energy Management System	3		2	4	30	70	25	125
TY Sem I									
EEHn-03B	Distributed Energy Integration	3		2	4	30	70	25	125
TY Sem II									
EEHn-04B	AI Applications to Power Systems Management	3		2	4	30	70	25	125
B.Tech Sem I									
EEHn-05B	Mini Project			4*	2			50	50
Sub Total		**12**	**1**	**10**	**18**	**120**	**280**	**150**	**550**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. Electrical Engineering Semester-I

(EEHn-01B) ADVANCED AND SUSTAINABLE ENERGY SOURCES

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Tutorial: - 1 Hrs/Week, 1 Credit

Examination Scheme
ESE - 70 Marks
ISE – 30 Marks
ICA - 25Marks

- **Course Objective:**
  - To introduce various sustainable energy source technologies.
  - To familiarize the students with characteristics and modeling various sustainable energy source.
- **Course Outcomes: Students' will be able to:**
  - Describe the various sustainable energy source technologies
  - Discriminate various sustainable energy sources according to their characteristics and modeling.

SECTION I

UNIT I: CONVENTIONAL SOURCES OF ENERGY: (9 Hrs)

Construction, working principal, application, advantages, disadvantages of Coal, Hydro, Nuclear, Diesel and Gas Turbine Power Stations. Comparative study of power stations. Environmental Impacts and Sustainability of conventional sources of power.

UNIT II: SUSTAINABLE SOURCES OF ENERGY (12 Hrs)

Wind Generation: Wind source, wind statistics, energy in the wind, aerodynamics, rotor design and types, braking systems, tower, control and monitoring system, power performance. Wind driven induction generators, power circle diagram, steady state performance, wind farm electrical design.

Solar Power Generation: Basic characteristics of sunlight, solar energy resource, photovoltaic cell characteristics, equivalent circuit, photo voltaic for battery charging. Solar power generation: Solar power plant, photo voltaic power generation.

SECTION II

UNIT III: ADVANCED ENERGY SOURCES: (11 Hrs)

Construction, working principal, environmental aspects, application, advantages, disadvantages, performance analysis and components design of Marine, biomass, Tidal, Geo-•thermal, OTEC, MHD, Beta voltaic, Recycling Radio Waves, turboelectric Nano generators, Fuel Cell, etc power generating sources.

UNIT IV: HYBRID & INTEGRATED SOURCES: (10 Hrs)

Construction, working principal, environmental aspects, application, advantages, disadvantages, performance analysis and components design of Wind-diesel, wind-•solar, Micro-•hydel, geothermal-•tidal. Co- generation, Hydro-•thermal Energy co-• ordination.

Reference Books:

1. G. D. Rai, "Non--Conventional Energy Sources", Khanna Publishers.
2. B. H. Khan, "Non--Conventional Energy Resources", Tata McGraw-•Hill Education.
3. G. S. Sawhney, "Non --Conventional Resources of Energy", PHI.

ICA:

ICA should consist minimum four assignments based on above syllabus and visit to any power plant mentioned in syllabus.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

S.Y. Electrical Engineering Semester-II

(EEHn-02B) SMART ENERGY MANAGEMENT SYSTEM

Teaching Scheme	**Examination Scheme**
Theory: - 3 Hrs/Week, 3 Credits	**ESE -** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ISE –** 30 Marks
	ICA - 25Marks

- **Course Objective:**
  - To introduce the concept of smart grid and its role in energy management systems.
  - To familiarize the students with modeling of smart grids components.
  - To give an understanding of smart cities.
- **Course Outcomes: Students' will be able to:**
  - Describe the role of smart grid in energy management systems.
  - Develop modeling of smart grid components.
  - Describe the concept of smart cities.

SECTION I

UNIT I: SMART GRID AND EMERGING TECHNOLOGIES (7 Hrs)

Introduction, Operating principles and models of smart gird components, Key technologies for generation, networks, loads and their control capabilities; Decision making tools, Hardware-Software Communication. Approaches to estimation, scheduling, management and control of next generation smart grid.

UNIT II: COMPONENT AND ENERGY STORAGE MODELING: (7 Hrs)

Generation Systems, Network Modeling: Transmission and Distribution. Various storage mediums, Distribution and grid scale storage, Load Modeling, Demand Side Management: Principles of DSM, rules and tools of DSM, fundamentals of demand response, Demand aggregation, DSM tools and practices.

UNIT III: COMPUTATIONAL METHODS FOR SEMS: (7 Hrs)

Estimation, optimization algorithms, data mining techniques and its applications, artificial intelligence techniques, Grid computing: Architecture, functionalities and features, applications to security, reliability and market analysis.

SECTION II

UNIT IV: DISTRIBUTION GRIDS: (7 Hrs)

Characteristics: Assets, topology, From passive to active grids. Distribution power flow. Metering for residential customers: ToU, RTP, CPP. Metering for industrial customers. Monitoring, Control and protection applications in distribution grids. Substation Automation and Equipment condition monitoring.

UNIT V SMART GRID APPLICATIONS: (7 Hrs)

Advanced Metering Infrastructure, Smart meters, Demand response and Demand side management, PHEV, application at the DSO side. Operation and control issues associated with intermittent generation. Impact of smart grid component integration on distribution network operation.

UNIT VI: SMART CITIES AND INTEGRATED APPROACHES TO ENERGY MANAGEMENT: (7 Hrs)

Components of Smart Cities, integrated approaches to smart city modeling, challenges, Smart Parking, Smart Roads, Smart Payments, Smart Vending Machines. Smart Home Systems: Home automation systems, building energy, smart appliances, Smart lighting. Electricity, Gas, Heating and cooling system, modeling.

Reference books:

1. S. Rajakaruna, F. Shahnia and A. Ghosh, “Plug in Electric Vehicles in Smart Grids Energy Management”, Springer 2015
2. Faruqui, “Pricing in Competitive Electricity Market”, Springer Science + Business Media.
3. Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed and Efficient Energy”, Academic Press, Elsevier
4. S. McClellan, “Smart Cities”, Springer International Publishing

ICA:

It should consist of minimum 6 experiments based on above syllabus but not restricted to list of experiments given below.

List of Experiments:

1. Modeling and Simulation of Smart grid components.
2. Modeling and Simulation of Energy storage system.
3. Development of optimization algorithm for smart energy management system..
4. Modeling for estimation of smart energy management system.
5. Architecture development of Smart and micro grids for energy management system.
6. Modeling and simulation of distributed grid configurations.
7. Smart City blueprint and prototype design.
8. Development of hardware-software communication signaling used in smart grid.