Regulation 2023
Program Structure

1124 Diploma in Renewable Energy

Program Outcomes (PO's)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability, attitude, and behavior that students acquire through the program.
The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of an engineering diploma graduate.
NBA has defined the following seven POs for an Engineering diploma graduate:
PO1: Basic and Discipline-specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and an engineering specialization to solve the engineering problems.
PO2: Problem analysis: Identify and analyse well-defined engineering problems using codified standard methods.
PO3: Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
PO4: Engineering Tools, Experimentation, and Testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
PO5: Engineering practices for society, sustainability and environment: Apply appropriate technology in the context of society, sustainability, environment and ethical practices.
PO6: Project Management: Use engineering management principles individually, as a team member or as a leader to manage projects and effectively communicate about well-defined engineering activities.
PO7: Life-long learning: Ability to analyse individual needs and engage in updating in the context of technological changes.

Credit Distribution

Semester	No of Courses	Periods	Credits
Semester I	8	640	20
Semester II	9	640	20
Semester III	8	640	21
Semester IV	7	640	20
Semester V	7	640	21
Semester VI	3	675	18
		Total	**120**

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R2023 DIPLOMA IN RENEWABLE ENERGY (1124)

Semester I

C. No.	Course Type	Course Title	Course Code	L-T-P	Periods	Credit	End Exam	Campus
1	Theory	Tamil Marabu	TA231110	2-0-0	30	2	Theory	College
2	Theory	Basic Mathematics	MA231120	3-1-0	60	4	Theory	College
3	Practicum	Basic Physics	PH231330	2-0-2	60	3	Theory	College
4	Practicum	Basics Chemistry	CH231340	2-0-2	60	3	Theory	College
5	Practicum	English for Workplace Communication	1124231540	1-0-2	45	2	Practical	Industry
6	Practicum	Basic Workshop Practices	WP231360	1-0-2	45	2	Practical	College
7	Practical	Digital Workplace Skills	DS231270	0-0-4	60	2	Practical	College
8	Integrated Learning	Advanced Certification Course - I (English for Employability)	1124231860	0-0-4	60	2	NA	Industry
9	Integrated Learning (Plant)	Growth Lab	1124231880	---	30			Industry
10	Integrated Learning (Plant)	Induction Program I	1124231881	---	40	0		Industry/College
11	Integrated Learning (Plant)	I&E/ Club Activity/ Community Initiatives	1124231882	---	30	0		Industry
12	Integrated Learning (Plant)	Shop Floor Immersion	1124231883	---	8	0		Industry
13	Integrated Learning (Plant)	Student Led Initiative	1124231884	---	22	0		Industry
14	Integrated Learning (Plant)	Health & Wellness	1124231886	---	30	0		Industry
		Library			30			Industry/College
		Test and Revisions			30			Industry/College
					640	20		

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Semester II

C. No.	Course Type	Course Title	Course Code	L-T-P	Periods	Credit	End Exam	Campus
1	Theory	Tamils & Technology	TA232110	2-0-0	30	2	Theory	College
2	Theory	Basics of Electrical and Electronics Engineering	1030232120	3-0-0	45	3	Theory	College
3	Practicum	Applied Mathematics II	MA232432	1-0-4	75	3	Practical	College
4	Practicum	Applied Physics II	PH232442	1-0-2	45	2	Practical	College
5	Practicum	Applied Chemistry II	CH232452	1-0-2	45	2	Practical	College
6	Practicum	Basics Engineering Practices	EP232460	1-0-2	45	2	Practical	College
7	Lab	Drafting Practices	DP232270	0-0-4	60	2	Practical	College
8	Practicum	Functional English for Technicians	1124232840	1-0-2	45	2	Practical	Industry
9	Advance Skill Certification	Advance Skills Certification II	1124232860	1-0-2	45	2	NA	Industry
10	Integrated Learning (Plant)	Growth Lab	1124232880	---	30	0		Industry
11	Integrated Learning (Plant)	I&E/ Club Activity / Community Initiatives	1124232882	---	30	0		Industry
12	Integrated Learning (Plant)	Shop Floor Immersion	1124232883	---	8	0		Industry
13	Integrated Learning (Plant)	Student Led Initiative	1124232884	---	24	0		Industry
14	Integrated Learning (Plant)	Emerging Technology Immersions	1124232885	---	8			Industry
15	Integrated Learning (Plant)	Health & Wellness	1124232886	---	30	0		Industry
		Library			15			Industry / College
		Test and Revisions			60			Industry / College
	Total				640	20		

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Semester III

C. No	Course Type	Course Title	Course Code	L-T-P	Periods	Credit	End Exam	Campus
1	Theory	Electrical Circuit & Machines	1124233110	4-0-0	60	4	Theory	College
2	Practicum	Fundamentals of Renewable Energy	1124233230	2-0-2	60	3	Theory	Industry
3	Practical	Electrical Circuit & Machine Practical	1124233320	0-0-4	60	2	Practical	College
4	Practicum	Fundamentals of Thermodynamics & Heat Transfer	1124233440	1-0-4	75	3	Practical	College
5	Practicum	Electronic Devices and Circuits Practical	1124233540	1-0-4	75	3	Practical	College
6	Practicum	Solar PV & Manufacturing - I	1124233640	1-0-4	75	3	Practical	Industry
7	Industry Skill Training	Advanced Skill Certification III	1124233760	0-0-4	60	2	NA	Industry
8	Integrated Learning (Plant)	Induction Program - II (Microsoft Tools Training)	1124233881	---	60	0		Industry
9	Integrated Learning (Plant)	I&E/ Club Activity/ Community Initiatives	1124233882	---	25	0		Industry
10	Integrated Learning (Plant)	Student-Led Initiative (Soft Skills I)	1124233884	---	30	0		Industry
11	Integrated Learning (Plant)	Health & Wellness	1124233886	---	30	1		Industry
		Library			15			Industry / College
		Test and Revisions			15			Industry / College
		Total			640	21		

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Semester IV

C. No	Course Type	Course Title	Course Code	L-T-P	Periods	Credit	End Exam	Campus
1	Theory	Generation,Transmission and Switch Gear	1124234110	4-0-0	60	4	Theory	College
2	Theory	Renewable Energy Instrumentation Applications	1124234210	3-0-0	45	3	Theory	Industry
3	Practicum	Distribution and Solar Installation	1124234330	2-0-2	60	3	Theory	College
4	Practical	Renewable Energy Instrumentation Applications Laboratory	1124234420	0-0-4	60	2	Practical	Industry
5	Practicum	Hydraulics & Pneumatics	1124234540	1-0-4	75	3	Practical	College
6	Practicum	Solar PV & Manufacturing - II	1124234640	1-0-4	75	3	Practical	Industry
7	Industry Skill Training	Advanced Skill Certification IV	1124234760	0-0-4	60	2	NA	Industry
8	Integrated Learning (Plant)	Induction Program - III (ERP Tools I)	1124234881	---	45	0		Industry
9	Integrated Learning (Plant)	I&E/ Club Activity/ Community Initiatives	1124234882	---	25	0		Industry
10	Integrated Learning (Plant)	Site Visits	1124234883	---	30	0		Industry
11	Integrated Learning (Plant)	Student-Led Initiative (Soft Skills II)	1124234884	---	30	0		Industry
12	Integrated Learning (Plant)	Technology Seminars / Workshops	1124234885	---	15	0		Industry
13		Health & Wellness	1124234886	---	15			Industry
		Library			15			Industry
		Test and Revisions			30			Industry
	Total				640	20		Industry

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Semester V

C. No.	Course Type	Course Title	Course Code	L-T-P	Periods	Credit	End Exam	Campus
1	Theory	Energy Efficiency, Economics & Audit	1124235110	4-0-0	60	4	Theory	College
2	Theory	Wind Energy and Battery Energy Storage System	1124235210	3-0-0	45	3	Theory	College
3	Practicum	**Elective 1**		3-0-2	75	4	Theory	College
4	Practicum	Power Electronics	1124235440	1-0-4	75	3	Practical	College / Industry
5	Practicum	PLC & Automation	1124235540	1-0-4	75	3	Practical	College / Industry
6	Practicum	Innovation & Start-ups	1124235640	1-0-2	45	2	Project	Industry
7	Industry Skill Training	Advanced Skill Certification V	1124235860	0-0-4	60	2	Skill	Industry
8	Integrated Learning (Plant)	Induction Program - IV (ERP Tools II)	1124235981	---	40	0		Industry
9	Integrated Learning (Plant)	I&E/ Club Activity/ Community Initiatives	1124235882	---	30	0		Industry
10	Integrated Learning (Plant)	Health & Wellness	1124235886	---	30	0		Industry
11	Integrated Learning (Plant)	Placement Training	1124235987	---	45	0		Industry
		Library			15			College / Industry
		Test and Revisions			45			College / Industry
		Total			640	21		

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Semester VI

.	Course Type	Course Title	Course Code	L-T-P	Periods	Credit	End Exam	Campus
1	Practicum	Elective 2		2-0-2	60	3	Theory	College / Industry
2	Practicum	Elective 3		1-0-4	75	3	Practical	College / Industry
3	Practical	Internship	1124236351		540*	12	Practical	Industry
		Total			675	18		

* Industry training periods.

Elective 1

Course Category	Course Title	Course Code	L-T-P	Periods	Credit	End Exam
Program Elective	Electric Vehicle Technology	1124235331	3-0-2	75	4	Theory
Program Elective	Bio Energy	1124235332	3-0-2	75	4	Theory
Open Elective	Online Courses	1124235300			4	

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Elective 2

Course Category	Course Title	Course Code	L-T-P	Periods	Credit	End Exam
Program Elective	Fuel Cell & Hydrogen Energy	1124236131	2-0-2	60	3	Theory
Program Elective	IOT and Applications	1124236132	2-0-2	75	3	Theory
Program Elective	Installation, Maintenance & Maintenance of Renewable Power Plants	1124236133	2-0-2	60	3	Theory

Elective 3

Course Category	Course Title	Course Code	L-T-P	Periods	Credit	End Exam
Program Elective	Electrical CAD Design	1124236241	1-0-4	75	3	Practical
Program Elective	Electrical Estimation & Costing	1124236242	1-0-4	75	3	Practical
Program Elective	Microcontroller & Embedded Systems	1124236243	1-0-4	75	3	Practical

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Program Structure

1. Academic Theory, Practical, and Practicum Subjects (College Campus)

- Venue: The core domain academic subjects, including theory, practicals, and practicum components, shall be conducted in the College Campus.
- Scheduling: These classes shall be scheduled by the Head of Institution (HOI) and Head of Department (HOD) at the time of student availability at the institution.
- Academic Calendar: A tentative academic calendar, jointly prepared by the HOI and Industry Partner in accordance with the DoTE academic calendar, shall be adhered to for effective planning and coordination of Board Examinations.
- The campus of delivery may be mutually decided by the Head of Institution and the Industrial Training Partner, depending on the selected course or ILE activity.
- Additional Sessions: With prior notice, supplementary classes may be arranged on Saturdays or during the industrial training phase to ensure syllabus coverage, revision, and remedial instruction.

2. Industry-based Learning Components (Industry Campus)

- The Courses and ILE activities shall be delivered at the Industry Campus:
- These sessions shall be conducted by industry experts or certified trainers and scheduled by the Industry Training Head in coordination with the institutional team.

3. College/Industry Campus can be decided based on the requirement

- Assessment & Credits:
    - The internal assessments conducted by industry trainers, aligned with the credit structure of each course, shall be submitted to the institution in the prescribed format and officially recorded in the student's academic performance records.

4. Coordination and Flexibility

- In case of any overlap or schedule conflict, rearrangements can be made mutually by:
    - The Training Program Coordinator (Institution) and
    - The Training Head (Industry)
- This coordination shall ensure the smooth execution of the academic and industrial training schedules, without affecting the credit allocation or student learning outcomes. Ensure the academic calendar and schedule released by the DoTE office should be maintained for the training programme.

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Guidelines for Internship Training

Internship training should be the blend of Teaching - Learning - Practice components.
For the award of skill credit, the following distribution can be maintained. .

Teaching - 3 Credits.

The credit for teaching can be awarded by conducting lecture (Theory) classes based on the key skills / industrial practices required for the Diploma Engineer.
The suitable assessment methodology (Test / MCQ etc. - online or offline) shall be planned by the industry supervisor from the lecture given for the award of the credits and grade.
The document for this assessment can be kept in the Institution, the grade awarded by the training partner shall be forwarded as per the requirement of the Chairman Board of Examinations for the result process.

Learning - 3 Credits.

The credit for learning can be awarded through the presentation / report submission / project submission by the students from learning of the activities assigned during the training by the industry supervisor. Minimum one special activity should be provided for the students and sufficient required time should be given to prepare and present their learning as per the guidelines of the industry supervisor. This can be assessed by the industry supervisor / training program coordinator as per the schedule prepared by the industry advisor.
The document for this assessment can be kept in the Institution, the grade awarded by the training partner shall be forwarded as per the requirement of the Chairman Board of Examinations for the result process.

Practice - 6 Credits.

Practice credit can be awarded by evaluating the dairy and report submitted by the student during the industry training period of every six months. The assessment methodology can be designed and evaluated by the industry supervisor. The distribution of credits can be carried out periodically and at the end of the training.
The industry supervisor should be the distinguished experts who have made remarkable contributions in their professions in the field of engineering, science, technology and entrepreneurship. Those who have proven expertise in their specific profession or role with at least 5 years of service/experience, preferably at a senior level, will be assigned for the assessment and award of skill credit in every semester.

1124231540	English for workplace communication	L	T	P	C
PRACTICUM		1	0	2	2

Introduction (Objective of the Course)

This course aims to develop effective communication skills essential for students' academic, professional, and personal success. It introduces the nature and importance of communication, focusing on listening, speaking, reading, and writing as core language skills. The syllabus equips students with practical techniques to overcome communication barriers and participate confidently in formal and informal situations. Emphasis is given to business communication, professional etiquette, and workplace documentation to enhance employability. Overall, the course nurtures clarity of expression, active listening, and professional competence.

Course Outcomes

CO1: Analyze the nature, forms, and types of communication to differentiate appropriate communication modes (verbal, written, non-verbal; reading, writing, speaking, listening) for academic, professional, and organizational contexts.

CO2: Evaluate the communication process, techniques, and barriers to assess their impact on effectiveness and propose strategies to overcome communication barriers in real-life and workplace situations.

CO3: Apply advanced listening skills by analyzing formal and informal conversations, announcements, and commentaries to interpret intent, extract key information, and demonstrate active listening behaviors.

CO4: Create professionally structured written communications including business letters, emails, resumes, cover letters, and reports by applying principles of formal writing, mail etiquette, and sentence structuring.

CO5: Evaluate and demonstrate business communication practices by preparing agendas, minutes of meetings, official correspondence, and participating effectively in group discussions and organizational communication networks.

1124231540	English for workplace communication	L	T	P	C
PRACTICUM		1	0	2	2

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	–	3	2
CO2	2	3	–	–	1	3	2
CO3	–	2	–	–	–	3	2
CO4	–	2	–	–	2	3	2
CO5	–	2	–	–	2	3	2

Correlation Levels: 3 – High | 2 – Medium | 1 – Low

Syllabus Contents

Unit – 1: Nature of Communication

Definition, need for and importance of communication skills, types of communication - Reading, Writing, Speaking, Listening. Forms of Communication – Verbal, Written, Non-Verbal.

Unit – 2: Effective Communication

Communication process, Essentials of effective communication, communication techniques, barriers of communication, ways of overcoming barriers.

Unit – 3: Listening Skills

Purpose of Listening, Listening to Conversation (Formal and Informal), Active Listening- an Effective Listening Skill, Benefits of Effective Listening, Barriers to Listening, Listening to Announcements- (railway/ bus stations/ airport /sports announcement/commentaries/News etc.)

1124231540	English for workplace communication	L	T	P	C
PRACTICUM		1	0	2	2

Unit – 4: Writing Skills

The process of formal written communication, Business letters writing – Leave letter, request letter, permission letter, apology letter, mail etiquettes, resume, cover letter, etc., Structuring sentences.

Unit – 5: Business Communication

Basic Etiquettes, preparing Agenda, Minutes of meetings, drafting official mails, Communication network in organization – Horizontal, Vertical. Report Writing, Group Discussions.

Suggested Student Activities (Unit-wise)

- Nature of Communication:
  Activity: Group discussion on "Importance of Communication in Professional Life" and role-play demonstrating verbal and non-verbal communication.
- Effective Communication:
  Activity: Case study analysis on communication barriers in organizations and student presentations suggesting solutions.
- Listening Skills:
  Activity: Listening to recorded announcements/news clips followed by comprehension questions and summary writing.
- Writing Skills:
  Activity: Drafting formal letters, resumes, and emails based on real-life workplace scenarios.
- Business Communication:
  Activity: Mock meeting to prepare agenda and minutes, followed by group discussion and report writing.

Text References

1. Meenakshi Raman & Sangeeta Sharma, Technical Communication – Principles and Practice, Oxford University Press.

1124231540	English for workplace communication	L	T	P	C
PRACTICUM		1	0	2	2

2. Sanjay Kumar & Pushp Lata, Communication Skills, Oxford University Press.
3. Lesikar, Pettit & Flatley, Business Communication: Making Connections in a Digital World, McGraw-Hill.

Web References

- https://nptel.ac.in (Communication Skills courses by IITs)
- https://www.skillsyouneed.com
- https://www.britishcouncil.org/education/skills-employability
- https://www.coursera.org (Professional Communication courses)

Assessment Methodology:

Assessment Pattern

- Internal Assessment (IA): 40 Marks
- External Assessment (End Semester Examination): 60 Marks
- Total: 100 Marks

Internal Assessment – 40 Marks

Component	**Marks**	**Method of Evaluation**
Continuous Assessment Test (CAT)	10	Written test (objective + short answers)
Listening & Speaking Activities	10	Role play, listening tasks, presentations
Writing Skills Assignment	10	Letters, email, resume, report
Group Discussion / Seminar	5	Participation & communication effectiveness
Attendance & Classroom Participation	5	Regularity, involvement, discipline
Total	40	

1124231540	English for workplace communication	L	T	P	C
PRACTICUM		1	0	2	2

Internal Assessment Rubrics

1. Listening & Speaking Skills (10 Marks)

Criteria	**Excellent (4)**	**Good (3)**	**Average (2)**	**Needs Improvement (1)**
Clarity of Speech	Clear, fluent, confident	Minor pauses	Hesitant speech	Unclear, frequent pauses
Listening Accuracy	Fully understands & responds	Minor errors	Partial understanding	Poor comprehension
Non-Verbal Cues	Effective gestures & eye contact	Adequate	Limited	Ineffective
Interaction	Actively engages	Responds well	Limited participation	Passive

2. Writing Skills Assignment (10 Marks)

Criteria	**3 Marks**	**2 Marks**	**1 Mark**
Format & Structure	Correct professional format	Minor errors	Poor structure
Language & Grammar	Accurate & clear	Few errors	Frequent errors
Relevance & Content	Fully relevant	Partially relevant	Irrelevant

3. Group Discussion / Seminar (5 Marks)

Criteria	Marks
Subject Knowledge	2
Communication Clarity	2
Team Participation	1

1124231540	**English for workplace communication**	L	T	P	C
PRACTICUM		1	0	2	2

II. External Assessment – 60 Marks

End Semester Examination Pattern (3 Hours)

Section	Type of Questions	Marks
Section A	Objective (MCQs – all units)	10
Section B	Short Answer (5 × 4)	20
Section C	Descriptive / Application-based (3 × 10)	30
Total		60

1124232840	FUNCTIONAL ENGLISH	L	T	P	C
PRACTICUM		1	0	2	2

Introduction

This course aims to build strong foundations in Functional English to enable students to communicate effectively in academic, professional, and real-life situations. It focuses on practical language usage, everyday vocabulary, correct grammar, pronunciation, and expressive speaking skills. The syllabus emphasizes modern communication methods, workplace interaction, and interview readiness to enhance employability. Through continuous practice in speaking, listening, reading, and writing, students gain confidence, clarity, and cultural awareness. Overall, the course prepares learners for professional communication and career-oriented interactions.

Course Outcomes

CO1: Analyze the scope, nature, forms, and cultural aspects of Functional English and evaluate its role in professional communication, distinguishing it from Academic English while identifying and correcting common grammatical errors.

CO2: Apply modern communication tools and language resources such as dictionaries, pronunciation techniques, intonation patterns, homophones, and prepositional phrases to analyze spoken, written, and listening texts for accurate everyday English usage.

CO3: Evaluate communicative situations and create context-appropriate spoken responses by expressing opinions, preferences, agreement or disagreement, persuasion, suggestions, and justifications in social and marketplace interactions.

CO4: Create and demonstrate effective spoken communication through greetings, introductions, impromptu speeches, and descriptions of people and events by applying appropriate vocabulary, structure, tone, and confidence-building strategies.

CO5: Evaluate employability communication requirements and create professional self-presentations, resumes, and interview responses by integrating verbal, non-verbal, and workplace communication skills.

1124232840	FUNCTIONAL ENGLISH	L	T	P	C
PRACTICUM		1	0	2	2

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	3	2	1
CO2	2	2	–	3	3	2	–
CO3	–	2	–	–	3	2	–
CO4	–	1	–	–	3	2	–
CO5	–	2	–	–	3	2	–

Correlation Levels: 3 – High. 2 – Medium. 1 – Low.

Syllabus Contents

Unit 1: Foundation of Functional English (12 Hours)

Functional English – its scope, nature, types, forms, cultural aspects and importance.

Difference between Academic English & Functional English.

Introducing a set of (Everyday) Vocabulary, and its importance.

Introducing Adjectives, Adverbs, and Exclamatory sentences.

Common Grammatical errors and corrections,

Functional English for professional communication.

Unit II: Modern Communication (8 Hours)

Homophones with spelling, prepositional phrases, situation-based questions and answers, Pronunciation, Intonation - Falling and rising tone.

Using dictionaries, Speaking – making questions and answers, Reading - Passages / Stories, using new words from the dictionary in the sentences.

Writing – Dictation, sentences, questions, answers. Modern everyday English usage. Collected from Newspapers.

Listening to videos and answering simple questions.

1124232840	FUNCTIONAL ENGLISH	L	T	P	C
PRACTICUM		1	0	2	2

Unit III: Expressive Speaking Skills (8 Hours)

Expressing opinions and preferences, agreeing and disagreeing politely, giving justifications, expressing likes and dislikes, persuasive language, making suggestions, market place situations.

Giving directions to reach a place, describing an object, event, experience, etc.

Unit IV: Speaking skills (7 Hours)

Greetings, Introductions, expressing needs, Short impromptu speaking - Basic structure and Tips for impromptu speaking, describing events.

Unit V: Interview and employability skills (10 Hours)

Self-Introduction in an interview, common interview questions and answers, body language and confidence development, Resume writing, Resume – based questions, Self-Presentation Skills, and workplace communication scenarios.

Suggested Student Activities

Foundation of Functional English

- Vocabulary-building exercises using real-life contexts.
- Error correction worksheets (common grammatical mistakes).
- Pair activity: Academic English vs Functional English comparison.
- Sentence construction using adjectives, adverbs, and exclamations

Modern Communication

- Pronunciation drills using homophones and prepositions
- Dictionary-based word exploration tasks
- Listening to short videos/audio clips followed by Q&A
- Reading comprehension passages with vocabulary identification

1124232840	FUNCTIONAL ENGLISH	L	T	P	C
PRACTICUM		1	0	2	2

Expressive Speaking Skills

- Role-play activities (marketplace, customer interaction)
- Group discussion: expressing opinions and polite disagreement
- Direction-giving activity using campus or town maps

Speaking Skills

- Mock introduction and greeting sessions
- Impromptu speaking on simple everyday topics
- Describing people, objects, or recent events

Interview and Employability Skills

- Mock interview sessions
- Resume drafting workshop
- Body language and confidence-building role plays
- Workplace communication case studies

Text Book References

1. Sanjay Kumar & Pushp Lata, Communication Skills, Oxford University Press.
2. Meenakshi Raman & Sangeeta Sharma, Technical Communication, Oxford University Press.
3. Raymond Murphy, English Grammar in Use, Cambridge University Press.
4. Lesikar & Flatley, Business Communication, McGraw-Hill Education

.Web References

- https://nptel.ac.in (Functional English & Communication Skills)
- https://learnenglish.britishcouncil.org
- https://www.skillsyouneed.com
- https://dictionary.cambridge.org
- https://www.coursera.org (Employability & Interview Skills)

1124232840	FUNCTIONAL ENGLISH	L	T	P	C
PRACTICUM		1	0	2	2

Assessment Scheme

Overall Evaluation Pattern

- Internal Assessment: 40 Marks
- External Assessment: 60 Marks
- Total: 100 Marks

Internal Assessment – 40 Marks

Component	Marks	Mode
Continuous Assessment Test (Written)	10	MCQs, short answers
Speaking & Listening Activities	10	Role play, listening tasks
Writing Skills Assignment	10	Resume, dictation, sentence writing
Seminar / GD / Impromptu Speech	5	Oral evaluation
Attendance & Participation	5	Regularity & involvement
Total	40	

1124232840	FUNCTIONAL ENGLISH	L	T	P	C
PRACTICUM		1	0	2	2

Internal Assessment Rubrics

Speaking & Listening Skills (10 Marks)

Criteria	Excellent (4)	Good (3)	Average (2)	Poor (1)
Pronunciation & Fluency	Clear, confident	Minor errors	Frequent pauses	Unclear
Listening Accuracy	Fully accurate	Minor mistakes	Partial	Poor
Body Language	Effective	Adequate	Limited	Ineffective
Interaction	Active	Responsive	Minimal	Passive

Writing Skills Assignment (10 Marks)

Criteria	Marks
Format & Organization	3
Grammar & Vocabulary	4
Relevance & Clarity	3

External Assessment – 60 Marks

End Semester Examination Pattern (3 Hours)

Section	Question Type	Marks
Section A	Objective (MCQs)	10
Section B	Short Answers (5 × 4)	20
Section C	Descriptive / Application (3 × 10)	30
Total		60

1124233110	ELECTRICAL CIRCUITS AND MACHINES	L	T	P	C
THEORY		4	0	0	4

Introduction

This course provides a comprehensive foundation in electrical circuits and electrical machines, focusing on both DC and AC systems widely used in industrial and utility applications. It enables students to understand fundamental electrical quantities, analyze DC and single-phase AC circuits, and apply circuit theorems for problem-solving. The course further introduces three-phase systems, DC machines, transformers, and AC machines, emphasizing construction, working principles, performance characteristics, and practical relevance. Through this course, students develop the analytical and technical skills required for installation, operation, testing, and maintenance of electrical equipment in industrial environments.

Course Outcomes:

CO1: Explain the fundamental electrical quantities, DC and AC circuit concepts, operating principles of electrical machines and transformers, and select suitable circuits, machines, and transformers for given domestic and industrial applications.

CO2: Apply circuit laws and theorems to solve basic DC and single-phase AC circuit problems and compute electrical parameters such as current, voltage, power, impedance, and efficiency.

CO3: Analyze the performance of single-phase and three-phase AC circuits, DC machines, induction motors, alternators, and transformers under different operating conditions.

CO4: Differentiate and examine various electrical machines and transformer types based on construction, characteristics, starting methods, speed control, losses, and applications.

CO5: Evaluate power, power factor, efficiency, losses and test results of AC/DC machines and transformers for practical electrical engineering applications.

1124233110	ELECTRICAL CIRCUITS AND MACHINES	L	T	P	C
THEORY		4	0	0	4

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-
CO4	-	3	-	-	-	-	-
CO5	-	3	-	-	-	-	-

Syllabus Contents

Unit I	**DC CIRCUITS**	
DC CIRCUITS Basics of AC to DC Conversion - Concept of electrical quantities – Voltage – current – resistance – power – energy – Ohm's law – Resistances in series – Resistances in parallel – series parallel circuits – Kirchhoff's laws - Super position and maximum power transfer theorems – Statement and explanations – Simple problems (Using Series, Parallel, Ohms Law, KCL& KVL for maximum three loops, Super position and maximum power transfer theorem)		
Unit II	**SINGLE PHASE AC CIRCUITS**	
SINGLE PHASE AC CIRCUITS AC fundamentals – AC waveform – sinusoidal and non-sinusoidal – period– frequency – cycle – amplitude – phase – peak value – average value – RMS value (effective value) – form factor – AC Through pure resistor, inductor and Capacitor		

1124233110	ELECTRICAL CIRCUITS AND MACHINES	L	T	P	C
THEORY		4	0	0	4

– Concept of impedance – Capacitors in series and parallel – simple problems. Power in AC circuits – power factor– RL, RC and RLC series – Simple problems (RL,RC (Maximum two branch circuit), RLC Series)		
Unit III	**THREE PHASE AC CIRCUITS DC MACHINES AND TRANSFORMER**	
THREE PHASE AC CIRCUITS Concept of 3 phase supply – line and phase voltage and current in star and delta connected circuits – three phase power – Measurement of three phase power by two watt meter method – advantages of three phase over single phase system. **DC MACHINES AND TRANSFORMER** **DC generators** – construction, principle of operation, types and application- DC motors: - construction, principle of operation, types and application -speed control of DC motor-applications - Necessity of starters: Three point, four point starters.		

1124233110	ELECTRICAL CIRCUITS AND MACHINES	L	T	P	C
THEORY		4	0	0	4

Unit IV	AC MACHINES - I	
AC MACHINES **Alternator**– construction and working – relation between speed and frequency **Three phase Induction motor**– Squirrel cage and slip ring Induction motors (construction and working principle only) – methods of starting of 3 phase induction motor - DOL and star/delta starter – slip – speed control of 3Φ Induction motor **Single phase Induction motor** Single phase induction motor – principle of operation – Types – capacitor start motors – Applications.		
UNIT V	**AC MACHINES -II**	
AC MACHINES **Transformers** Transformer – Ideal transformer – principle of working – constructional details – EMF equation – turns ratio – core loss – copper loss – efficiency – SC and OC tests – Transformer on No load – Transformer on load – All-day efficiency - Auto transformer – construction and working – applications.		
TOTAL HOURS		
Assessment Test and Revision with Student activity		

Suggested list of Students Activity:

- Circuit Assembly and Testing
- Simulation-Based Learning
- Case Study / Mini Assignment
- Industry Visit / Expert Talk

1124233110	ELECTRICAL CIRCUITS AND MACHINES	L	T	P	C
THEORY		4	0	0	4

Reference Books:

1. B.L. Theraja & A.K. Theraja, A Textbook of Electrical Technology – Vol. I & II, S. Chand & Company.
2. V.K. Mehta & Rohit Mehta, Principles of Electrical Machines, S. Chand.
3. D.P. Kothari & I.J. Nagrath, Theory and Problems of Electrical Machines, Tata McGraw-Hill.
4. J.B. Gupta, Electrical Technology, Katson Books.
5. Tamil Nadu Directorate of Technical Education, Electrical Circuits and Machines – Diploma Course Notes.

Web Reference:

- NPTEL – Electrical Engineering Courses
  https://nptel.ac.in
  (DC Circuits, AC Circuits, Electrical Machines – beginner level)
- All About Circuits
  https://www.allaboutcircuits.com
  (Concept clarity with solved examples)
- Electrical4U
  https://www.electrical4u.com
  (Machines, transformers, starters, and power systems)
- Khan Academy – Electrical Engineering Basics
  https://www.khanacademy.org
  (Fundamental concepts and numerical practice)
- DoTE / AICTE Curriculum Resources
  https://www.aicte-india.org

Assessment Methodology:

As per the Chairman Board of Examinations guidelines.

1124233230	**Fundamentals of Renewable Energy**	L	T	P	C
THEORY		2	0	2	3

Course Introduction

This course provides a comprehensive understanding of solar photovoltaic (PV) systems, covering the fundamental principles of semiconductor physics, solar cell operation, materials, fabrication technologies, and performance evaluation. It enables students to analyze the electrical characteristics of solar cells, understand factors affecting efficiency, and gain hands-on experience in testing, installation, and maintenance of PV systems. Emphasis is placed on industry-relevant skills, including PV module assembly, performance measurement, system layout, and basic troubleshooting. The course prepares students for entry-level roles in solar PV installation, operation, and maintenance, supporting India's renewable energy initiatives.

Course Outcomes:

CO1: Describe semiconductor behavior, photovoltaic effects, solar cell materials, and the working principles of solar cells and photovoltaic systems.

CO2: Determine solar cell electrical characteristics by calculating Voc, Isc, fill factor, maximum power point, efficiency, and associated energy losses.

CO3: Examine the influence of environmental and operating parameters such as radiation, temperature, wind velocity, tilt angle, and electrical connections on photovoltaic performance.

CO4: Classify and compare photovoltaic cell types, materials, fabrication technologies, and PV system configurations based on structure, functionality, and applications.

CO5: Assess photovoltaic module performance through testing, installation practices, maintenance procedures, and energy output measurements for practical applications.

1124233230	**Fundamentals of Renewable Energy**	L	T	P	C
THEORY		2	0	2	3

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	1	-	-	-
CO2	-	1	-	2	-	-	-
CO3	-	-	1	2	-	-	-
CO4	-	-	-	3	-	-	-
CO5	-	-	-	3	-	-	-

Syllabus Contents

Unit I	Solar cell fundamentals:	
Current conduction in semiconductor. Atomic structure of silicon, Energy band formation in semiconductor, P-Type and N-type material with silicon, Formation of P-N junction of semiconductor. Principles for Electron - Hole Pair generation by Photon absorption, Photo- electric effect, photo-conductive effect and Photovoltaic effect. Materials for Opto-Electronic applications. Concept of solar cell, Main elements of silicon solar cell.		
Unit II	Solar cell characteristics:	
Current-Voltage (I-V) characteristics of a Photovoltaic cell. Power-Voltage (P-V) characteristics of a Photovoltaic cell. Equivalent circuit of a solar cell, Maximum power point (MPP). Design considerations of Solar cells – Short circuit current (Isc), Open circuit voltage (Voc), Fill factor (FF), Energy losses & factors for loss,		

1124233230	**Fundamentals of Renewable Energy**	L	T	P	C
THEORY		2	0	2	3

Efficiency. Factors limiting the efficiency of solar cell. Impact of external parameters on solar cell performances – (i) Radiation, (ii) Temperature, (iii) Wind velocity. **Practical Exercises:** 1. Conduct the experiment to understand the characteristics of Solar cell. i) Open-Circuit Voltage (Voc) Measurement ii)Short-Circuit Current (Isc) Measurement iii) I-V Curve Measurement iii) Power Output and Efficiency Calculation.	
Unit III	Materials for Photovoltaic Cells:
Classification of solar cell, Cell size. Single crystalline silicon cell, Polycrystalline silicon cell. Thin film solar cell – Amorphous Silicon, Gallium Arsenide, Cadmium Telluride, Copper Indium Gallium Diselenide. Multijunction solar cell. Other non-silicon materials for photovoltaic cell fabrications. Production technology of Gallium Arsenide and Amorphous Solar Cell. Materials required for solar panel and formation of solar panel.	
Unit IV	Technologies for Photovoltaic Cells Fabrication:
Dye-sensitized Solar Cell (DSSC) technology, Organic solar cell technology, Quantum Dot Solar cell technology. Concept of PV module, PV panel, PV array and its formation. Silicon Group and non-Silicon Group, PV cell, PV module, PV panel and PV array fabrication. Application of Nano-Technology in Solar Cell. Technical data sheet of solar PV panel. Basic control diagram of PV system and its components. Power distribution layout of PV system. **Practical Exercises:** 2. Dismantle and Assemble of Solar PV Panel. 3. Study of Solar cell manufacturing process.	

1124233230	**Fundamentals of Renewable Energy**	L	T	P	C
THEORY		2	0	2	3

UNIT V	Testing and Evaluation of Photovoltaic Cells:	
Solar Simulator and its application. Current-voltage analysis of solar cell, Power analysis. Light soaking and temperature cycling analysis. **Practical Exercises:** 4. Measuring Solar Panel Performance. 5. Understand how series and parallel connections affect voltage, current, and power output. 6. Observe how the tilt angle of a solar panel affects energy generation. 7. Learn the step-by-step process of installing a solar panel on a mounting structure. 8. Learn how to clean and maintain solar panels for optimal performance. 9. Measure the energy output of a solar panel over a specific period and calculate efficiency.		
TOTAL HOURS		
Assessment Test and Revision with Student activity		

Reference Books:

1. Fundamentals of Renewable Energy Sources by N.S. Rathore (Author), Khobragade Chetan (Author), Asnani Bhawana (Author)
2. Fundamentals and Applications of Renewable Energy Mehmet Kanoğlu Yunus A. Çengel John M. Cimbal
3. Fundamentals of Renewable Energy Sources by G.N. Tiwari
4. Fundamentals of Renewable Energy Processes By Aldo Vieira da Rosa.
5. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning.

1124233230	**Fundamentals of Renewable Energy**	L	T	P	C
THEORY		2	0	2	3

6. S.P. Sukhatme & J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill.
7. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers.
8. B.H. Khan, Non-Conventional Energy Resources, Tata McGraw-Hill.

Web Reference:

- NPTEL – Solar Photovoltaic Systems
  https://nptel.ac.in
  (Fundamentals, PV characteristics, system design)
- MNRE – Ministry of New and Renewable Energy, Govt. of India
  https://mnre.gov.in
  (Standards, policies, and PV system guidelines)
- PV Education
  https://www.pveducation.org
  (Solar cell physics and performance parameters)
- Energy.gov – Solar Energy Basics
  https://www.energy.gov/solar
  (Technology overview and testing methods)
- National Institute of Solar Energy (NISE)
  https://nise.res.in
  (Training materials, testing procedures, and best practices)

Assessment Methodology:

As per the Chairman Board of Examinations Guidelines.

1124233320	**Electrical Circuit & Machine Practical**	L	T	P	C
PRACTICAL		0	0	4	2

Introduction

This laboratory course is designed to strengthen students' understanding of electrical circuits and electrical machines through hands-on experimentation and performance analysis. The experiments enable students to verify fundamental circuit theorems, accurately measure electrical power, and study the operational characteristics of DC machines, transformers, alternators, and induction motors. Emphasis is placed on practical skills, safe handling of electrical equipment, data observation, and interpretation of performance curves under various load conditions. The course prepares students for industrial testing, operation, maintenance, and troubleshooting of electrical systems and machines.

Course Outcomes

CO1: Perform experimental verification of basic electrical circuit theorems and measure electrical power using standard instruments under DC and single-phase AC conditions.

CO2: Operate DC machines and transformers under no-load and load conditions by following standard laboratory procedures and safety practices.

CO3: Plot and interpret performance characteristics of DC generators, DC motors, transformers, alternators, and induction motors based on experimental observations.

CO4: Investigate the effect of load, excitation, and control methods on speed, efficiency, regulation, and losses of electrical machines.

CO5: Estimate efficiency, voltage regulation, and performance indices of transformers and rotating machines using experimental data from load tests, O.C., and S.C. tests.

1124233320	**Electrical Circuit & Machine Practical**	L	T	P	C
PRACTICAL		0	0	4	2

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	-	3	-	-	-
CO2	-	1	-	3	-	-	-
CO3	-	1	-	3	-	-	-
CO4	-	-	1	3	-	-	-
CO5	-	-	1	3	-	-	-

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	100	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- CA1 and CA2: All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to

select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

Cycle 1 - 50 % of exercise

Cycle 2 - 50 % of exercise

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim & Tools required	10
B	CIRCUIT DIAGRAM	20
C	CONNECTIONS AND PROCEEDING THE EXPERIMENT	20
TOTAL		50

- CA 3: Practical document should be maintained for every exercise immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or a printed manual or a file with documents. The part program and sketch should be written by the student manually.

1124233320	**Electrical Circuit & Machine Practical**	L	T	P	C
PRACTICAL		0	0	4	2

The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

- CA 4: All the exercises should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Tools required	10
B	CIRCUIT DIAGRAM	25
C	CONNECTIONS AND PROCEEDING THE EXPERIMENT	25
D	READING/CALCULATION/	20
E	GRAPH/RESULT	10
F	VIVA VOCE	10
	TOTAL MARKS	100

1124233320	**Electrical Circuit & Machine Practical**	L	T	P	C
PRACTICAL		0	0	4	2

Syllabus Contents

LIST OF EXPERIMENTS: CIRCUITS: 1. Verification of Superposition Theorem with two different DC Voltages for a common load. 2. Verification of Thevenin's Theorem with DC Supply 3. Measurement of Power. a. using Ammeter and Voltmeter b. using Wattmeter for Single Phase Resistive Load.	
MACHINES: 4. No load and FULL Load Characteristics of Self Excited DC Shunt Generator. 5. Load Test on DC Shunt Motor and Draw the Performance Curve. 6. Speed Control of DC Shunt Motor by a. Armature Control Method b. Field Control Method. 7. Load Test on Single Phase Transformer. 8. Load Test on Three Phase Transformer. 9. Predetermine the Efficiency and Regulation of Single-Phase Transformer by conducting O.C and S.C Tests 10. Load test on 3 Phase Alternator. 11. Load test on Single Phase Induction Motor. 12. Load test on 3 Phase Induction Motor.	

1124233320	**Electrical Circuit & Machine Practical**	L	T	P	C
PRACTICAL		0	0	4	2

Suggested list of Students Activity:

Circuits – Core Activities

- Construct lab worksheets for Superposition & Thevenin tests, with space for hypotheses, circuit diagrams, results and conclusion.
- Design a simple breadboard challenge: Create a resistive network that maximizes power transfer to a given load and explain why the theorem holds.
- Power measurement comparison: Students measure power using (a) ammeter/voltmeter and (b) wattmeter on single-phase resistive loads, and then discuss errors and sources of discrepancy.

DC Machines

- Performance Curve Projects: For DC shunt motors/generators, students plot speed vs. torque and efficiency vs. load curves and interpret trends.
- Speed Control Workshop: Hands-on comparison of armature vs. field control methods; students prepare posters explaining advantages/limitations.
- Fault & Safety Drill: Simulate open circuit/field failure in a controlled environment and discuss machine behavior.

Transformers & AC Machines

- O.C. & S.C. Test Simulation: Before lab, students simulate open-circuit and short-circuit tests for a transformer using tools like LTspice or MATLAB/Simulink.
- Group case studies on regulation and efficiency: Students compare measured values with theoretical.
- Three-phase Machine Connections: Activity on identifying star vs delta connections, balanced load effects and power factor using two-wattmeter method.

Report & Presentation Activities

- Journal & Video Recordings: Students record each experiment with photos/video clips and write conclusions.
- Peer-Review Sessions: Groups review each other's reports and give structured feedback.

1124233320	**Electrical Circuit & Machine Practical**	L	T	P	C
PRACTICAL		0	0	4	2

Mini Projects

- Model of a Load Test Rig: Build a small experimental setup to automatically vary load on DC motor.
- Power Factor Improvement Demo: Using capacitor banks on a single-phase load and measuring with wattmeter.

Web/Online References

- NPTEL Online Courses — Free lecture videos on electrical machines & circuits (search by topic).
- Online circuit simulators (e.g., Tinkercad, Falstad) for verifying Superposition/Thevenin before hands-on lab.

Reference Books:

1. “Electrical Machines Lab Manual with MATLAB Programs” – D.K. Chaturvedi (Laxmi Publications).
2. “Laboratory Manual for Electrical Machines” – D.P. Kothari & B.S. Umre
3. “A Reference Book on Experiments with Basic AC/DC Circuits & Electrical Machines” – Dr. Yash Pal
4. “Electric Machines” – D.P. Kothari & I.J. Nagrath (Tata McGraw Hill)
5. “Electrical Machinery” – P.S. Bimbhra (Khanna Publishing House)
6. “Electric Machinery” – A.E. Fitzgerald, C. Kingsley & S. Umans (McGraw Hill)
7. “Fundamentals of Electrical Machines” – B.R. Gupta / S.K. Bhattacharya

1124233320	**Electrical Circuit & Machine Practical**	L	T	P	C
PRACTICAL		0	0	4	2

END SEMESTER EXAMINATION – Practical Exam

Note:

- All the exercises should be completed. All the exercise should be given for examinations, students can select any one exercise by lot ot the question paper supplied by the DOTE shall be used.
- Practical documents should be prepared, the same should be submitted for the End Semester Examinations along with the bonafide certificate.

DETAILED ALLOCATION OF MARKS.

Part	Description	Marks
A	Aim & Tools required	10
B	CIRCUIT DIAGRAM	25
C	CONNECTIONS AND PROCEEDING THE EXPERIMENT	25
D	READING/CALCULATION/	20
E	GRAPH/RESULT	10
F	VIVA VOCE	10
	TOTAL MARKS	100

1124233440	**Fundamentals of Thermodynamics & Heat Transfer**	L	T	P	C
PRACTICUM		1	0	4	3

Introduction

This course introduces the fundamental principles of thermodynamics and heat transfer, which form the basis for understanding the behavior of energy in engineering systems. It covers basic concepts such as systems and properties, laws of thermodynamics, energy interactions, and ideal gas processes, enabling students to analyze simple engineering applications. The course also provides an overview of heat transfer mechanisms including conduction, convection, and radiation, along with the working principles of heat exchangers. Through practical exercises, students gain hands-on experience in measuring thermal properties, studying heat transfer phenomena, and analyzing the performance of thermal systems, thereby developing essential skills required for mechanical and thermal engineering applications.

Course Outcomes

CO1: Analyze thermodynamic systems and processes by applying concepts of pure substances, system classification, properties, equilibrium, energy interactions (heat and work), and ideal gas relations to interpret system behavior and performance.

CO2: Apply and evaluate the laws of thermodynamics (Zeroth, First, and Second Laws) to assess the performance of engineering devices such as heat engines, refrigerators, heat pumps, and steady-flow systems using appropriate efficiency and entropy concepts.

CO3: Analyze and evaluate heat transfer mechanisms—conduction, convection, and radiation—and compare the performance of heat exchangers and extended surfaces under steady and transient conditions for practical engineering applications.

CO4: Conduct, analyze, and interpret thermal experiments to determine thermo-physical properties such as specific heat, enthalpy of vaporization, and thermal conductivity, and to evaluate heat transfer through composite walls and metal/insulating materials using experimental data.

CO5: Analyze and evaluate heat transfer mechanisms and thermal system performance in natural convection, heat exchangers, and solar water heating systems, and compare experimental results with theoretical predictions.

1124233440	**Fundamentals of Thermodynamics & Heat Transfer**	L	T	P	C
PRACTICUM		1	0	4	3

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				3	-	-	-
CO2	3		2		-	-	-
CO3			3		-	-	-
CO4	3		2	3	–	2	2
CO5			2		2	2	2

3 – Strong correlation 2 – Moderate correlation 1 – Low correlation

Assessment Methodology:

	Continuous Assessment (40 marks)				**End Semester Examination (60 marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Practical Test	Practical Examination
Portion	Cycle I Exercises	Cycle II Exercises	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 hours
Exam Marks	60	60	100	100	100
Converted to Marks	10	10	15	15	60
Marks	10		15	15	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1124233440	**Fundamentals of Thermodynamics & Heat Transfer**	L	T	P	C
PRACTICUM		1	0	4	3

Note:

CA1 and CA2: All the exercises/experiments should be completed as per the portions above and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded shall be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

Practical documents should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise/experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

The details of the documents to be prepared as per the instruction below.

Each exercise should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

This documentation can be carried out in a separate notebook or a printed manual or a file with documents. The procedure and sketch should be written by the student manually in the documents.

The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

1124233440	**Fundamentals of Thermodynamics & Heat Transfer**	L	T	P	C
PRACTICUM		1	0	4	3

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim and Apparatus required	10
B	Procedure, Observation / Reading /	20
C	Formulae/ Calculation	20
TOTAL		50
D	Practical Documents (As per the portions)	10
		60

Cycle I: 50 % of syllabus

Cycle II: Balance 50 % of syllabus

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment.

Question pattern – Written Test Theory

Description		**Marks**	
Part – A	30 MCQ from the complete theory portions.	30 X 1 Mark	30 Marks
Part – B	Seven Questions to be answered out of 10 Questions.	7 X 10 Marks	70 Marks
TOTAL			100 Marks

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation below. After completion of all

1124233440	Fundamentals of Thermodynamics & Heat Transfer	L	T	P	C
PRACTICUM		1	0	4	3

the exercises the practical test should be conducted as per End Semester Examination question pattern scheme of evaluation. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim and Apparatus required	10
B	Procedure, Observation / Reading /	20
C	Formulae/ Calculation	20
D	Output/Result	10
E	Viva	10
F	Written test	30
		100

Note: For the written test 30 MCQ shall be asked from the theory portions.

Syllabus Contents.

THEORY PORTION

Unit I	**Fundamentals of Thermodynamics:**	
Pure substance - System, Boundary, Surrounding. Classification of system: open system, closed system, isolated system. - Properties of system: Intensive and Extensive properties with units and its conversion like Pressure (Atmospheric Pressure, Gauge Pressure and Absolute pressure), Volume, Sp-mass and Temperature. State of a system, change of state, Path, Process and thermodynamic cycle. - Equilibrium of a system, including Mechanical, Thermal, Chemical and Thermodynamic equilibrium. Definition and units of Transient energy (Work and Heat): Stored energy (P.E., K.E and Internal energy). Point Function & Path Function. Displacement work & Flow work.		8

1124233440	**Fundamentals of Thermodynamics & Heat Transfer**	L	T	P	C
PRACTICUM		1	0	4	3

Laws of Thermodynamics and their Applications: Zeroth Law of Thermodynamics and Temperature measurement. First law of Thermodynamics, Simple Energy Equation for non-flow process (Q - W) = E, Steady Flow Energy Equation and its applications. Second Law of Thermodynamics: Kelvin – Plank Statement & Clausius' Statement, Heat Engine, Heat Pump and Refrigerator, Thermal Efficiency, C.O.P., definition and units of Entropy. - Description only **Ideal gas processes:** Definition of Specific heat, Specific heat at constant pressure (Cp), Specific heat at constant volume (Cv) and Adiabatic Index (Cp/Cv). Governing equation of processes (Pressure & Volume relations). Representation of the processes on P-V and T-S diagram.	
Unit II **Elements of Heat Transfer**	
Basic concepts - Conduction of Heat Transfer: Heat conduction through a Cylinder - Heat Conduction through a Sphere - Fins - Transient Heat conduction - Convective Heat Transfer - Heat Exchangers: - Parallel Flow Heat Exchanger - Counterflow Heat Exchanger. Radiant Heat Transfer. Combined Convection and Radiation - Description.	7
PRACTICAL EXERCISES	40
1. Measurement of Specific Heat of a Liquid 2. Determination of Enthalpy of Vaporization of Water 3. Determination of Thermal Conductivity of a Metal Rod 4. Determination of Thermal Conductivity of an Insulating Material 5. Study the Heat Transfer through a Composite Wall 6. Study the Natural Convection Heat Transfer from a Vertical Plate 7. Study of a Performance Analysis of a Solar Water Heater 8. Study of Heat Exchangers (Parallel and Counterflow)	
Practice + Revision + Test	20
Total	75

1124233440	Fundamentals of Thermodynamics & Heat Transfer	L	T	P	C
PRACTICUM		1	0	4	3

APPARATUS REQUIRED:

Measurement of Specific Heat of a Liquid

- Calorimeter
- Thermometer
- Weighing scale
- Heating element
- Stopwatch
- Liquid (e.g., water, oil)

Determination of Enthalpy of Vaporization of Water

- Boiler or kettle
- Thermometer
- Measuring cylinder
- Stopwatch
- Energy meter

Determination of Thermal Conductivity of a Metal Rod

- Metal rod (e.g., copper, aluminum)
- Thermocouples
- Heater
- Insulating material
- Stopwatch
- Thermal conductivity apparatus

Thermal Conductivity of an Insulating Material

- Guarded hot plate apparatus
- Thermocouples
- Insulating sample material
- Heater
- Power supply

1124233440	**Fundamentals of Thermodynamics & Heat Transfer**	L	T	P	C
PRACTICUM		1	0	4	3

Heat Transfer through a Composite Wall

- Composite wall apparatus with different materials (e.g., metal, wood, insulation)
- Thermocouples
- Heater
- Power supply
- Stopwatch

Natural Convection Heat Transfer from a Vertical Plate

- Vertical plate setup with a heating element
- Thermocouples
- Stopwatch
- Power supply

Performance Analysis of a Solar Water Heater

- Solar water heater setup
- Thermometer
- Measuring jar
- Stopwatch
- Pyranometer (to measure solar radiation)

Study of Heat Exchangers (Parallel and Counterflow)

- Heat exchanger setup (parallel and counterflow)
- Hot water tank and pump
- Coldwater supply
- Thermocouples
- Stopwatch

Suggested List of Students Activity

Simple numerical problems.

1124233440	**Fundamentals of Thermodynamics & Heat Transfer**	L	T	P	C
PRACTICUM		1	0	4	3

Reference

1. A Course in Thermal Engineering. Domkundwar V. M. Dhanpat Rai & Co.
2. A Textbook of Thermal Engineering. R. S. Khurmi S. Chand & co. Ltd.
3. Engineering Thermodynamics Dr. D.S.Kumar S.K. Kataria& Sons
4. A Course in Thermal Engineering. P. L. Ballaney Khanna Publishers
5. Basic and Applied Thermodynamics, Second Edition , P.K.Nag, McGraw Hill Education (India) Private Limited.

END SEMESTER EXAMINATIONS

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim and Apparatus required	10
B	Procedure, Observation / Reading /	20
C	Formulae/ Calculation	20
D	Output/Result	10
E	Viva	10
F	Written test	30
		100

Note: For the written test 30 MCQ shall be asked from the theory portions.

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

Introduction

This course provides students with a foundational understanding of semiconductor devices, electronic circuits, and basic power electronics, which are essential for modern electrical, electronics, and renewable energy applications. It introduces the operating principles, characteristics, and applications of diodes, transistors, rectifiers, regulators, oscillators, and thyristors, with emphasis on practical circuit construction and testing. Through laboratory experiments, students gain hands-on experience in device characterization, power supply design, amplification, wave shaping, and switching operations. The course also highlights the application of electronic devices in solar energy systems and power conditioning, preparing students for entry-level roles in electronics servicing, installation, and maintenance.

Course Outcomes:

CO1: Conduct experiments to plot and verify the V–I characteristics and operating behavior of basic semiconductor devices such as PN junction diodes, Zener diodes, and LEDs.

CO2: Assemble and test rectifier circuits, filter circuits, and Zener-based voltage regulators to obtain required DC outputs for electronic and renewable energy applications.

CO3: Examine the input and output characteristics of bipolar junction transistors and analyze their performance when used as switches and amplifiers.

CO4: Design and evaluate wave-shaping circuits and RC oscillators by observing signal modification and oscillation conditions through experimental results.

CO5: Assess the working and application of basic power electronic circuits such as SCR triggering circuits, DC–DC converters, and inverters used in solar and renewable energy systems.

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	-	2	-	-	-
CO2	1	-	-	3	-	-	-
CO3	-	1	-	2	-	-	-
CO4	-	-	2	3	-	-	-
CO5	-	-	-	3	-	-	-

Assessment Methodology:

	Continuous Assessment (40 marks)				**End Semester Examination (60 marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Practical Test	Practical Examination
Portion	Cycle I Exercises	Cycle II Exercises	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 hours
Exam Marks	60	60	100	100	100
Converted to Marks	10	10	15	15	60
Marks	10		15	15	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

Note:

- **CA1 and CA2:** All the exercises/experiments should be completed as per the portions above and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded shall be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical documents should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise/experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

  The details of the documents to be prepared as per the instruction below.

  Each exercise should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or a printed manual or a file with documents. The procedure and sketch should be written by the student manually in the documents.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim and Apparatus required	10
B	Procedure, Observation / Reading	20
C	Formulae/ Calculation	20
TOTAL		50
D	Practical Documents (As per the portions)	10
		60

Cycle I: 50 % of syllabus

Cycle II: Balance 50 % of syllabus

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment.

Question pattern – Written Test Theory

Description		Marks	
Part – A	30 MCQ from the complete theory portions.	30 X 1 Mark	30 Marks
Part – B	Seven Questions to be answered out of 10 Questions.	7 X 10 Marks	70 Marks
TOTAL			100 Marks

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation below. After completion of all

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

the exercises the practical test should be conducted as per End Semester Examination question pattern scheme of evaluation. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim and Apparatus required	10
B	Procedure, Observation / Reading /	20
C	Formulae/ Calculation	20
D	Output/Result	10
E	Viva	10
F	Written test	30
		100

Note: For the written test 30 MCQ shall be asked from the theory portions.

Syllabus Contents.

UNIT I	**Semiconductor Devices**	
Basics of Semiconductors: Intrinsic and Extrinsic - PN Junction Diode: Characteristics and Applications - Zener Diode: Characteristics and Voltage Regulation - Light Emitting Diode (LED): Operation and Applications.		3
Ex.No.	Name of the experiment	
1	Plot the VI characteristics of a PN junction diode.	9
2	Study and test the VI characteristics of a Zener diode.	
3	Test the operation of LEDs for various input voltages.	

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

UNIT II	**Rectifiers and Power Supplies**	3
Rectifiers: Half-wave, Full-wave, and Bridge Rectifiers - Filter Circuits: Capacitor Filter. Voltage Regulators: Using Zener Diodes - Applications in Power Supplies for Solar Energy Systems.		
Ex.No.	Name of the experiment	
4	Construct and test a half-wave rectifier.	9
5	Construct and test a full-wave rectifier with and without a capacitor filter.	
6	Design and test a Zener diode voltage regulator.	
UNIT III	**Transistors**	3
Bipolar Junction Transistor (BJT): CE Configuration and Characteristics - Transistor as a Switch - Simple CE Amplifier: Circuit and Applications.		
Ex.No.	Name of the experiment	
7	Plot the input and output characteristics of a CE transistor configuration.	9
8	Design and test a transistor as a switch.	
9	Construct and test a simple CE amplifier.	
UNIT IV	**Wave Shaping Circuits and Oscillators**	3
Clippers and Clampers: Operation and Applications - Basics of Oscillators: RC Oscillators and Applications.		
Ex.No.	Name of the experiment	
10	Design and test a simple clipper circuit.	9
11	Design and test a simple clamper circuit.	
12	Construct and test an RC phase-shift oscillator.	
UNIT V	**Basics of Power Electronics**	3
SCR: Construction, Working, and Applications - Basics of DC-DC Converters and Inverters - Application of Thyristors in Renewable Energy Systems.		
Ex.No.	Name of the experiment	
13	Trigger and test an SCR using a DIAC.	

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

14	Construct and test a basic DC-DC converter circuit.	9
15	Study and test a simple inverter block diagram for solar energy applications.	
	REVISION	**15**
	TOTAL HOURS	**75**

Suggested List of Students Activity

- Presentation/Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly/fortnightly based on the course
- Micro project that shall be an extension of any practical lab exercise to real-world application

Text Books

1. "Basic Electronics" by V.K. Mehta and Rohit Mehta.
2. "Electronic Devices and Circuits" by David A. Bell
3. "Electronic Devices and Circuits" by S. Salivahanan and N. Suresh Kumar.
4. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky

Web Reference

1. NPTEL – Semiconductor Devices and Electronic Circuits
   https://nptel.ac.in
   (PN junctions, diodes, BJTs, rectifiers, oscillators)
2. All About Circuits
   https://www.allaboutcircuits.com
   (Clear explanations, circuit diagrams, and practical insights)

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

3. Electronics Tutorials
   https://www.electronics-tutorials.ws
   (Semiconductor devices, amplifiers, wave shaping circuits)
4. Electrical4U – Electronics & Power Electronics
   https://www.electrical4u.com
   (SCRs, converters, inverters, and renewable energy applications)
5. MIT OpenCourseWare – Electronics Fundamentals
   https://ocw.mit.edu
   (Basic theory and illustrative examples)
6. MNRE – Ministry of New and Renewable Energy, Govt. of India
   https://mnre.gov.in
   (Application of power electronics in solar energy systems)

END SEMESTER EXAMINATIONS

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim and Apparatus required	10
B	Procedure, Observation / Reading /	20
C	Formulae/ Calculation	20
D	Output/Result	10
E	Viva	10
F	Written test	30
		100

Note: For the written test 30 MCQ shall be asked from the theory portions.

1124233540	**Electronic Devices and Circuits Practical**	L	T	P	C
PRACTICUM		1	0	4	3

List of Equipments required for a Batch of 30 students

S.No	Name of the Equipments	Range	Required Nos.
1	DC Regulated power supply	0-30V,1A	10
2	Signal Generator	1MHz	4
3	Dual trace CRO	20MHz/ 30MHz	5
4	Digital Multimeter	-	10
5	DC Voltmeter (Analog/Digital)	-	10
6	DC Ammeter (Analog/Digital)	-	10

1124233640	SOLAR PV AND MANUFACTURING - I	L	T	P	C
PRACTICUM		1	0	4	3

Introduction

This course provides students with a comprehensive foundation in Solar Photovoltaic (PV) technology, focusing on the working principles, system components, installation practices, and quality aspects of solar PV systems. It introduces the solar photovoltaic effect, construction and electrical characteristics of PV modules, and the importance of proper orientation, inclination, and interconnection of panels for efficient energy generation. The course further covers different types of PV systems—off-grid, on-grid, and hybrid—along with key solar power parameters and measurement techniques used in the field. Emphasis is also placed on PV connectors, cables, charge controllers, inverters, and basic solar cell manufacturing and quality processes, enabling students to acquire industry-relevant skills for installation, operation, testing, and quality control in solar PV applications.

Course Outcomes

CO1 : Analyze the performance of different solar PV modules and systems by interpreting electrical characteristics, datasheets, STC/NOCT conditions, PSH, and solar insolation measurements for optimal system selection.

CO2 : Evaluate the suitability of stand-alone, grid-connected, and hybrid PV systems by comparing system components, metering arrangements, panel orientation, inclination, and area requirements for given site conditions.

CO3 : Analyze PV system reliability by diagnosing connector failures, cable selection issues, diode malfunctions, and inverter/MPPT operation to ensure safe and efficient power generation.

CO4 : Analyze and apply solar cell and module manufacturing processes—including wafer preparation, doping, metallization, ARC application, encapsulation, and interconnection—to improve efficiency and quality.

CO5 : Evaluate solar module quality using QC tools (IQC, IPQC, FQC) and design corrective actions for identified defects during inspection and performance testing of PV modules.

1124233640	SOLAR PV AND MANUFACTURING - I	L	T	P	C
PRACTICUM		1	0	4	3

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3		2			
CO2			3	3			
CO3		3		2			
CO4		2		3			
CO5			3	2	1		2

(3–Strong, 2–Moderate, 1–Low)

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Practical Test	Practical Examination
Portion	Cycle I Exercises	Cycle II Exercises	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 hours
Exam Marks	60	60	100	100	100
Converted to Marks	10	10	15	15	60
Marks	10		15	15	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1124233640	SOLAR PV AND MANUFACTURING - I	L	T	P	C
PRACTICUM		1	0	4	3

Note:

- **CA1 and CA2:** All the exercises/experiments should be completed as per the portions above and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded shall be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical documents should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise/experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

  The details of the documents to be prepared as per the instruction below.

  Each exercise should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or a printed manual or a file with documents. The procedure and sketch should be written by the student manually in the documents.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

1124233640	SOLAR PV AND MANUFACTURING - I	L	T	P	C
PRACTICUM		1	0	4	3

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim, Tools and Instruments required	10
B	Procedure/Process	20
C	Output	20
TOTAL		50
D	Practical Documents (As per the portions)	10
		60

Cycle I: 50 % of syllabus

Cycle II: Balance 50 % of syllabus

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment.

Question pattern – Written Test Theory

Description		Marks	
Part – A	30 MCQ from the complete theory portions.	30 X 1 Mark	30 Marks
Part – B	Seven Questions to be answered out of 10 Questions.	7 X 10 Marks	70 Marks
TOTAL			100 Marks

1124233640	SOLAR PV AND MANUFACTURING - I	L	T	P	C
PRACTICUM		1	0	4	3

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation below. After completion of all the exercises the practical test should be conducted as per End Semester Examination question pattern scheme of evaluation. The marks awarded should be converted to 15 Marks for the internal assessment.

Syllabus Contents

Unit I	**Solar PV (Photovoltaic) Basics, Solar PV Module**	
Solar Photovoltaic effect - Working of a Solar PV system - Direction & inclination of Solar PV panels - Area required for Solar PV installations - Solar cell & PV module - Components of a PV module - Types of Solar PV Modules - Electrical Connections of a Solar Panel - Electrical characteristics of PV module - Bypass diode and Blocking diode - Anti-Reflection Coatings (ARC) - Typical PV Module data sheet - Series and parallel connections of solar PV modules		3
Unit II	**Solar PV System, Solar Power Parameters**	
Types of PV systems & their Components - Stand-alone PV system (Off grid) - Grid-connected PV system (ON grid) - Hybrid PV system (Hybrid) - Metering Arrangements for PV Systems - Standard Test Conditions (STC) - Nominal Operating Cell Temperature (NOCT) - Pyranometer – measurement of solar insolation - Peak Sun Hours (PSH)		4
Unit III	**Solar PV Connectors, Cables, Charge Controller, Inverters for Solar PV Systems**	
Role of PV Connectors - Selecting right connector - Connecting Solar Panels - Causes of PV Connection Failure - Cables used in Solar PV Systems - Cable glands - Functions of Solar PV Charge controller - Maximum Power Point Tracker (MPPT) - Role of inverter in PV systems - Working of an inverter		4

1124233640	SOLAR PV AND MANUFACTURING - I	L	T	P	C
PRACTICUM		1	0	4	3

UNIT IV	Solar CELL	
Basics of Wafer Manufacturing & Introduction of Cell Manufacturing process, Types of Solar Cells - Multi and Mono (Different tech) – PERC - Multi and Mono (Different tech) - PERC – 7QC Tools – General – Quality Introduction - Difference between Quality Control and Quality Assurance – IQC, IPQC, FQC		4
TOTAL HOURS		15
Assessment Test and Revision with Student activity		

List of Practical Exercises

1. Silicon Wafer Preparation :
   Learn the process of silicon wafer preparation from ingots.
2. Solar Cell Doping Process
   Understand the diffusion process to dope wafers for forming the p-n junction.
3. Screen Printing for Contact Metallization.
   Apply conductive contacts using screen printing.
4. Solar Cell Interconnection (Soldering).
   Connect solar cells using tabbing and busbar soldering techniques.
5. Solar Module Encapsulation.
   Encapsulate interconnected solar cells to form a solar module.
6. Solar Module Assembly.
   Assemble and frame a complete solar PV module.
7. Solar Module Quality Testing.
   Test the assembled solar module for performance and reliability.
8. Anti-Reflective Coating Application.
   Apply an anti-reflective coating to increase light absorption.
9. Defect Inspection of Solar Cells.

Identify defects in solar cells and modules.

Suggested list of Students Activity,

- Presentation/Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly/fortnightly based on the course.

List of Equipment required.

1. Silicon Wafer Preparation

Equipment:

- Silicon ingot.
- Wire saw machine.
- Wafer thickness gauge.
- Cleaning chemicals (e.g., acetone, isopropyl alcohol).
- Ultrasonic cleaning bath.

2. Solar Cell Doping Process

Equipment:

- Diffusion furnace.
- Dopant sources (e.g., phosphorus or boron).
- Wafer carriers.
- Temperature controllers.

3. Screen Printing for Contact Metallization

Equipment:

- Screen-printing setup.
- Conductive paste (silver or aluminum).
- Drying oven.
- Microscope for pattern inspection.

4. Solar Cell Interconnection (Soldering)

Equipment:

- Soldering iron and flux.
- Tabbing ribbons.
- Multimeter for continuity testing.
- Jig for holding cells during soldering.

5. Solar Module Encapsulation

Equipment:

- EVA sheets, tempered glass, back sheet.
- Vacuum laminator.
- Cutting tools for trimming excess material.
- Heat-resistant gloves.

6. Solar Module Assembly

Equipment:

- Aluminum frames and clamps.
- Sealant for edges.
- Framing tools (e.g., screwdriver, clamps).
- Multimeter for electrical testing.

7. Solar Module Quality Testing

Equipment:

- Flash tester for power output.
- Electroluminescence (EL) imaging setup.
- Thermal cycling chamber.
- Humidity testing chamber.
- IR thermometer for hotspot detection.

8. Anti-Reflective Coating Application

Equipment:

- Chemical vapor deposition (CVD) setup or spray coating system.
- Reflectivity measurement tool (spectrophotometer).
- UV curing lamp.

9. Defect Inspection of Solar Cells

1124233640	SOLAR PV AND MANUFACTURING - I	L	T	P	C
PRACTICUM		1	0	4	3

Equipment:

- EL imaging system.
- Microscopes for surface inspection.
- Crack detection tool (mechanical stress tester).

Suggested list of Students Activity,

- Presentation/Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly/fortnightly based on the course.

End Semester Examination - Practical Exam

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim, Tools and Instruments required	10
B	Procedure/Process	20
C	Output	20
D	Finish	10
E	Viva Voce	10
F	Written test	30
		100

1124234110	GENERATION, TRANSMISSION AND SWITCH GEAR	L	T	P	C
THEORY		4	0	0	4

Course Outcomes:

CO1: Outline the principles and functional elements involved in electrical power generation, transmission, protection, and grounding systems used in modern power networks.

CO2: Compute essential electrical parameters related to AC transmission lines, interconnected systems, and insulation requirements for reliable power delivery.

CO3: Investigate the operational behavior and performance limitations of power systems considering line effects, insulation failures, over-voltages, and fault conditions.

CO4: Differentiate switching, protection, and safety devices such as circuit breakers, fuses, relays, lightning arresters, and grounding methods based on construction, working principles, and applications.

CO5: Appraise the suitability of generation schemes, transmission methods, protection systems, and grounding practices to ensure safety, reliability, and continuity of power supply.

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-
CO3	-	3	-	-	-	-	-
CO4	-	2	1	-	-	-	-
CO5	-	2	1	-	-	-	-

1124234110	GENERATION, TRANSMISSION AND SWITCH GEAR	L	T	P	C
THEORY		4	0	0	4

Syllabus Contents

Unit I	**NON-RENEWABLE GENERATIONOFELECTRICALPOWER:**	
Introduction- Conventional methods of power generations –Schematic arrangement and choice of site for Hydro, Thermal, Nuclear power plants-Advantages and Disadvantages-comparison of these power plants-Principle and types of co-generation. Schematic arrangement of Diesel, Gas, Pumped storage schemes-Advantages and Disadvantages-Grid or Inter connected system-Advantages of Interconnected systems- Load Transfer through Interconnector		
Unit II	**A.C. TRANSMISSION:**	
A.C. Transmission: Introduction-Typical Layout of A.C. Power supply scheme -Advantages and Disadvantages of A.C Transmission-Economic choice of Transmission voltage-Elements of a Transmission Line-Over Head Line-Line supports-Types of supports and their applications-spacing between conductors-length of span-Sag in overhead lines-Transposition of Transmission lines-Skin Effect-Ferranti Effect-Corona formation and corona loss-Factors affecting corona-Advantages and Disadvantages –Classification of O.H Transmission lines.		
Unit III	**LINE INSULATORS AND UNDERGROUND CABLES:**	
Line Insulators: Introduction - Line Insulator Materials-Properties of Insulators- Types & causes of failure of Insulators-Testing of Insulators-Potential Distribution over suspension Insulator String-String Efficiency - Methods of improving string efficiency. (Theory only) **Underground cables:**		

1124234110	GENERATION, TRANSMISSION AND SWITCH GEAR	L	T	P	C
THEORY		4	0	0	4

Introduction--construction of a three- core cable-Insulating materials for cables- classification of cables- cables for three phase service-Laying of underground cables-Direct laying, Drawing system, Advantages and Disadvantages.	
Unit IV	**CIRCUIT BREAKERS AND OVER VOLTAGE PROTECTION:**
CIRCUIT BREAKERS: Basic principle of Circuit Breaker -Arc Phenomenon- methods of Arc Extinction- Classification of Circuit Breakers – Construction and Working principle of Air Circuit Breakers, E.L.C.B, SF6 and Vacuum Circuit Breaker **OVER VOLTAGE PROTECTION**: **FUSES**- L.V fuses- Re-wirable fuse, HRC fuse-H.V. fuses **MCB** – Type B, C and D **LIGHTNING ARRESTOR**- Protection against lightning- Earthing screen, overhead ground Wires, Lightning arresters	
UNIT V	**PROTECTIVE RELAYS AND GROUNDING:**
PROTECTIVE RELAYS: Basic principle-Fundamental requirements of protective relaying- Primary and back up Protection-relay characteristics- Classification of relays-Construction, Principle of operation and applications of Induction type over current relay (Directional and Non-directional), Differential relay. Static relays- Basic elements of static relay (Block diagram explanation only). **GROUNDING**: Introduction-Equipment grounding- system grounding- ungrounded neutral system-Necessity of Neutral grounding – Methods- Solid grounding, Resistance grounding, Reactance grounding, Resonant grounding	
TOTAL HOURS	
Assessment Test and Revision with Student activity	

1124234110	GENERATION, TRANSMISSION AND SWITCH GEAR	L	T	P	C
THEORY		4	0	0	4

Reference Books:

1. VK. Mehta, Rohit Mehta, Principles of Power Systems, Revised Edition, S. Chand & Co, 2022.
2. M.L. Sony, P.V. Gupta and U.S. Bhatnagar, A Course in Electrical Power, Dhanpath Rai & Co (P) Ltd., 2013.
3. C.L. Wadhwa, Electrical Power Systems, Eighth Multi Colour Edition, New Age International Publishers.
4. K.R. Padiyar, HVDC Power Transmission Systems Technology and System Interactions, Reprint, New Age International, 2005.

Web Reference

- https://www.tangedco.org/en/tangedco/about-us/generation/
- https://nptel.ac.in/courses/108102047
- https://pvwatts.nrel.gov/
- https://nptel.ac.in/courses/108105104
- https://onlinecourses.nptel.ac.in/noc20_ee39/preview
- https://www.tangedco.org/en/tangedco/about-us/

Assessment Methodology:

As per the Chairman Board of Examinations guidelines.

1124234210	**Renewable Energy Instrumentation Applications**	L	T	P	C
THEORY		3	0	0	3

Course Outcomes:

CO1: Analyze the performance of a measurement system by correlating static characteristics (accuracy, precision, sensitivity, linearity, hysteresis, repeatability, reproducibility, and resolution) and dynamic behavior to measurement reliability.

CO2: Evaluate displacement and force measurement techniques (strain gauge, LVDT, and load cell) by comparing their working principles, sensitivity, limitations, and application suitability.

CO3: Analyze level and flow measurement systems using Bernoulli's theorem and transmitter principles to select appropriate instruments based on accuracy, range, and industrial conditions.

CO4: Evaluate temperature measurement methods (RTD and thermocouple) by interpreting their characteristics, equations, construction, and specifications for precision thermal monitoring.

CO5 : Design and justify an appropriate pressure measurement and calibration setup using manometers, bourdon tubes, pressure transmitters, and dead weight testers for given engineering applications.

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3					
CO2		3	2				
CO3		3					
CO4		3					
CO5			3		1	1	2

(3 – Strong, 2 – Moderate, 1 – Low)

1124234210	**Renewable Energy Instrumentation Applications**	L	T	P	C
THEORY		3	0	0	3

Syllabus Contents.

THEORY PORTION

Unit I	**Characteristics of Measurement System:**	
Concept of Static characteristics. - Definition of different static characteristic – Accuracy, Precision, Sensitivity, Linearity, Repeatability, Reproducibility, Hysteresis, Resolution. Dynamic characteristics concept only.		
Unit II	**Measurement of Displacement and Force:**	
Measurement of displacement: (i) Strain gauge, (ii) LVDT. Measurement of force: Load cell (column type).		
Unit III	**Measurement of Level & Flow:**	
Level measurement by Gauge glass, Displacer, Ultrasonic, D/p transmitter. Bernoulli's theorem. Principle of operation, advantages and disadvantages of different flow measuring instruments: (i) Orifice, (ii) Rotameter, (iii) Differential. Pressure Transmitter.		
Unit IV	**Measurement of Temperature:**	
RTD: Basic principle of operation, Equation, Construction, Types, Range, Specification. Thermocouple: Basic principle of operation, Equation, Construction, Types, Range, Specification.		
Unit V	**Measurement of Pressure:**	
Units of pressure, Concept of Absolute pressure, gauge pressure and vacuum. Basic principle of operation of different pressure measuring instruments – (i) U tube manometer, (ii) C type bourdon tube. Concept of pressure transmitter. Dead weight tester.		

1124234210	**Renewable Energy Instrumentation Applications**	L	T	P	C
THEORY		3	0	0	3

Reference

1. Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications(Wiley - IEEE) by Haitham Abu-Rub (Author), Mariusz Malinowski (Author), Kamal Al-Haddad.
2. Applications of Renewable Energy Sources by K P Prasad Rao
3. Renewable Energy and Future Power Systems by Singh, V.K., Bhoi, A.K., Saxena, A., Zobaa, A.F., Biswal, S.
4. Renewable Energy Resources, Challenges and Applications by Mansour Al Qubeissi.

Assessment Methodology:

As per the Chairman Board of Examinations guidelines.

1124234330	DISTRIBUTION AND SOLAR INSTALLATION	L	T	P	C
PRACTICUM		2	0	2	3

Course Outcomes:

CO1: Analyze AC and DC electrical distribution systems by comparing configurations, connection schemes, and overhead/underground arrangements to justify their suitability for power and solar PV integration.

CO2 : Evaluate substation types and layouts (110/11 kV and 11 kV/400 V), including busbar arrangements and equipment selection, for reliable and safe power distribution.

CO3 : Analyze and design standalone, grid-connected, and hybrid solar PV systems using design charts, lookup tables, and system parameters to meet specified load and capacity requirements.

CO4 : Evaluate and design grid-connected solar PV power plants by estimating energy output, configuring PV arrays and balance-of-system components, and developing system layouts for small and large power applications.

CO5 : Design, install, test, and troubleshoot solar PV systems by performing electrical measurements, earthing tests, safety checks, commissioning procedures, and preparing a detailed 1 MW AC / 1.5 MWp DC grid-tied PV system with Bill of Materials up to switchyard level.

CO–PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3					
CO2	3	3					
CO3		3					
CO4			3				
CO5			3	3	2		2

(3 – Strong, 2 – Moderate, 1 – Low)

1124234330	DISTRIBUTION AND SOLAR INSTALLATION	L	T	P	C
PRACTICUM		2	0	2	3

Syllabus Contents.

THEORY PORTION

Unit I	
DISTRIBUTION SYSTEM - Requirements and parts of Distribution system -Classification - Comparison of different distribution systems (A.C and D.C, Overhead & Underground) - A.C Distribution - Types - Connection schemes of AC Distribution system.	
Unit II	
SUB STATIONS - Classification of sub stations - Indoor and outdoor S.S - Gas insulated S.S – Layout of 110/11KV Substation and 11KV/400V Distribution Substation - Substation equipments - Bus bar - Types of bus bar arrangements.	
Unit III	
SOLAR PV SYSTEM DESIGN AND INTEGRATION Types of Solar PV Systems- Standalone SPV System -Grid-connected SPV System-Hybrid SPV System . Design Methodology for SPV System- Approximate Design of Standalone System-Solar PV System Design Chart- Look Up Table for PV System Design.	
Unit IV	
GRID-CONNECTED SOLAR PV POWER SYSTEMS Introduction to Grid-connected PV Systems: Grid-connected PV Systems for Small Power Applications and Large Power Applications. Configuration of Grid-connected Solar PV Systems-Grid-connected PV Systems without Battery Back-up and Battery Back-up. Components of Grid-connected Solar PV Systems- Solar PV Array, Array Combiner Box, DC Cabling, DC Distribution Box, Grid-connected Inverter, AC Cabling, AC Distribution Box Grid .	

1124234330	DISTRIBUTION AND SOLAR INSTALLATION	L	T	P	C
PRACTICUM		2	0	2	3

Grid-connected PV System Design for Power Plants- Estimation of Energy Output of PV Plant, Determining Configuration of PV Plant.	
Unit V	
INSTALLATION, TROUBLESHOOTING AND SAFETY Installation and Troubleshooting of Standalone Solar PV Systems- Installing PV System Components: BoS, Installing Mechanical Structure and Mounting of PV Modules, Maintenance of Solar PV System. **Safety in Installation of Solar PV Systems:** Electrical Safety, Safety Precautions for Batteries , Mechanical Safety. **Solar PV Plant Installation Check List** Electrical Testing of PV Array, Electrical Testing of Inverter, Testing of Islanding Protection, Commissioning and System Functional Testing.	
Practice + Revision + Test	
Total	

1124234330	**DISTRIBUTION AND SOLAR INSTALLATION**	L	T	P	C
PRACTICUM		2	0	2	3

PRACTICAL EXERCISES

1. **Measure the current of the PV module Output using Multimeter , Amp meter , Energy Meter .**

   Multimeter

   Connect the positive lead of the multimeter to the panel's positive terminal

   Connect the negative lead of the multimeter to the panel's negative terminal

   The panel's voltage will appear on the multimeter's screen Amp meter

   Use an amp meter to measure the amperage of the solar panel Energy meter

   Also known as a wattmeter or power meter, an energy meter measures the electricity produced by the panels

2. **Solar Module Mounting Structure Installation**

   Site assessment and planning:

   Determine the optimal location for your solar panels considering sun exposure, shading, and roof structure.

   Preparation:

   Obtain necessary tools like drills, wrenches, level, measuring tape, safety gear.

   Clear the installation area of debris and obstacles.

   Mounting structure installation:

   Set up the ground posts or poles at the desired spacing and level them carefully as per the GA drawing

   Attach the mounting rails to the posts using brackets and hardware.

3. **Solar Module String grouping and Combiner Box Interconnection and Measure Voc**

   A photovoltaic (PV) array is a group of solar panels that are wired together to produce a higher voltage and current

   Solar modules are connected in series to increase voltage

   Solar modules are connected in parallel to increase current

   Solar modules are connected using solar cables and MC4 connectors

   Connect Group of Strings to String Combiner Box

Measure the VOC (Open Circuit Voltage)

Use a voltmeter to measure the voltage difference between the two wires coming from the panel

4. **Underground Cable laying for AC and DC Cables**

   Digging a trench as per the drawing

   Laying cables the trench and covered with a 10 cm thick layer of sand.

   To protect against mechanical injury the trench is then covered with bricks and other materials

5. **Perform a test for the earthing protection.**

   Earth Resistance Testing (Fall-of-Potential Method):

   Disconnect the individual earthing electrode from the system.

   Use an earth resistance tester to measure the resistance between the electrode and the surrounding soil.

   This test is crucial to ensure each electrode meets the required resistance level.

   Continuity Testing:

   Check for continuity within the earthing system using a suitable ohmmeter.

   This verifies that there are no breaks in the conductors.

6. **Theoretical work**

   Design a commercial grid-tied PV system of AC 1 MW and DC 1.5 MWp with detailed Bill of Materials up to switchyard

Assessment Methodology:

As per the Chairman Board of Examinations guidelines.

1124234420	**Renewable Energy Instrumentation Applications Laboratory**	L	T	P	C
THEORY		0	0	4	2

Introduction

Students will be able to learn efficient operation of various types of instruments utilized for renewable power applications and to know the characteristics of different instruments and their specific use.

Course Objectives

After completing the course the student will be able to:

1. Know the characteristics and specification of different instruments.
2. Know the principle of operation, advantages, disadvantages of different process parameter like Displacement, Force, Pressure, Temperature, Level, Flow etc.
3. Identify different measuring instruments related to specific plants.
4. Use instruments for specific applications.
5. Operate various types of instruments in renewable power applications.

After learning the course, the students should be able to:

Pre-requisites

Nil

Instructional Strategy

The basic instructional strategy to teach Renewable Energy Instrumentation Applications Laboratory to Know the characteristics and specification of
different instruments. Know the principle of operation, advantages, disadvantages of different process parameter like Displacement, Force, Pressure, Temperature,
Level, Flow etc. Identify different measuring instruments related to specific plant.

1124234420	**Renewable Energy Instrumentation Applications Laboratory**	L	T	P	C
THEORY		0	0	4	2

Course Outcomes

CO1 : Select and justify appropriate measuring instruments for displacement, force, level, pressure, flow, and temperature based on range, accuracy, sensitivity, and application requirements.

CO2:Conduct experiments and plot characteristic curves of transducers (strain gauge, LVDT, load cell) and interpret their static characteristics such as linearity, sensitivity, hysteresis, and repeatability.

CO3: Analyze level and flow measurement systems using multiple industrial methods and compare their performance, limitations, and suitability for different operating conditions.

CO4: Evaluate temperature and pressure measurement systems by interpreting experimental data, identifying constructional features, and assessing calibration accuracy.

CO5: Perform calibration and error analysis of pressure measuring instruments using standard devices and document experimental results using professional engineering practice.

CO–PO Mapping

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	-	3	–	-	–	–
CO2	-	3	–	3	-	-	-
CO3	-	3	2	-	-	-	–
CO4	3	2	–	3	-	–	-
CO5	-	-	–	3	3	-	3

(3 = Strong, 2 = Moderate, 1 = Low, "–" = No direct mapping)

1124234420	**Renewable Energy Instrumentation Applications Laboratory**	L	T	P	C
THEORY		0	0	4	2

Assessment Methodology:

	Continuous Assessment (40 marks)				End Semester Examination (60 marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Practical Document	Practical Test	Practical Examination
Portion	First Cycle	Second Cycle	All Exercises	All Exercises	All Exercises
Duration	2 Periods	2 Periods	Regularly	3 Hours	3 Hours
Exam Marks	50	50	100	100	100
Converted to	10	10	10	20	60
Marks	10		10	20	60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- CA1 and CA2: All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Cycle 1 - 50 % of exercise

  Cycle 2 - 50 % of exercise

1124234420	**Renewable Energy Instrumentation Applications Laboratory**	L	T	P	C
THEORY		0	0	4	2

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim & Tools required	10
B	CIRCUIT DIAGRAM	20
C	CONNECTIONS AND PROCEEDING THE EXPERIMENT	20
TOTAL		50

- CA 3: Practical document should be maintained for every exercise immediately after completion of the practice. The same should be evaluated for 10 Marks. The total marks awarded should be converted to 10 Marks for the internal assessment. The practical document should be submitted for the Practical Test and End Semester Examination with a bonafide certificate

  The details of the documents to be prepared as per the instruction below.

  Each exercise should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or a printed manual or a file with documents. The part program and sketch should be written by the student manually.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

- CA 4: All the exercises should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded should be converted to 20 Marks for the internal assessment.

1124234420	**Renewable Energy Instrumentation Applications Laboratory**	L	T	P	C
THEORY		0	0	4	2

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Tools required	10
B	CIRCUIT DIAGRAM	25
C	CONNECTIONS AND PROCEEDING THE EXPERIMENT	25
D	READING/CALCULATION/	20
E	GRAPH/RESULT	10
F	VIVA VOCE	10
	TOTAL MARKS	100

Syllabus Contents - List of Practicals:

EXERCISE NUMBER	**PRACTICAL**	
1	Study of different instruments specification for displacement, force, level, pressure, flow measuring system.	
2	Experiment to plot and analyse the characteristics curve of strain gauge.	
3	Experiment to plot and analyse the characteristics curve of LVDT with distance as input.	

1124234420	**Renewable Energy Instrumentation Applications Laboratory**	L	T	P	C
THEORY		0	0	4	2

4	Experiment to plot the load cell characteristics using different load as input.	
5	Experiment to measure level of a tank using Gauge glass, Rotameter and Differential Pressure Transmitter.	
6	Experiment to measure level of a tank using Displacer, Ultrasonic level meter.	
7	Experiment to measure the flow of liquid using Rotameter, and Differential Pressure Transmitter.	
8	Experiment to measure the temperature using Pt100 and Thermocouple.	
9	Identification of different parts of C type bourdon tube pressure gauge.	
10	Study of operation of dead weight tester and calibration of pressure gauge using it	

Reference Books:

1. Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications(Wiley - IEEE) by Haitham Abu-Rub (Author), Mariusz Malinowski (Author), Kamal Al-Haddad.
2. Applications of Renewable Energy Sources by K P Prasad Rao
3. Renewable Energy and Future Power Systems by Singh, V.K., Bhoi, A.K., Saxena, A., Zobaa, A.F., Biswal, S.
4. Renewable Energy Resources, Challenges and Applications by Mansour Al Qubeissi.

1124234420	**Renewable Energy Instrumentation Applications Laboratory**	L	T	P	C
THEORY		0	0	4	2

END SEMESTER EXAMINATION - PRACTICAL EXAMS

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Tools required	10
B	CIRCUIT DIAGRAM	25
C	CONNECTIONS AND PROCEEDING THE EXPERIMENT	25
D	READING/CALCULATION/	20
E	GRAPH/RESULT	10
F	VIVA VOCE	10
	TOTAL MARKS	100

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

Introduction

This course introduces the fundamental principles of Fluid Mechanics, Hydraulics, Pneumatics, and PLC systems, which form the backbone of modern mechanical and industrial automation systems. Students gain knowledge of fluid properties, fluid flow through pipes, pressure measurement, and energy principles, followed by practical exposure to hydraulic and pneumatic control systems used in industries. The course also provides essential skills in Programmable Logic Controllers (PLC), enabling students to design and implement basic automation logic using ladder diagrams. Emphasis is given to hands-on laboratory experiments, fostering problem-solving ability, system understanding, and industry readiness.

COURSE OUTCOMES

CO1: Explain and apply fundamental principles of fluid properties, fluid kinematics, and fluid dynamics to solve basic engineering problems related to pressure, flow, and energy in pipe flow systems.

CO2: Conduct experiments and analyze fluid flow behavior by verifying Bernoulli's theorem and determining friction factor, interpreting losses, and validating theoretical principles with experimental results.

CO3: Design, analyze, and operate pneumatic and hydraulic circuits using standard components, ISO symbols, and control techniques for industrial applications such as speed control and automation.

CO4: Develop and interpret PLC ladder logic programs using logic gates, timers, counters, and I/O concepts to control motors and electro-pneumatic systems.

CO5: Integrate PLC, hydraulic, and pneumatic systems to implement sequential and automatic control of industrial actuators through experimentation, testing, and structured documentation.

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

CO–PO MAPPING

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	–	–	–
CO2	-	-	–	3	-	-	-
CO3	-	-	3	2	-	-	–
CO4	-	-	3	2	-	–	1
CO5	-	-	3	3	3	-	-

(3 – Strong, 2 – Moderate, 1 – Low)

Assessment Methodology:

	Continuous Assessment (40 marks)				**End Semester Examination (60 marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Practical Test	Practical Examination
Portion	Cycle I Exercises	Cycle II Exercises	All Portions	All Exercises	All Exercises Experiments
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 hours
Exam Marks	60	60	100	100	100
Converted to Marks	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

Note: **CA1 and CA2:** All the exercises/experiments should be completed as per the portions above and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded shall be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

Practical documents should be maintained for every experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise/experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

The details of the documents to be prepared as per the instruction below.

Each exercise should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next experiment.

This documentation can be carried out in a separate notebook or a printed manual or a file with documents. The Procedure, Sketch and Result / Output should be written by the student manually in the documents.

The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DoTE Official.

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Procedure / Preparation	15
B	Circuit / Program	20
C	Execution / Connection	15
TOTAL		50
D	Practical Documents (As per the portions)	10
		60

Cycle - I - 50 % Exercises

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

Cycle - II - Balance 50 % Exercises.

CA 3: Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment.

Question pattern – Written Test Theory

Description		**Marks**	
Part – A	30 MCQ Questions.	30 X 1 Mark	30 Marks
Part – B	7 Questions to be answered out of 10 Questions.	7 X 10 Marks	70 Marks
TOTAL			100 Marks

CA 4: All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation below. After completion of all the exercises the practical test should be conducted as per End Semester Examination question pattern scheme of evaluation. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical Examination and End Semester Examination - Practical Exam

PART	**DESCRIPTION**	**MARKS**
A	Procedure / Preparation	15
B	Circuit / Program	20
C	Execution / Connection	15
D	Result	10
E	Written Test	30
F	Viva Voce	10
TOTAL		100

Note: For the written test 30 MCQ shall be asked from the theory portions.

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

Syllabus Contents

Theory Portion:	
UNIT I: FLUID AND FLUID PROPERTIES, PIPE FLOW.	
Concept and classification of fluid, Properties of fluid - Density - weight - Specific volume - Specific gravity - Viscosity - Surface tension Cohesion & Adhesion – Capillarity - Bulk modulus of elasticity - Vapor Pressure - Description only. Pressure head- atmospheric gauge and vacuum pressure – Classification pressure measuring devices - Working and application of pressure measuring devices: Piezometer- Simple U tube manometers – Differential U tube manometers – problems - Pressure Gauges - Description. Fluid Kinematics: Streamline, path line and streak lines and stream tube, classification of fluid flows-Reynolds number, steady & unsteady, uniform, non-uniform, laminar, turbulent, rotational, and irrotational flows-equation of continuity for one dimensional flow. Fluid Dynamics: Energies of fluid-Bernoulli's equations for flow along a streamline - Description and simple problems - Applications of Bernoulli's theorem. Description. friction factor, Darcy's and Chezy's equations - Description only, Moody's chart- Water hammer and cavitation, its cause, effect, and remedies. Introduction to pipe and pipe flow - Major and minor losses - Reynold's experiment, friction factor, Darcy's and Chezy's equations - Description only, Moody's chart- Water hammer and cavitation, its cause, effect, and remedies.	
Fluid Mechanics Lab	
Practical: **Exercise 1:** Verify Bernoulli's theorem. **Exercise 2:** Find the friction factor for the given pipeline.	

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

UNIT II: HYDRAULICS AND PNEUMATIC SYSTEMS	
Pneumatic systems: Elements - FLR unit - Direction Control Valves - Flow control Valves - ISO Symbols of Pneumatic Components-pneumatic circuits for various industrial applications. Hydraulic Systems: Elements – comparison of Pneumatic systems and Hydraulic systems-service properties of hydraulic fluids-ISO symbols of hydraulic Components-hydraulic circuits for various industrial applications.	
Pneumatics Lab	
Exercise 3: Operation of double acting cylinder with quick exhaust valve. Speed control of a double acting cylinder using metering-in and metering-out circuits.	
Exercise 4: Automatic operation of double acting cylinder in single cycle - using limit switch.	
Hydraulics Lab	
Exercise 5: Direct operation of the double acting cylinder. Speed control of double acting cylinder metering-in and metering-out control.	
Theory Portion UNIT II: LOGIC GATES AND PLC	
PLC Features of PLC - PLC Block diagram - PLC scan. Fixed and Modular PLC. Ladder logic - Basic principles of Ladder diagram , Analog I / O and Digital I /O, NO, NC contacts - Coils - AND logic, OR logic.- Applications - Timer - Counter.	
PLC Lab	
Exercise 6: Direct operation of a motor using a latching circuit, AND, OR, logic circuits.	

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

Exercise 7: On-Delay control of a motor and Off –Delay control of a motor.	
Exercise 8: Automatic operation of Double acting cylinder-Multi cycle.	
Exercise 9: Sequential operation of a double acting cylinder and a motor.	
Exercise 10: Automatic operation of DAC, Forward time delay return.	
Assessment Test and Revision	10
Total	75

Suggested List of Students Activity:

Demonstrate various fluid properties viscosity, surface tension, cohesion, Adhesion and capillarity.

Measure the fluid pressure using a simple manometer and pressure gauge. Find the pressure difference using a differential manometer.

Reference Books:

1. Raghuwanshi & Kaushik, Fluid Mechanics, S. Chand & Co.
2. R. Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand
3. K. Rajagopal, Fluid Mechanics, Anuradha Publishers (Tamil Nadu)
4. Dr. Raghunath, Fluid Mechanics, Wiley Eastern
5. Anthony Esposito, Fluid Power with Applications, Pearson
6. Jagadeesha T., Hydraulics and Pneumatics, I.K. International
7. S. Ilango & V. Soundararajan, Hydraulics and Pneumatics, New Age International
8. Hugh Jack, Automating Manufacturing Systems with PLCs, Cengage
9. Gary Dunning, Programmable Logic Controllers, Delmar
10. K. P. Raghavan, PLC Programming, SciTech Publications (India)

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

Web Reference:

Fluid Mechanics

- https://nptel.ac.in (Fluid Mechanics – IITs)
- https://www.engineeringtoolbox.com
- https://www.learnengineering.org

Hydraulics & Pneumatics

- https://www.festo-didactic.com
- https://www.hydraulicspneumatics.com
- https://automationforum.co

PLC

- https://nptel.ac.in (PLC & Industrial Automation)
- https://www.plcacademy.com
- https://www.instrumentationtools.com

Equipment / Facilities required to conduct the Practical Course.

Note: The components should be supplied separately. Students should fix the board to execute the circuit.

1. Pneumatic Trainer Board – 2 Nos

   (All Cylinders, Control Valves, Limit switches and other accessories should be kept separately and should not be fixed permanently in the board/ stand.)
2. Hydraulics Trainer Board – 2 No.

   (All Cylinders, Control Valves, Limit switches and other accessories should be kept separately and should not be fixed permanently in the board / stand.)
3. PLC – 3 Nos.
4. Computer with software – 10 Nos.
5. Bernoulli's theorem Kit.
6. Flow Through Pipes experimental kit.

1124234540	**Hydraulics, Pneumatics and PLC**	L	T	P	C
PRACTICUM		1	0	4	3

END SEMESTER EXAMINATION - Practical Exam

Note:

All the exercises should be completed before the Board Practical Examinations. End Semester Practical examination should be conducted for all the exercises / experiments for 100 Marks. Students will be permitted to select any one exercise by lot or question paper supplied by the DOTE Exam section shall be used. The practical document prepared by the student should be submitted with a Bonafide Certificate.

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Procedure / Preparation	15
B	Circuit / Program	20
C	Execution / Connection	15
D	Result	10
E	Written Test	30
F	Viva Voce	10
TOTAL		100

Note: For the written test 30 MCQ shall be asked from the theory portions.

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

Introduction

This course provides in-depth knowledge of solar photovoltaic (PV) manufacturing technologies, covering the complete value chain from silicon wafer production to solar module fabrication, quality assurance, and system installation. Students are exposed to modern industrial practices such as automation, PLC control, clean-room protocols, TPM, and advanced quality tools used in high-efficiency solar manufacturing plants. The course emphasizes hands-on practical training, advanced cell technologies (PERC, HJT, bifacial modules), and real-world troubleshooting, enabling learners to meet the skill requirements of the rapidly growing renewable energy and solar manufacturing sector.

COURSE OUTCOMES

CO1 : Analyze the end-to-end manufacturing process of solar modules, silicon wafers, and solar cells, including material preparation, process flow, working principles, and industrial best practices.

CO2: Apply silicon wafer and solar cell fabrication techniques such as crystal growth, wafering, junction formation, surface texturing, passivation, and advanced cell structures to enhance efficiency and performance.

CO3: Analyze automation, PLC-based control systems, and cleanroom protocols used in solar manufacturing lines to improve throughput, reliability, and process consistency.

CO4: Implement quality control, quality assurance, and advanced diagnostic techniques to evaluate solar wafers, cells, and modules using standard QC tools, imaging methods, reliability testing, and international quality standards.

CO5: Design, install, commission, maintain, and troubleshoot photovoltaic systems in compliance with safety practices and national/international standards, including sustainability and end-of-life considerations.

CO–PO MAPPING

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	-	2	–	–	–	–	–
CO2	3	-	-	-	–	1	–
CO3	-	3	3	3	–	1	1
CO4	-	3	–	3	2	1	2
CO5	-	3	3	3	3	2	3

(3 = Strong, 2 = Moderate, 1 = Low)

Assessment Methodology:

	Continuous Assessment (40 marks)				**End Semester Examination (60 marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Practical Test	Practical Examination
Portion	Cycle I Exercises	Cycle II Exercises	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 hours
Exam Marks	60	60	100	100	100
Converted to Marks	10	10	15	15	60
Marks	10		15	15	60

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

Tentative Schedule	7th Week	14th Week	15th Week	16th Week	

Note:

- **CA1 and CA2:** All the exercises/experiments should be completed as per the portions above and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation as below. The marks awarded shall be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical documents should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise/experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

  The details of the documents to be prepared as per the instruction below.

  Each exercise should be completed on the day of practice. The same shall be evaluated for 10 marks on the day or next day of practice before commencement of the next exercise.

  This documentation can be carried out in a separate notebook or a printed manual or a file with documents. The procedure and sketch should be written by the student manually in the documents.

  The detailed date of the practices and its evaluations should be maintained in the course logbook. The log book and the practical documents should be submitted for the verification by the Flying Squad and DOTE Official.

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim, Tools and Instruments required	10
B	Procedure/Process	20
C	Output	20
TOTAL		50
D	Practical Documents (As per the portions)	10
		60

Cycle I: 50 % of syllabus

Cycle II: Balance 50 % of syllabus

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment.

Question pattern – Written Test Theory

Description		Marks	
Part – A	30 MCQ from the complete theory portions.	30 X 1 Mark	30 Marks
Part – B	Seven Questions to be answered out of 10 Questions.	7 X 10 Marks	70 Marks
TOTAL			100 Marks

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

- **CA 4:** All the exercises/experiments should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The practical test should be conducted as per the scheme of evaluation below. After completion of all the exercises the practical test should be conducted as per End Semester Examination question pattern scheme of evaluation. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim, Tools and Instruments required	10
B	Procedure/Process	20
C	Output	20
D	Finish	10
E	Viva Voce	10
F	Written test	30
		100

Syllabus Contents

Unit I	**Manufacturing Process of Solar Module**	
Process flow of Solar Module Manufacturing (28 Process) - Working principle		1
Unit II	**Silicon Wafer Production**	
Czochralski Process – chunk and fluidized bed reactor (FBR) polysilicon feedstock – load chunk and FBR granules to crucible – melting of polysilicon, doping –		3

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

introduction of seed crystal – beginning of crystal growth – crystal pulling – extraction of crystal ingot from puller – cropping (band sawing) – bricking and squaring – grinding and polishing of ingot corners – gluing to glass substrate – wafering with diamond wire – chemical batch to dissolve glue and release wafer from glass – cleaning, singulation and inspection of monocrystalline silicon wafer.		
Unit III	**Manufacturing Process of Solar Cell**	
Process flow of Solar Cell Manufacturing - Basics of Cycle time and Throughput - PN Junction Diode Function - Clean Room Protocol - Introduction of TPM - PLC function and usage - Automation controls and devices		3
Unit IV	**Quality Control and Quality Assurance**	
Introduction to Quality – difference between QC and QA – IQC– IPQC– FQC– 7QC Tools - Quality Documents (SOP/WI) – Quality Audit – ISO Certifications		4
UNIT V	**Design, Installation, Commissioning, Maintenance & Troubleshooting**	
Basic principles of system design - Site analysis - Mounting systems - Wiring and connections - Installation of modules, inverters, and battery systems - Testing and commissioning - Routine maintenance practices - Common issues in PV systems - Troubleshooting techniques - Troubleshooting tools - Safety protocols - Monitoring systems and alarms - National and international standards (IEC 61215, etc.,)		4
TOTAL HOURS		15
Assessment Test and Revision with Student activity		

Practical Exercises

1. Advanced Silicon Wafer Processing: Study surface texturing and passivation to enhance efficiency.

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

2. Plasma-Enhanced Chemical Vapor Deposition (PECVD): Apply anti-reflective and passivation coatings using PECVD.
3. High-Efficiency Cell Structure Fabrication: Manufacture Passivated Emitter and Rear Cell (PERC) or Heterojunction (HJT) cells.
4. Photoluminescence and Electroluminescence (PL/EL) Imaging: Detect micro-cracks, dislocations, and defects in wafers or modules.
5. Laser Scribing for Cell Division: Perform precision laser scribing to divide solar cells.
6. Solar Cell Efficiency Enhancement: Optimize doping and metallization processes to improve efficiency.
7. Module Reliability Testing: Test the durability of solar modules under extreme conditions.
8. Advanced Interconnection Techniques: Implement busbar-less interconnection or shingled solar cells.
9. Bifacial Solar Cell and Module Fabrication: Fabricate and test bifacial solar cells and modules for enhanced energy yield.
10. Advanced Quality Analysis of Solar Modules: Conduct in-depth quality analysis using advanced tools.
11. Recycling and End-of-Life Processing: Study the recycling process for solar modules.

List of Equipments

1. Advanced Silicon Wafer Processing

Equipment:

- Etching setup (for chemical texturing).
- Reactive Ion Etching (RIE) equipment.
- Surface passivation materials (e.g., SiNx or Al2O3).
- Spectrophotometer for reflectance measurement.

2. Plasma-Enhanced Chemical Vapor Deposition (PECVD)

Equipment:

- PECVD system.

- Precursors for SiNx or similar materials.
- Thickness measurement tools (ellipsometer).
- Spectrophotometer for coating evaluation.

3. High-Efficiency Cell Structure Fabrication

Equipment:

- Laser doping or ablation system.
- ALD or PECVD system for rear passivation.
- Diffusion furnace for emitter formation.
- Tools for creating TCO (Transparent Conductive Oxide) layers.

4. Photoluminescence and Electroluminescence (PL/EL) Imaging

Equipment:

- PL imaging system.
- EL imaging setup with high-resolution cameras.
- Software for defect analysis.

5. Laser Scribing for Cell Division

Equipment:

- Laser scribing machine.
- Micrometer for precise measurements.
- Inspection microscope for scribing quality assessment.

6. Solar Cell Efficiency Enhancement

Equipment:

- Advanced doping furnace with variable parameters.
- High-resolution IV curve tracer.
- Quantum efficiency measurement setup.
- Thermal testing equipment.

7. Module Reliability Testing

Equipment:

- Thermal cycling chamber.
- Damp heat testing chamber.

- UV exposure tester.
- Mechanical load tester.
- IR camera for detecting thermal anomalies.

8. Advanced Interconnection Techniques

Equipment:

- Conductive adhesives or low-temperature soldering tools.
- Shingling setup with alignment jigs.
- Solar simulator for performance testing.
- EL imaging for quality assurance.

9. Bifacial Solar Cell and Module Fabrication

Equipment:

- Bifacial wafer processing tools.
- Dual-side metallization and encapsulation setup.
- Bifacial solar simulator.
- Rear-side irradiance testing setup.

10. Advanced Quality Analysis of Solar Modules

Equipment:

- Infrared (IR) thermal imaging system.
- Light-induced degradation (LID) testing chamber.
- Micro-crack detection setup.
- Optical inspection system for solder bond evaluation.

11. Recycling and End-of-Life Processing

Equipment:

- Thermal delamination setup.
- Chemical processing equipment for material recovery.
- Tools for separating glass, silicon, and metals.
- Spectroscopic analysis tools for material purity testing.

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

SUGGESTED STUDENT ACTIVITIES

- Student seminars on recent advancements in solar PV technology
- Online or classroom quizzes
- Industrial visit to solar module manufacturing or solar power plant
- Mini-project on efficiency improvement techniques

Reference Books

1. Chetan Singh Solanki, Solar Photovoltaics – Fundamentals, Technologies and Applications, PHI Learning, India
2. Sukhatme & Nayak, Solar Energy – Principles of Thermal Collection and Storage, McGraw Hill
3. Adrian Kitai, Thin Film Solar Cells: Fabrication, Characterization and Applications, Wiley
4. Green, M.A., Solar Cells: Operating Principles, Technology and System Applications, UNSW
5. Dale H. Besterfield, Quality Control, Pearson
6. K.C. Arora & S. Kaushik, Total Quality Management, Dhanpat Rai
7. Bolton, W., Programmable Logic Controllers, Newnes

WEB REFERENCES

- https://nptel.ac.in (Solar PV, Manufacturing, Quality, Automation – IITs/IISc)
- https://www.iea-pvps.org
- https://www.seia.org
- https://www.pveducation.org
- https://www.energy.gov/eere/solar
- https://www.solarpowerworldonline.com
- https://www.automation.com

1124234640	SOLAR PV AND MANUFACTURING - II	L	T	P	C
THEORY		1	0	4	3

End Semester Examination - Practical Exam

SCHEME OF EVALUATION

PART	DESCRIPTION	MARKS
A	Aim, Tools and Instruments required	10
B	Procedure/Process	20
C	Output	20
D	Finish	10
E	Viva Voce	10
F	Written test	30
		100

1124235110	**Energy Efficiency, Economics and Audit**	L	T	P	C
THEORY		4	0	0	4

COURSE OUTCOMES

CO1: Explain and interpret energy efficiency and energy conservation principles by correlating legal provisions (Indian Electricity Act, star labelling), energy-efficient technologies, building energy concepts, tariff structures, and power system practices for sustainable energy utilization.

CO2: Apply energy conservation techniques and energy-efficient equipment in lighting, heating, cooling, motive power, buildings, industries, and power systems to achieve measurable reduction in energy consumption and losses.

CO3: Analyze energy performance and losses in buildings, industrial systems, tariff mechanisms, and transmission & distribution networks using thermal comfort methods, load calculations, power factor, load factor, and numerical evaluation.

CO4: Evaluate and select appropriate energy management solutions such as VFDs, APFC, efficient motors, photovoltaic materials, building design strategies, demand side management, and reactive power compensation based on technical and economic criteria.

CO5: Design and recommend integrated energy conservation strategies incorporating efficient end-use equipment, optimized tariffs, building energy simulation, and transmission & distribution loss minimization while adhering to sustainability and regulatory requirements.

CO–PO MAPPING

(3 = Strong, 2 = Moderate, 1 = Low, "–" = No direct mapping)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	–	3	1
CO2	2	2	3	2	3	2	–
CO3	2	3	2	3	2	2	–
CO4	2	3	3	2	3	2	1
CO5	2	3	3	3	2	3	2

Syllabus Contents

1124235110	**Energy Efficiency, Economics and Audit**	L	T	P	C
THEORY		4	0	0	4

Unit I	**Introduction to Energy Efficiency:**
Concepts of Energy Efficiency and Energy Conservation. Indian Electricity Act 2001. Relevant clauses of energy conservation. Star Labelling – Need and its benefits.	
Unit II	**Energy Conservation:**
Lighting Energy: Techniques of energy efficient lighting, Components of energy efficient lighting system. Periodic survey and adequate maintenance programs. Heating: Techniques of energy saving in Furnaces, Ovens and Boilers. Cooling: Techniques of energy saving in Ventilating systems and Air Conditioners. Motive power. Energy Efficient Motors. Energy Conservation Equipment: Soft starters, Automatic star delta convertor. Variable Frequency Drives. Automatic p. f. controller (APFC). Materials for Photovoltaic Cells:	
Unit III	**Energy Conservation in Buildings:**
Introduction. Orientation and Planning for Environment. Indoor Air Quality (IAQ) requirements. Thermal Comfort of Building, Thermal Comfort Improvement Methods, Thermal Insulation, Control of Humidity and Condensation. Thermal Admittance Method. Building energy Simulation, Load Calculation. Use of daylighting integrated artificial lighting system	
Unit IV	**Tariff and Energy Conservation in Industries:**
Energy cost and Recent WBSEB/CESC tariffs. Application of Tariff System to reduce Energy bill. Prosumer tariff. Availability Based Tariff (ABT). Time of Day (TOD) tariff. Indian Energy Exchange (IEX). Energy conservation by improving load factor and power factor. (Numerical)	
UNIT V	**Energy Conservation In Transmission and Distribution Systems:**

1124235110	**Energy Efficiency, Economics and Audit**	L	T	P	C
THEORY		4	0	0	4

Reactive power compensation. Demand side management, system voltage optimization and phase current balancing. Losses in transmission and distribution system and its minimization.	

Reference Books:

1. Generation Distribution and Utilization of Electrical Energy C.L. Wadhawa New Age 2004

2. Electric system M.J. Steinburg and T.H. Smith John Willey and sons.

3. Energy conservation Guide book Steven R. Patrick, Dale R. Patric Stephen W. Fardo Fairmont Press.

4. Industrial Energy Management: Principles and applications Giovanni Petrecca Kluwer Academic Publisher.

5. Handbook of Energy Engineering. Fifth ed.Thumann, Mehta.The Fairmount Press, 2001.

Assessment Methodology:

As per the Chairman Board of Examinations guidelines.

1124235210	WIND ENERGY AND BATTERY ENERGY STORAGE SYSTEM	L	T	P	C
THEORY		3	0	0	3

COURSE OUTCOMES

CO1: Explain and correlate wind resource characteristics, wind turbine components, energy conversion principles, storage systems, and grid integration concepts to understand the complete wind energy ecosystem from resource to grid.

CO2: Apply wind energy conversion theory, turbine performance equations, hybrid system concepts, and energy storage principles to estimate power, torque, energy production, and capacity factors for practical wind energy systems.

CO3: Analyze wind turbine performance, hybrid configurations, storage technologies, and grid interaction challenges considering aerodynamic behavior, generator operation, environmental conditions, and Indian grid requirements.

CO4: Evaluate techno-economic, environmental, and operational aspects of wind energy projects including cost of energy, ROI, IRR, environmental impact, safety, storage selection, and grid code compliance.

CO5: Design and recommend integrated wind energy solutions incorporating turbine selection, hybrid systems, energy storage, monitoring (SCADA), maintenance strategies, and renewable grid integration for reliable and sustainable power delivery.

CO–PO MAPPING

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	2	2	1
CO2	2	3	2	2	–	–	–
CO3	2	3	2	2	1	1	–

1124235210	WIND ENERGY AND BATTERY ENERGY STORAGE SYSTEM	L	T	P	C
THEORY		3	0	0	3

CO4	2	3	2	–	3	3	1
CO5	2	3	3	3	2	2	2

(3 = Strong, 2 = Moderate, 1 = Low, "–" = No direct mapping)

Syllabus Contents

Unit I	Basics & Meteorology of Wind & Wind Turbine:	
Wind resources, Wind energy scenario in India. Types of Winds. Local & Regional Wind System. Factors influencing Wind. Pressure Gradient Force, Coriolis Force. Power in the Wind, Power vs. Wind speed characteristics. Guidelines for Wind turbine site selection. Parts of wind turbine – Nacelle, Rotor blades, Blade count, Blade materials, Hub, Low speed shaft, Gearbox, High speed shaft, Electrical generator, Yaw mechanism, Electronic controller, Hydraulics system, Cooling unit, Tower, Anemometer, Wind wane. Classification of Wind Turbine: Types, Drag force, Lift force. Vertical axis Wind Turbine (VAWT) –Horizontal axis Wind Turbine (HAWT) – Direct drive Wind Turbine – Geared drive Wind Turbine – Constructional details, Operating principle, Advantage & Disadvantages.		
Unit II	Wind Energy Conversion: & Wind Power Generation & Hybrid Systems:	
Principles of Wind Energy Conversion, Lift force, Drag force, Pitch angle, Angle of attack, Theory of energy extraction from Wind, Wind turbine theory, Condition for maximum performance coefficient. Characteristics of Windmill rotor – Pitch, Tip Speed Ratio (TSR), Number of rotor blade, Solidity. Rotor Torque equation,		

1124235210	WIND ENERGY AND BATTERY ENERGY STORAGE SYSTEM	L	T	P	C
THEORY		3	0	0	3

Co-efficient of Performance, Power co-efficient, Maximum torque. (Numerical) Torque – TSR characteristics. Working principle of generators used with wind turbine – Induction generator (IG). Permanent magnet alternators. Synchronous generators. DC generators. Fixed Speed Drive Scheme. Variable Speed Drive Scheme. load control. Hybrid System Models. Wind–Diesel Hybrid System. Wind– Photovoltaic Hybrid System. Battery Banks and Power Converters. Cost components of wind power project, Fixed cost and variable costs. Failure Analysis, Ageing and Rehabilitation: Effective Operation of Wind Farm. Central Monitoring System. Modern Developments & SCADA. Estimation of Energy Production, Capacity Factor, Capacity Credit. Off shore Wind farm Development. Operation & Supervision of Wind Farm.		
Unit III	Economics of Wind Energy & Environmental Impact: Installation & Maintenance of Wind Turbine:	
Economics of Wind Energy: Cost of energy, Return on Investment (ROI). Life time cash flow and Internal rate of Return (IRR). National & International Wind Energy Market. Environmental Impact and safety Aspects: Environmental Impact. Aviation interaction. Visual impact. Noise, Radio waves interference. Bird life, Land use, Impact on flora & fauna. Installation steps of small wind turbine. Maintenance of different parts of wind turbine. Common electrical faults in wind turbine.		
Unit IV	Energy Storage Systems	
Types of electrical energy storage (Battery & Non-battery) and key characteristics (Technologies moving from pilot to commercial production) Parameters for electrical energy storage (In Indian context viz. high humidity & high ambient temperature). Types and applications of thermal energy storage systems.		

1124235210	WIND ENERGY AND BATTERY ENERGY STORAGE SYSTEM	L	T	P	C
THEORY		3	0	0	3

UNIT V	Renewable Energy Grid Integration	
Various Grid related Applications, the role of energy storage in ancillary services to improve the stability of the grid. Off-Grid Systems, Energy Storage Technologies, and Grid Integration. Off-grid systems, architecture, and sizing | Small scale battery storage systems, Costs, and pricing Various Codes and Standards followed for Storage technologies and Integration of energy storage into electrical grids (Specific Indian grid code requirements to be covered) Statutory requirements of disposal of various battery systems and Precautions to be taken while procurement. Future developments in energy storage Aspects of Round the Clock Energy.		9

Reference Books:

1. Non-Conventional Energy Resources B.H Khan McGraw-Hill
2. Non-Conventional Energy Sources G. D. Rai Khanna Publishers
3. Wind Energy System Gary L. Johnson Prentice Hall Inc, New Jersy
4. Power Plant Technology E. I. Walil McGraw Hill Publishers, New York
5. Handbook of Wind Energy T. Burton John Wiley and Sons
6. Wind Electrical Systems S.N. Bhadra, D. Kasthaand S. Banerjee Oxford Univ. Press
7. Non-Conventional Energy Resources Shobh Nath Singh Pearson
8. Non-Conventional Energy Resources S.H.Saeed, D.K.Sharma S.K.Kataria & Sons
9. Power Plant Engineering, 3rd Edition, P K. Nag Tata McGraw Hill, 2008.
10. Wind Energy Technology John F. Walker and Nicholas Jenkins John Wiley, 1997

1124235210	WIND ENERGY AND BATTERY ENERGY STORAGE SYSTEM	L	T	P	C
THEORY		3	0	0	3

Suggested list of Students Activity:

Hybrid projects / tenders

Assessment Methodology:

As per the Chairman Board of Examinations guidelines.

1124235331	**Electric Vehicle technology & Policy**	L	T	P	C
Practicum		3	0	2	4

COURSE OUTCOMES

CO1: Explain and correlate the environmental impact, evolution of electric and hybrid vehicles, EV architectures, battery technologies, propulsion systems, charging methods, and electric mobility policies to understand the complete EV ecosystem.

CO2: Apply principles of batteries, motors, power converters, charging systems, and hybrid configurations to operate, test, and demonstrate EV components, battery packs, chargers, and electrical circuits safely and effectively.

CO3: Analyze the performance, energy flow, and operating characteristics of electric and hybrid vehicles by evaluating tractive effort, battery management, motor drives, converter operation, charging infrastructure, and grid interaction.

CO4: Evaluate EV technologies, charging standards, battery systems, hybrid configurations, and policy frameworks based on technical feasibility, safety, cost, sustainability, recycling, and Indian regulatory requirements.

CO5: Demonstrate and recommend integrated EV and electric mobility solutions involving battery testing, charging station operation and maintenance, smart charging (OCPP/RFID), troubleshooting, and compliance with national and state EV policies.

CO–PO MAPPING

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	–	-	-
CO2	3	-	-	3	-	–	–
CO3	-	3	2	3	-	-	–
CO4	-	3	-	-	-	-	-
CO5	-	2	3	-	3	2	2

(3 = Strong, 2 = Moderate, 1 = Low)

1124235331	**Electric Vehicle technology & Policy**	L	T	P	C
Practicum		3	0	2	4

Syllabus Contents

Unit I	Environmental impact and history and E-Vehicles	
Environmental impact and history: Environmental impact of conventional vehicle - Air pollution – Petroleum resources – History of Electric vehicles & Hybrid Electric Vehicles – Need for Electric Vehicle. Electric vehicle Types – Definition BEV – Major Components of Electric Vehicle –Block diagram and working of BEV - Different between BEV and Conventional Vehicle. Fuel Cell – Working Principle - Fuel Cell-operated Electric Vehicle (FCEV) - Major component - Working principle - Advantages.		9
Unit II	Electric Vehicle Battery Technology and Charging Methods	
Battery: Electrochemical Batteries – Battery Technologies – Construction and working of Nickel-cadmium, Nickel-ion, Lithium-ion, and lithium-polymer batteries – Ultra-capacitor - Battery Management System (BMS) – Battery pack development Technology: sell Series, Parallel and mixed connection to develop battery pack. Battery Charging Techniques: Battery Charging techniques – Constant current and Constant voltage, Trickle charging – Battery Swapping Techniques – DC charging – Wireless charging – Maintenance of Battery pack		9
Unit III	Electric propulsion system and Converters	
Configurations of Electric Vehicle –Electric power drive train – Performance of Electric Vehicles – Tractive Effort in Normal Driving. EV motors - Types - Principles, Construction, Working, Merits and Demerits of DC motor drives, Permanent Magnetic Brush Less DC Motor Drives - Hub motor Drive system. Power Converters: Role of Power Converters – Block diagram of Power Converters in EV – Types of Power Converters – DC to DC Converter, Inverter and Rectifier and its types.		8

1124235331	**Electric Vehicle technology & Policy**	L	T	P	C
Practicum		3	0	2	4

Unit IV	Hybrid Electric Vehicle	
HEV: Hybrid Electric Vehicle – Advantages, Disadvantages – Components of Hybrid Electric Vehicle – IC Engine, Electric Motor, Controller, DC/DC Converter, Transmission, Batteries – Working of Hybrid Vehicle – Starting, Braking, Cruising, Passing. - - Plug-in Hybrid Electric Vehicle Types of Hybrid Vehicle: Hybridisation – Micro Hybrid, Mild Hybrid, Fully Hybrid – Advantages, Disadvantages & its Applications. Drive Configuration: Series Hybrid – Control Strategies, Advantages & Disadvantages, Configuration - Parallel Hybrid –Control Strategies, Advantages & Disadvantages, Configuration – Split Power Hybrid.		8
Unit V	Electric Mobility & Electric Vehicle Policies	
Electric mobility ecosystem- Global scenario of EV adoption - Electric mobility in India - National Electric Mobility Mission Plan 2020 (NEMMP 2020) - FAME, India (Faster Adoption and Manufacturing of (Hybrid & Electric) Vehicles in India) I & II - Champion OEM Incentive Scheme - Recycling Ecosystem of battery and EVs - Battery Recycling. TAMIL NADU ELECTRIC VEHICLES POLICY 2019 - Key Features. TAMIL NADU ELECTRIC VEHICLES POLICY 2023: Need for a Revised Policy - Scope & Definitions – Objectives - Supply Side Policy Measures - Demand Side Measures - Charging Infrastructure - Ecosystem Development - Policy Implementation Mechanism		5
Unit VI	EV Charging System & Technology	
EV charging standards (Domestic & International)- Overview of Type of charger (AC & DC chargers)- Classification of EV Charging Infrastructure (Public/Semi-Public/Fleet/Bus/Home/Community charging) - Charge point operators and E-mobility Service providers- Planning Charging station Locations & Land allocation- Charger installation & Safety compliances- Assessing charging demand & EV-Grid integration- Battery Swapping Station, Challenges in EV Charging station set-up & maintenance.		4

1124235331	**Electric Vehicle technology & Policy**	L	T	P	C
Practicum		3	0	2	4

TEST + REVISION	10
Practical	22
TOTAL HOURS	75

Practical:	
Experiment 1: Practice on measuring instruments in single and three phase circuits e.g. multi-meter, Wattmeter, Ammeter, Voltmeter, etc.	1
Experiment 2: Measure current and voltage in electrical circuits to verify Kirchhoff's Law.	1
Experiment 3: Show how to check the supply unit with AC supply/multimeter to find out the voltage/current input/output and use of soldering station.	1
Experiment 4: Show how to check and measure battery capacity, through use of multimeter	1
Experiment 5: Demonstrate how to use a multimeter and individually check the components of the section where voltage output is found to be less than desired or no output.	1
Experiment 6: Demonstrate how to do soldering of wires and make connections in case of loose, de-soldered wires and connections, connect batteries to EV and EV chargers and record various outcomes or distortions	2
Experiment 7: Show how to use CCS; CHAdeMO; GB/T plug & sockets, Cables.	1
Experiment 8: Demonstration of AC-DC EV Charging System.	2
Experiment 9: Demonstrate Radio Frequency Identification system, how it is use, features and types, RFID cards and Tags.	2
Experiment 10: Show how to do Device Management, Transaction handling, Smart Charging functionalities through OCPP.	2
Experiment 11: Demonstrate Level 1, 2, and 3 of network and non-network charging.	2

1124235331	**Electric Vehicle technology & Policy**	L	T	P	C
Practicum		3	0	2	4

Experiment 12: Performing demonstration on EV charging stations regular maintenance. Charging station maintenance includes regular inspections of the charging station, its components, and any necessary repairs.	2
Experiment 13: Demonstrate how to Reset the Charging Dock connector by unplugging it and reinserting it fully into the vehicle receptacle. Ensure that the connector latch engages completely.	2
Experiment 14: Show how to inspect the Charging Dock output cable and connector terminals for damage. If damaged, discontinue use immediately and replace socket.	2

Suggested List of Student Activity:

- Presentation/Seminars by students on any recent technological developments based on the course.
- Poster presentation on layout and wiring harness of electric Two-wheeler / Four-wheeler.

Text and Reference Books:

1. A.K Babu, Electric & Hybrid Vehicle, Second edition, Khanna Publication, 2022.
2. James D. Halderman, Electric and Hybrid Electric Vehicles, First edition Pearson, 2023.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E.Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Third edition, CRC Press, 2019.
4. Tamil Nadu Electric Vehicles Policy 2019 & 2023.

Web-based/Online Resources:

- NPTEL Fundamentals of Electric vehicles: Technology & Economics https://nptel.ac.in/courses/108106170
- NPTEL Introduction to Hybrid and Electric Vehicles, IIT Guwahati https://nptel.ac.in/courses/108103009

1124235331	**Electric Vehicle technology & Policy**	L	T	P	C
Practicum		3	0	2	4

Equipment / Facilities required to conduct the Practical Course.

Sl. No.	Machines / Tools / Equipment	Quantity
1.	Lead acid battery / Lithium-ion Battery	8 Nos
2.	Battery Load tester	1 No
3.	Battery Charger Unit with Lead Acid battery	1 No
4.	Two-wheeler Wiring Harness board or kit	1 No
5.	Buck Converter	1 No
6.	Inverter Trainer Kit	1 No
7.	E – Bicycle kit or Accessories 24V DC Controller, 24 V DC motor, Throttle, Brake, Power ON key, Headlamp with Horn.	1 No
8.	E – Bike kit or Accessories 48 V BLDC Controller, 500W or 750 W, 48 V BLDC motor, Throttle, Brake, Power ON key, Display Board, Head lamp with Horn, Left & Right Indicator	1 No
9.	E-Auto Rickshaw 500 W or 750 W, 48 V BLDC motor with differential arrangement, Throttle, Brake, Power ON key, Display Board, Head lamp with Horn, Left & Right Indicator	1 No
10.	Consumable: - Battery Cell - 1.5 V or 3.65 V , Soldering Iron , Flux, De-solder gun or Solder wick, Lead Tools: - Continuity Tester, Line Tester, Multi-meter, Hydrometer, Screw Drive set & Spanner set	As per requirement.

1124235332	Bio Energy	L	T	P	C
THEORY		3	0	2	4

COURSE OUTCOMES

CO1: Explain and correlate biomass resources, fuel properties, conversion technologies, gasification principles, and biogas production systems to understand biomass-based energy generation in the Indian context.

CO2: Apply biomass conversion, gasification, and anaerobic digestion principles to set up, operate, and demonstrate biogas plants and gasifiers, including measurement of gas composition, calorific value, and energy output.

CO3: Analyze the performance and efficiency of biomass and biogas energy systems by studying feedstock properties, pre-treatment methods, gasifier types, operational parameters, and experimental results from biogas plant trials.

CO4: Evaluate different biomass conversion routes and system configurations (incineration, gasification, biochemical conversion, biogas plant models) based on technical feasibility, efficiency, environmental impact, and sustainability.

CO5: Design and recommend integrated biomass and biogas energy solutions by selecting suitable feedstock, conversion technology, gasifier or digester type, and operating conditions to meet energy and societal needs.

CO–PO MAPPING

(3 = Strong, 2 = Moderate, 1 = Low, "–" = No direct mapping)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	–	2	1
CO2	2	2	2	3	2	2	–
CO3	2	3	2	3	2	1	–
CO4	2	3	2	2	–	3	1
CO5	2	3	3	3	2	3	2

1124235332	Bio Energy	L	T	P	C
THEORY		3	0	2	4

Syllabus Contents

Unit I	Fundamentals of Biomass:	
Biomass resources. Energy farming. Different forms of Biomass, their composition & fuel properties. Indian scenario for Biomass resources. Bio-Fuel quality assessment studies. Advantages of biomass energy.		
Unit II	Biomass Conversion Technology Methods:	
Physical method. Incineration. Thermo-chemical method. Bio-chemical method. Urban waste to energy conversion – Municipal solid waste incineration plant, Sewage to energy conversion.		
Unit III	Biomass Gasification:	
Theory of Gasification. Pre-Treatment methods of Biomass. Physical Treatment – Mechanically Grinding & Chipping, Moisture Removing or Adding, Application of Binding Agent, Steaming, Torrefaction. Low temperature & High temperature Gasification. Chemistry of Gasification & its products.		
Unit IV	Classification of Gasifier:	
Updraft Gasifier – Principles, Design & Application. Downdraft Gasifier – Principles, Design & Application. Cross Draft Gasifier – Principles, Design & Applications. Open core Gasifier – Principles, Design & Applications. Fluidized Bed Gasifier – Principles, Design & Applications. Advantages & disadvantages of different gasifiers. Gasifier Biomass feed parameters. Different Models of Gasifiers.		
UNIT V	Biogas Production:	
Biogas & its composition. Materials used for Biogas generation. Anaerobic digestion – Basic process, advantages. Constructional details of a Biogas plant. Working		9

1124235332	Bio Energy	L	T	P	C
THEORY		3	0	2	4

principle of a Biogas plant. Operational parameters of Biogas plant. Types of Biogas plant – Fixed dome type. Floating type. Comparison between the two types, Their advantages & disadvantages. Different models of Biogas plant in India – Construction & advantages. Constructional details of Digester. Design parameters of Digester. Benefits of Biogas, Utilization of Biogas. Maintenance of Biogas plant. Numerical on Biogas plant	
TOTAL HOURS	

PRACTICAL EXERCISES

1. Identify the components of Biogas and measure the quantity in percentage.
2. Set up a one cubic meter Anaerobic Digestion Biogas plant.
3. Measure the calorific value of the Biogas.
4. Measure the yield of the Biogas changing the input parameters e.g. temperature, input raw materials.
5. Measure the yield of the Biogas after cleaning.
6. Calculate the efficiency of the Biogas plant.
7. Measure the efficiency of the gas engine with Biogas input.
8. Generate electricity from a Bio gas plant and use it for lighting load.

Assessment Methodology:

As per the Chairman Board of Examinations guidelines.

Reference Books:

1. Non-Conventional Energy Resources B. H. Khan The McGraw Hill Publications.
2. Non-Conventional Energy Sources G.D. Rai Khanna Publications.
3. Non-Conventional Energy Resources ShobhNath Singh Pearson.
4. Non-Conventional Energy S.H.Saeed, S.K.Kataria& Sons Resources D.K.Sharma.

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THEORY		3	0	2	4

5. Understanding Clean Energy and fuels from biomass Mukunda HS. Wiley-India Pvt. Ltd, 2011.
6. Hand book of plant based bio fuel Pandey A. CRC Press, Taylor & Francis, 2008.
7. Biogas Systems, Principle and Applications Mital KM. New Age International Ltd. 1996.
8. Biomass, Energy and Environment, A developing country perspective from India. Ravindranath NH. Hall DO. Oxford University Press, 1995

END SEMESTER EXAMINATIONS

As per the Board Examinations Guide lines.

1124235440	POWER ELECTRONICS	L	T	P	C
PRACTICUM		1	0	4	3

Introduction

Electronic control circuits play major role in industries. In this era of automation in industry and manufacturing sector, the mechanical controls are largely replaced by power electronic devices. In this context this course aims at acquainting the pass outs with a comprehensive knowledge base about the devices and circuits used in Electrical Power so that they can maintain the control circuits used in the field. Hence this course has been designed to achieve this aim.

Course Objectives:

The objective of this course is to enable the student to

- Explain the operating region and rating of SCR.
- Explain the trigger and commutation circuits of SCR.
- Familiarize with the phase controlled rectifier circuits.
- Understand the operation of cyclo converter.
- Understand the working of choppers and inverters.

Course Outcomes:

CO1: Demonstrate the working principles and characteristics of power electronic devices, triggering circuits, commutation methods, and controlled converters through laboratory experiments.

CO2: Construct and test SCR-based triggering circuits, commutation circuits, and phase-controlled rectifiers for different load conditions.

CO3: Observe and interpret output waveforms, firing angles, and performance characteristics of rectifiers, choppers, inverters, and cycloconverters.

CO4: Implement and examine power electronic converter–based DC and AC drive systems to study speed control and PWM operation.

CO5: Evaluate the performance and applicability of power electronic circuits for practical applications such as lamp dimming, solid-state switching and motor speed control.

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	3	-	-	-
CO2	-	1	-	3	-	-	-
CO3	-	2	-	3	-	-	-
CO4	-	-	1	3	-	-	-
CO5	-	-	2	3	-	-	-

Assessment Methodology:

	Continuous Assessment (40 Marks)				End Semester Examination (60 Marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Written Test Theory	Model Practical Examination	Practical Examination
Portion	Ex. 1 to 5	Ex. 6 to 10	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 Hours
Exam Marks	60	60	100	100	100
Converted to	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	-

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

Note:

- CA1 and CA2: All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical document (Hand written document / Notebook consists of Aim, Apparatus Required, Circuit, Tabulation / Graph, Procedure and Result) should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise / experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

SCHEME OF EVALUATION – Practical Test

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Circuit Diagram	15
C	Connection	10
D	Execution and Output/Result	20
TOTAL		50
E	Practical Documents (As per the portions)	10
EXAM MARKS		60

1124235440	POWER ELECTRONICS	L	T	P	C
PRACTICUM		1	0	4	3

- CA 3: Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment. The question setting details are as follows.

	Description	Pattern	Marks
PART-A	30 Multiple Choice Questions (MCQ)	30 x 1 Mark	30
PART-B	7 Questions to be answered out of 10 Questions	7 x 10 Mark	70
TOTAL MARKS			100

- CA 4: All the exercises/experiments should be completed and kept for the Model Practical Examination. The students shall be permitted to select any one by lot for the exam. The model practical examination should be conducted as per the End Semester Examination question pattern as given below. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical and End Semester Examination- Practical Exam

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Circuit Diagram	20
C	Connections	15
D	Execution and Output/Result	20
E	MCQ from Theory Portions	30
F	Viva Voce	10
TOTAL MARKS		100

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

Note: Practical Document with Bonafide certificate must be submitted to Model Practical Examination and End Semester Practical Examination.

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion :		
UNIT I	COMMUTATION CIRCUITS AND PHASE CONTROLLED RECTIFIERS	Period
Power Electronics: Definition – Scope and Applications – Power Electronic Switch Specifications – Types of Power Electronic Circuits. SCR – rating and their importance, Symbol, Circuit, Working, Characteristics and Applications - Line Synchronized UJT Triggering Circuits - Working, Characteristics and Applications of IGBT and MOSFET. Commutation Circuits: SCR Turn Off Methods – Natural Commutation – Forced Commutation – Class A, Class B, Class C, Class D, Class E and Class F. Phase Controlled Rectifiers: Introduction – Phase Controlled Rectifiers - Single Phase Fully Controlled Bridge with R Load, RL Load - Single Phase Dual Converter - Three Phase Fully Controlled Bridge with RL Load - Introduction to Single Phase Cyclo Converter with Simple Circuit.		7
Practical Exercises:		
Ex.No	Name of the Experiment	Period
1.	Construct the Line synchronized Ramp trigger circuit using UJT with AC Load to measure firing angles.	6
2.	Construct and test the SCR commutation circuits.	6
3.	Construct and test a Half wave controlled rectifier with R Load.	6
4.	Construct and test a Single phase fully controlled bridge rectifier with RL- Load.	6
5.	Construct and test the Single phase to single phase Cyclo converter.	6

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion:		
UNIT II	CONVERTERS AND APPLICATIONS OF POWER ELECTRONICS	Period
Choppers: Introduction, Principle of Chopper Operation. Control Strategies – Constant Frequency System and Variable Frequency System - Circuit Diagram and Working – Step Up Chopper - Four Quadrant Choppers. Inverters: Introduction, Classification of Inverter. Circuit Diagram, Working and Waveform - Full Bridge Inverter - Three Phase Bridge Inverter Under 180° Mode & 120° Mode Operations - Pulse Width Modulated Inverters, (Single Pulse, Multiple Pulse, Sinusoidal Pulse). DC Drives: Basic DC Motor Speed Equation- Circuit Diagram, Output Waveforms and Output Equation of – Separately Excited DC Motor – Single Phase Full Converter Drives. AC Drives: Speed Control by Rotor Resistance for Slip Ring Induction Motors – Static Scherbius Drive (Slip Power Recovery Scheme) - Variable voltage and Variable frequency drive - Block Diagram.		8
Practical Exercises:		
Ex.No	Name of the Experiment	Period
6.	Design the PWM based step down DC Chopper using MOSFET/IGBT.	6
7.	Construct and test the Single phase Single pulse / Sinusoidal PWM inverter using MOSFET/IGBT.	6
8.	Construct and test the ON / OFF control of Lamp using solid state Relay.	6
9.	Construct and test the Speed Control of AC Motor using VFD drive.	6
10.	Construct a Lamp dimmer circuit using TRIAC.	6

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

TOTAL PERIODS	75

Note: Common Test and Revision periods can be used for conducting Continuous Assessment.

Suggested List of Students Activity:

- Presentation/Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly/fortnightly based on the course
- Viva Voce will be conducted before conducting an experiment

Text and Reference Books:

1. MD Singh, K.B. Khanchandani, Power Electronics, Seventh reprint, Tata Mc Graw Hill Publishing Company Ltd, 2005.
2. Mohammed H. Rashid, Power Electronics, Third Edition, New age publication, 2004.
3. William P. Robbins, Ned Mohan, Tore M. Undeland, Power Electronics: Converters, Applications and Design, Third Edition, Wiley, 2002.

Web-based/Online Resources:

- https://www.electronicsforu.com/technology-trends/learn-electronics/understanding-power-electronics
- https://www.geeksforgeeks.org/power-electronics
- https://www.youtube.com/watch?v=1Auay7ja2oY – NPTEL Lecture Series on Power Electronics by Prof. B.G. Fernandes, Department of Electrical Engineering, IIT Bombay.

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

Equipment / Facilities required to conduct the Practical Course. (Batch Strength: 30 Students)

S.No	Name of the Equipment's	Quantity Required
1.	Line synchronized Ramp trigger circuit using UJT	3 Nos.
2.	SCR commutation circuit kit	1 No.
3.	Half wave controlled rectifier kit	1 No.
4.	Single phase fully controlled bridge rectifier with RL- Load	1 No.
5.	Single phase to single phase cyclo converter kit	1 No.
6.	PWM based step down DC chopper using MOSFET/IGBT kit	1 No.
7.	Single phase Single pulse / Sinusoidal PWM inverter using MOSFET/IGBT kit	1 No.
8.	Solid state Relay	1 No.
9.	Lamp 60W	1 No.
10.	Variable Frequency Drive (VFD)	1 No.
11.	Single Phase/Three Phase Induction Motor	1 No
12.	TRIAC - BT136, DIAC - DB32, Resistor - 2KΩ,26Ω, Capacitor - 0.01µf, Potentiometer - 1 MΩ	Each 1 No

1124235440	**POWER ELECTRONICS**	L	T	P	C
PRACTICUM		1	0	4	3

13.	CRO	5 Nos.

End Semester Examination- Practical Exam

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Circuit Diagram	20
C	Connections	15
D	Execution and Output/Result	20
E	MCQ from Theory Portions	30
F	Viva Voce	10
TOTAL MARKS		100

1124235540	PLC AND AUTOMATION	L	T	P	C
PRACTICUM		1	0	4	3

Introduction:

Nearly all the industrial equipment that you find in a modern manufacturing facility shares one thing in common - computer control. The most commonly used controller is the PLC. PLC is using a programming language called Ladder Logic. Its format is similar to the electrical style of drawing known as the “ladder diagram”. A diploma holder when employed in automated industrial process controls will be required to know the basics of Programmable Logic Controllers, their working and their programming.

Course Objectives:

The objective of this course is to enable the student to

1. Understand the role of each component of PLC system.
2. Practice Relay Type Instructions and Timers Instructions in PLC Programming.
3. Implement Counter, Math and Compare Instructions in conveyor applications.
4. Explain the importance of Analog I/O Module in PLC.
5. Learn the concept of I/O Bus networks and SCADA.

Course Outcomes

CO1 : Configure and operate PLC hardware by interfacing discrete, analog input/output field devices and executing ladder logic programs.

CO2: Monitor and interpret PLC-controlled system behavior by observing input–output status, sequencing, timing, and counting operations in automation systems.

CO3: Implement and examine PLC-based motor control and process automation systems such as DOL starters, star–delta starters, conveyor systems, water level control, and lift control.

CO4: Validate the performance of PLC-based automation solutions involving energy conservation, illumination control, object counting, and industrial communication concepts.

1124235540	PLC AND AUTOMATION	L	T	P	C
PRACTICUM		1	0	4	3

CO5: Develop and execute PLC ladder logic programs using relay logic, timers, counters, math, and data compare instructions for industrial control applications.

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	1	-	-	-
CO2	-	1	-	3	-	-	-
CO3	-	1	-	3	-	-	-
CO4	-	-	1	2	-	-	-
CO5	-	-	2	1	-	-	-

Assessment Methodology:

	Continuous Assessment (40 Marks)				End Semester Examination (60 Marks)
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Model Practical Examination	Practical Examination
Portion	Cycle I Ex.	Cycle 2 Ex.	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 Hours
Exam Marks	60	60	100	100	100

1124235540	**PLC AND AUTOMATION**	L	T	P	C
PRACTICUM		1	0	4	3

Converted to	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	-

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical document (Hand written document / Notebook consists of Aim, Apparatus Required, Ladder Diagram, Interfacing circuit, Procedure and Result) should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise / experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

1124235540	PLC AND AUTOMATION	L	T	P	C
PRACTICUM		1	0	4	3

SCHEME OF EVALUATION – Practical Test

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Ladder Diagram	15
C	Connections / Interfacing	10
D	Execution and Output/Result	20
TOTAL		50
E	Practical Documents (As per the portions)	10
EXAM MARKS		**60**

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment. The question setting details are as follows.

	Description	Pattern	Marks
PART-A	30 Multiple Choice Questions (MCQ)	30 x 1 Mark	30
PART-B	7 Questions to be answered out of 10 Questions	7 x 10 Mark	70
TOTAL MARKS			**100**

1124235540	PLC AND AUTOMATION	L	T	P	C
PRACTICUM		1	0	4	3

- **CA 4:** All the exercises/experiments should be completed and kept for the Model Practical Examination. The students shall be permitted to select any one by lot for the exam. The model practical examination should be conducted as per the End Semester Examination question pattern as given below. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical and End Semester Examination- Practical Exam

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Ladder Diagram	20
C	Connections / Interfacing	20
D	Execution and Output/Result	25
E	MCQ from Theory Portions	20
F	Viva Voce	10
TOTAL MARKS		**100**

Note: *Practical Document with Bonafide certificate must be submitted to Model Practical Examination and End Semester Practical Examination*.

Theory Portion:		
UNIT I	**INTRODUCTION TO PLC**	Period

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PRACTICUM		1	0	4	3

Automation – Components of Automation - Factory Automation and Process Automation – Advantages of Automation - Block diagram of PLC – Principle of operation – PLC Scan – Advantages of PLC. Typical Discrete I/O field Devices – Sinking and Sourcing I/O modules – Relay output module – Isolated output module - Criteria for selection of suitable PLC – List of PLCs available in the market – Develop ladder logic program using Relay type instructions - Introduction about Timer Instructions – ON Delay and OFF Delay Timer – Retentive Timer Instruction.	7

Practical Exercises:

Ex.No	Name of the Experiment	Period
1.	PLC BASED DOL STARTER <u>Sequence of Operation:</u> Develop and Execute Ladder Logic in PLC for DOL Starter Operation with Single Phasing Prevention. Check the output by interfacing PLC with three phase Cage Induction Motor.	5
2	INTERFACING OF DISCRETE FIELD DEVICES WITH PLC <u>Sequence of Operation</u>: Develop Ladder Logic in PLC to execute the following logical relation between the input and output field devices. ● Y = A + B + C + D ● Y = A . B .C . D ● Y = (A+B) . (C+D) ● Y = (A.B) + (C.D) Interface Push Button (A), Limit Switch (B), Reed Switch (C) and 3 wire Proximity Sensor (D) and Buzzer (Y) with PLC and check the output.	5

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PRACTICUM		1	0	4	3

3	PLC BASED STAR DELTA STARTER Sequence of Operation: Develop and Execute Ladder Logic in PLC for Automatic Star- Delta Starter Operation. Check the output by interfacing PLC with three phase cage induction motor.	5
4	PLC BASED FORWARD AND REVERSE CONTROL OF INDUCTION MOTOR* Sequence of Operation: Develop and Execute Ladder Logic in PLC to control three phase induction motor in Forward and Reverse direction of Rotation. Interface external pilot lamp with PLC to indicate the direction of rotation. Check the output by interfacing PLC with three phase cage induction motor.	5
5	PLC BASED CONVEYOR SYSTEM WITH PRE WARNING SIREN Sequence of Operation: Develop and Execute Ladder Logic in PLC using an ON delay timer to delay the start of a conveyor. While press the START button, activate the Warning Siren for Pre-set Time. After the Pre-Set time delay the Warning siren turns OFF and the conveyor starts running. When STOP button is pressed turns OFF the conveyor.	5
6	PLC BASED WATER LEVEL CONTROL SYSTEM Sequence of Operation: Develop and Execute Ladder Logic in PLC to fill the empty tank with liquid when the START button is pressed. When liquid reaches the HIGH Level, turn OFF the Pump Motor and turn ON the Solenoid Valve to drain the liquid from tank. When liquid reaches the LOW Level, turn OFF the Solenoid Valve and turn ON the Pump Motor for refilling. Interface	5

	external pilot lamp with PLC to indicate the operation of Pump Motor and Solenoid Valve.	

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PRACTICUM		1	0	4	3

Theory Portion:		
UNIT II	**COUNTERS, MATH & DATA COMPARE INSTRUCTIONS.**	Period
Introduction about Counter Instructions – UP Counter – DOWN Counter – Applications of Counter Instructions – Math Instructions - Data Compare Instructions – Simple programs using above instructions.		3
Practical Exercises:		
Ex.No	Name of the Experiment	Period
7	PLC BASED COUNTING OF MOVING OBJECTS ON A CONVEYOR Sequence of Operation: Develop and Execute ladder logic in PLC for counting the object moving in the conveyor. Interface manual START and STOP push buttons to operate the conveyor motor and Proximity sensor detect the object. Interface buzzer to give beep sound while sensor is detecting the product. When the pre-set value of count has reached turn OFF the conveyor automatically.	5
8	PLC BASED COUNTING OF MOVING OBJECTS ON TWO CONVEYORS Sequence of Operation: A manufacturing plant is arranged with 2 feeder conveyors for transferring the Objects into the plant. Develop and Execute Ladder Logic using math instruction in PLC to get the total number of objects transferred by 2 conveyors into the Plant. When the count of total object has reached pre-set count value, turn ON buzzer to give beep sound for 1 second and turn OFF the conveyors.	5
9	PLC BASED CAR PARKING CONTROL SYSTEM*	5

	Sequence of Operation: A parking lot allows 10 cars. Sensor 1 senses the incoming car at ENTRY Gate. Sensor 2 senses the outgoing car at the EXIT Gate. Develop and Execute ladder logic in PLC to count the number of cars parked and based on the parking slot available turn ON pilot lamps to Indicate FULL or AVAILABLE. Interface suitable proximity sensors with PLC.	
10	PLC BASED FAN CONTROL FOR ENERGY CONSERVATION Develop and Execute a ladder logic in PLC to operate Fans in the Meeting Hall based on counting the number of persons entering into the Hall. Interface suitable types of sensor with PLC to sense the person entering into the hall through ENTRY Gate. Interface Low Voltage DC Fan with PLC to check the output. Assume the capacity of the Meeting Hall as 10 or something. ● If less than 50% of the hall capacity is filled, turn ON Fan F1 & F2. ● If 70 to 80% of the capacity is filled turn ON Fan F1 to F3. ● If greater than or equal to 90% of capacity is filled turn ON F1 to F4.	5
11	PLC BASED THREE FLOOR LIFT CONTROL SYSTEM Develop and Execute a ladder logic in PLC to control Lift/Elevator in 3 floor system. Interface Call buttons, suitable sensors for detecting floors and Motor with PLC to check the sequence of operation.	5
Theory Portion:		
UNIT III	**ANALOG I/O MODULE& INDUSTRIAL NETWORK**	Period

1124235540	**PLC AND AUTOMATION**	L	T	P	C
PRACTICUM		1	0	4	3

Analog Input Modules - Typical Analog Input field devices – Analog Output Modules - Typical analog output field devices. Block diagram of I/O bus networks - Serial communications – Fieldbus Networks - Typical PROFIBUS architecture - Typical MODBUS architecture - Typical Foundation fieldbus architecture – Importance of HMI and SCADA in Automation - Typical SCADA system architecture.	5

1124235540	**PLC AND AUTOMATION**	L	T	P	C
PRACTICUM		1	0	4	3

Practical Exercises:		
Ex.No	Name of the Experiment	Period
12.	PLC BASED ILLUMINATION CONTROL SYSTEM. Develop and Execute a ladder logic program for multilevel Illumination control system. ● When the potentiometer reaches 25% of its value, turn ON one Lamp in the output to get minimum illumination. ● When the potentiometer reaches 50% of its value, turn ON two Lamps in the output to get medium illumination. ● When the potentiometer reaches 75% of its value, turn ON three Lamps in the output to get Maximum illumination.	5
TOTAL PERIODS		**75**

Note: *Common Test and Revision periods can be used for conducting Continuous Assessment.*

** Exercises No. 4 & 9 is for Demonstration only and Not to be given for Examination. But it must be included in the Practical Document.*

Cycle I Exercises: 1, 2, 3, 5 & 6 and Cycle II Exercises : 7, 8, 10, 11 & 12

Suggested List of Students Activity:

- Activity 1 – PLC Based Mini Project: Four students can be grouped as a batch to do PLC based Mini project. Photograph Evidence to be maintained by faculty as record of activity.
- Activity 2 – Audio or Video Assignment: Ask the students to submit the recorded audio or video of his Technical Explanation or Demonstration on PLC and Automation related topics.
- Activity 3 – Industrial visit to Fully Automated Industry to observe the practical applications of PLC.

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PRACTICUM		1	0	4	3

- Activity 4: PLC Based Round Table Liquid Filling System: Develop and Execute a ladder logic in PLC to control round table liquid filling system.
- Activity 5: PLC Based Temperature Control System: Develop ladder logic in PLC to control the heating element in the water tank to maintain the temperature between two predetermined limits.

Text and Reference Books:

1. Frank D. Petruzella, Programmable Logic Controllers, 6th Edition, Indian Edition, Mc Graw Hill, 2023
2. Richard A. Cox, Technician's Guide to Programmable Logic Controllers, Fourth Edition, Delmer Cengage Learning, 2013.
3. Gary Dunning , Introduction to Programmable Logic Controllers, Third Edition, Cengage Learning India Pvt Ltd, 2021.
4. Hugh Jack, Automating Manufacturing Systems with PLCs, Free Software Foundation, 2007.
5. L. A. Bryan and E. A. Bryan, "Programmable Controllers Theory and Implementation," 2nd Edition, Industrial Text Company Publication, 1997.

Web-based/Online Resources:

- https://www.sanfoundry.com/100-plc-programming-examples/
- https://archive.nptel.ac.in/courses/108/105/108105062/
- https://www.youtube.com/watch?v=MS3qJq2jvu0
- https://www.youtube.com/watch?v=rqxoREpOjTU

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PRACTICUM		1	0	4	3

Equipment / Facilities required to conduct the Practical Course. (Batch Strength: 30 Students)

S.No	Name of the Equipment's	Quantity Required
1.	PLC with Digital I/O Module	6 Nos
2.	PLC with Analog I/O Module	1 No
3.	PC (or) Laptop installed with PLC Programming Software	7 Nos
4.	DOL Starter Interfacing Kit	1 No
5.	Push Button, Limit Switch, Reed Switch, 3 Wire Proximity Sensor and Buzzer or Pilot Light	Each 1 No
6.	Star Delta Starter Interfacing Kit	1 No
7.	Forward and Reverse Control Interfacing Kit	1 No
8.	Conveyor Arrangement With Siren	1 No
9.	Water Tanks with Float Switch and Solenoid Valve	1 No
10.	Conveyor Arrangement With Proximity Sensor and Buzzer	2 Nos
11.	Car Parking Arrangement with two Sensors and Pilot Light	1 No
12.	Thru beam type Sensor (1No) & DC Fan (4Nos)	1 Set
13.	3 Floor Lift Interfacing Model	1 No
14.	Push Button, Buzzer, Pilot Lights and Connecting cables	As required

1124235540	PLC AND AUTOMATION	L	T	P	C
PRACTICUM		1	0	4	3

End Semester Examination- Practical Exam

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Ladder Diagram	20
C	Connections / Interfacing	20
D	Execution and Output/Result	25
E	MCQ from Theory Portions	20
F	Viva Voce	10
TOTAL MARKS		**100**

Note: *Practical Document with Bonafide certificate must be submitted to Model Practical Examination and End Semester Practical Examination.*

1124235640	INNOVATION AND START-UPS	L	T	P	C
PRACTICUM		1	0	2	2

Introduction:

The integration of Innovation and Start-ups concept within the syllabus is testament to the forward thinking nature of educational institutions. By introducing this concept, students are provided with a solid foundation upon which they can build their skills in Innovation and Start-ups. This course can bridge the gap between theory and practice. It allows students to apply the knowledge they have acquired in a real world context, thereby enhancing their understanding and retention of the above concept. This experimental learning approach not only fosters a deeper level of engagement but also trains student with practical skills necessary to navigate the complexities of the business world. This also empowers students to become an Innovator or Entrepreneur. With necessary tools and knowledge, educational institutions are preparing the next generation of entrepreneurs to tackle the challenges and opportunities that lie ahead. This syllabus will explore the different facets of innovation, including its importance, types and strategies for fostering a culture of innovation within organization.

Course Objectives:

The objective of this course is to enable the student to

1. Understand the concept of Innovation and Start-ups.
2. Acquire knowledge of Prototype development, IPR, Patents and Copyrights.
3. Have Practical experience in preparing Business plan for Start-ups.
4. Prepare project report about the present challenges of that industry.
5. Know the different funding supports available from Government and Non-Government schemes for Start-ups.

COURSE OUTCOMES

CO1: Explain the concepts of innovation, creativity, entrepreneurship, design thinking, IPR, and startup ecosystem to understand the framework for generating and managing innovative ideas.

1124235640	INNOVATION AND START-UPS	L	T	P	C
PRACTICUM		1	0	2	2

CO2: Apply innovation management principles, idea generation techniques, prototype development, and startup registration processes to develop feasible business models and project plans.

CO3: Analyze funding schemes, market opportunities, and challenges for startups from government and non-government sources, including angel investors, venture capital, and CSR funds, to plan sustainable business ventures.

CO4: Evaluate innovation strategies, organizational culture, leadership, and commercialization processes by preparing seminars, presentations, and reports on selected topics, incorporating professional networking and market insights.

CO5: Design and develop an industry-exposure-based project by studying real industries, incubation centers, or startups, analyzing process flow, manufacturing methods, quality control, marketing, and product commercialization strategies.

CO–PO MAPPING

(3 = Strong, 2 = Moderate, 1 = Low)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	–	2	3	–
CO2	2	2	3	2	3	2	2
CO3	2	3	2	3	2	2	1
CO4	2	3	2	2	3	2	2
CO5	2	3	3	3	2	3	3

1124235640	INNOVATION AND START-UPS	L	T	P	C
PRACTICUM		1	0	2	2

Assessment Methodology:

	Continuous Assessment (40 Marks)			End Semester Examination (60 Marks)
	CA1	CA2	CA3	
Mode	Theory Test	Seminar Presentation	Submission of Industry Visit Project Report	Practical Examination
Portion	Unit I, II & III	Unit IV	Unit V	Project
Duration	2 Periods	--	--	3 Hours
Exam Marks	50	20	30	100
Converted to	10	10	20	60
Marks	10	10	20	60
Internal Marks	40			60
Tentative Schedule	14th Week	15th Week	16th Week	-

Note:

1124235640	**INNOVATION AND START-UPS**	L	T	P	C
PRACTICUM		1	0	2	2

Continuous Assessment:

S. No	Description	Marks
CA 1	Class Assessment (50 marks) - Unit – I, II & III Written Examination - Theory Questions 10 questions out of 15 questions (10 x 3 marks :30 marks) 4 questions out of 6 questions (4 x 5 marks : 20 marks)	10 marks
CA 2	Seminar Presentations (20 marks- each topic carries 10 marks) - Unit IV Students should present any two topics with PPTs	10 marks
CA 3	Submission of Industry Visit Project Report (30 marks) - Unit V	20 marks
Total		40 marks

1124235640	INNOVATION AND START-UPS	L	T	P	C
PRACTICUM		1	0	2	2

Theory Portion :		
UNIT I	INTRODUCTION TO INNOVATION	Period
An Introduction to Innovation and Creativity- Innovation in current Environment - Types of Innovation - Challenges of Innovation - Steps of Innovation Management - Divergent v/s Convergent thinking - Design thinking and Entrepreneurship.		6
UNIT II	INCUBATION CLUBS, IPR, PATENTS AND COPYRIGHTS	Period
Idea Generation - Incubation Clubs - Prototype Development - Marketing of Innovation - Management of Innovation - Creation of IPR -Types of IPR - Patents and Copyrights - Patents in India - Technological and Non-Technological Innovation Process.		6
UNIT III	GOVERNMENT AND NON-GOVERNMENT FUNDING SCHEMES FOR START-UPS	Period
An introduction to Start-up - Start-ups in India - Procedure for registration of Start-ups - Business Model- Business Plan - Case Studies - Opportunities and Challenges - Funding supports from Government Schemes - MUDRA, TANSEED, NEEDS, PMEGP, UYEGP – Non-Government Schemes - CSR Fund - Angel Investors - Venture Capitalist.		6

1124235640	INNOVATION AND START-UPS	L	T	P	C
PRACTICUM		1	0	2	2

UNIT IV	SEMINAR	Period
All the students have to select a minimum of 2 topics from the list given below. They are expected to collect the resources with the help of faculty assigned to them to prepare PPTs for presentation. 1. Idea Generation 2. Innovation Management 3. Product Development 4. Business Model Innovation 5. Organizational Culture and Change Management 6. Leadership and Innovation 7. Barriers to Innovation 8. Innovation Marketing 9. E-Commerce success stories (any one) 10. Role of Start-ups in Higher Education 11. Professional Networking in Building Brands 12. How to start a start-up in India		9
UNIT V	EXPOSURE TO INDUSTRY	Period
All the students should visit and study the nearby industries, incubation centres, start-ups etc., and select any one to prepare a project report which covers the Name of the Industry/Organization, Introduction of the Industry, Type of the Industry, Scope of the Industry, Plant Layout and Location, Details of Plant and Machineries, Process flow chart, Manufacturing Methods, Process of Manufacturing, Product Manufacturing, Quality Control, Marketing, Product selling – Conclusion.		18
TOTAL PERIODS		45

Note: Common Test and Revision periods can be used for conducting Continuous Assessment.

1124235640	**INNOVATION AND START-UPS**	L	T	P	C
PRACTICUM		1	0	2	2

Reference Books:

1. Ina Goller, John Bessant, Creativity for Innovation Management, First Edition, Routledge, 2017.
2. Walter Brenne and Falk Uebernickel , Design Thinking for Innovation, Research and Practice, Springer, 2016.
3. Henri Charmasson, John Buchaca, Patents, Copyrights & Trademarks for Dummies, Second Edition, Wiley Publishing Inc.

Web-based/Online Resources:

- https://www.startupindia.gov.in/
- https://www.mudra.org.in/
- https://startuptn.in/tanseed/
- https://www.msmetamilnadu.tn.gov.in/needs.php
- https://www.kviconline.gov.in/pmegpeportal/pmegphome/index.jsp
- https://msmeonline.tn.gov.in/uyegp/

1124235640	**INNOVATION AND START-UPS**	L	T	P	C
PRACTICUM		1	0	2	2

SCHEME OF EVALUATION

End Semester Examination- Practical Exam

Part	Description	Marks
A	Written Examination: Theory question from Unit I, II & III Answer any 10 questions out of given 15 Questions. Each question carries 3 Marks. (10 x 3 = 30 marks)	30
B	Written Examination: Theory question from Unit I, II & III Answer all 3 questions in Either or pattern. Each question carries 5 Marks. (3 x 5=15)	15
C	Presentation of Industry Visit Project Report	25
D	Interaction and Evaluation	30
TOTAL MARKS		100

1124236131	Fuel Cell & Hydrogen Energy	L	T	P	C
THEORY		2	0	2	3

COURSE OUTCOMES

CO1: Explain the fundamentals of hydrogen energy and fuel cells, including types of fuel cells, thermodynamics, performance characteristics, and system components, to understand hydrogen-based energy systems.

CO2: Apply thermodynamic principles, fuel cell efficiency calculations, and performance metrics to evaluate low and high temperature fuel cells, polymer electrolyte, alkaline, phosphoric, molten carbonate, and solid oxide fuel cells.

CO3: Analyze fuel cell electrochemical reaction kinetics, electrode processes, overvoltages, charge transfer, and mass transport phenomena to optimize fuel cell operation and design.

CO4: Evaluate fuel cell performance using characterization techniques, including i-V curves, frequency response analysis, and material properties, while considering process safety and engineering design aspects.

CO5: Demonstrate and interpret practical experiments on fuel value determination, fuel cell performance, membrane properties, hydrogen storage, and electrolyzer-fueled systems to integrate theoretical knowledge with hands-on hydrogen energy applications.

CO–PO MAPPING

(3 = Strong, 2 = Moderate, 1 = Low)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	2	2	3	2
CO2	2	3	2	2	2	2	2
CO3	2	3	3	2	1	2	–
CO4	2	3	3	3	2	2	2
CO5	2	2	3	2	2	2	2

1124236131	Fuel Cell & Hydrogen Energy	L	T	P	C
THEORY		2	0	2	3

Syllabus Contents

Unit I	Introduction	
Overview of Hydrogen Energy and Fuel Cells. Low and high temperature fuel cells. Fuel Cell performance. Polymer electrolyte fuel cells, Alkaline fuel cells, Phosphoric fuel cells. Molten carbonate fuel cells, Solid oxide fuel cells, Fuel cell systems and Sample calculations.		
Unit II	Fuel cell thermodynamics	
Heat, work potentials.. Prediction of reversible voltage. Fuel cell efficiency.		
Unit III	Fuel cell reaction kinetics.	
Electrode kinetics, overvoltages, Tafel equation, charge transfer reaction. Exchange currents, electro catalyses - design, activation kinetics. Fuel cell charge and mass transport - flow field. Transport in electrode and electrolyte.		
Unit IV	Fuel cell characterization.	
In-situ and ex-situ characterization techniques, i-V curve. Frequency response analyses Process Safety and Process Design. Materials Science and Engineering.		
UNIT V	PRACTICAL EXERCISES:	
1. Determination of Fuel Value. 2. Performance Characteristics of Polymer Electrolyte Fuel Cell.		

1124236131	Fuel Cell & Hydrogen Energy	L	T	P	C
THEORY		2	0	2	3

3. Properties of Proton Exchange Membranes Used in Fuel Cells. 4. Performance Characteristics of a Dissolved Methanol Fuel Cell. 5. Borohydride Fuel Cell Performance Characteristics. 6. Solar Electrolyzer Fueled Polymer Electrolyte Membrane Fuel Cell. 7. Hydrogen Storage Capacity of Hydrogen-Containing Compounds.	

Reference Books:

1. Non-Conventional Energy Resources B. H. Khan The McGraw Hill Publications.
2. Non-Conventional Energy Sources G.D. Rai Khanna Publications
3. Non-Conventional Energy Resources Shobh Nath Singh Pearson
4. Non-Conventional Energy S.H.Saeed, S.K.Kataria & Sons Resources D.K.Sharma
5. Understanding Clean Energy and fuels from biomass Mukunda HS. Wiley-India Pvt. Ltd, 2011
6. Hand book of plant based bio fuel Pandey A. CRC Press, Taylor & Francis, 2008
7. Biogas Systems, Principle and Applications Mital KM. New Age International Ltd. 1996
8. Biomass, Energy and Environment, A developing country perspective from India. Ravindranath NH. Hall DO. Oxford University Press, 1995

1124236132	IoT AND APPLICATION	L	T	P	C
PRACTICUM		1	0	4	3

COURSE OUTCOMES

CO1: Explain the fundamentals of IoT, its applications, characteristics, stack, enabling technologies, and integration with cyber-physical systems, along with basic programming concepts of Python, including data types, control structures, and functions.

CO2: Apply Python programming concepts to solve problems and implement logic, control flow, loops, functions, and exception handling for IoT applications.

CO3: Analyze IoT system design using Raspberry Pi, including sensor/actuator interfacing, LED/buzzer control, and input/output handling, to develop embedded IoT solutions.

CO4: Evaluate IoT applications using cloud storage, web servers, and communication APIs, and integrate sensors and actuators to build smart solutions like smart cities and industrial IoT systems.

CO5: Demonstrate and implement practical IoT projects using Raspberry Pi, sensors, and Python programming, such as LED control, LDR-based street light automation, and air pollution monitoring, to integrate theoretical knowledge with hands-on skills.

CO–PO MAPPING

(3 = Strong, 2 = Moderate, 1 = Low)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	2	2	2	2
CO2	3	2	2	3	1	–	2
CO3	2	3	2	3	2	2	2
CO4	2	3	2	3	2	3	2
CO5	2	2	3	3	2	3	3

1124236132	**IoT AND APPLICATION**	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion :		
UNIT I	BASICS OF IoT & PYTHON	Period
Application areas of IoT - Characteristics of IoT - Things in IoT - IoT stack - Enabling technologies - IoT challenges - IoT levels - IoT and cyber physical system - IoT and WSN. Introduction to Python - Language features of Python - Data types - Looping instructions - Control of flow - functions - classes - Exception handling Python packages.		7
Practical Exercises:		
Ex.No	Name of the Experiment	Period
1.	Write a simple Python program to display message on screen.	6
2.	Write a simple Python program using Logical operators.	6
3.	Write a simple Python program to demonstrate use of if else statement.	6
4.	Write a Python program to demonstrate use of ‘while’ loop.	6
5.	Write a Python program to demonstrate use of ‘for’ loop.	6

1124236132	**IoT AND APPLICATION**	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion:		
UNIT II	IoT WITH RASPBERRY PI	Period
Raspberry Pi-Linux on Raspberry Pi-Raspberry Pi Interfaces-Programming Raspberry Pi with Python - Controlling LED/Buzzer with Raspberry Pi -Interfacing an LED and Switch with Raspberry Pi - Interfacing a Light Sensor (LDR) with Raspberry Pi. Introduction to Cloud Storage models and communication APIs Webserver - Web server for IoT - Cloud for IoT - IOT Case studies: smart cities, Industrial IOT.		8
Practical Exercises:		
Ex.No	Name of the Experiment	Period
6.	Install an OS in Raspberry pi.	6
7.	Write a program to blink a LED using raspberry pi.	6
8.	Write and Execute a program for turning a LED ON, when the switch is pressed using raspberry pi.	6
9.	Write a program to control street light automatically using LDR and raspberry pi.	6
10.	Construct an IoT based Air pollution monitoring system.	6
TOTAL PERIODS		75

Note: Common Test and Revision periods can be used for conducting Continuous Assessment.

1124236132	**IoT AND APPLICATION**	L	T	P	C
PRACTICUM		1	0	4	3

Suggested List of Students Activity:

- Activity 1: Students shall practice on their own “Arduino DIY Kits”.
- Activity 2: Mobile based Home automation (IOT) using Raspberry pi.
- Activity 3: Micro project that shall be an extension of any practical lab exercise to real-world application.

Text and Reference Books:

1. Simon Monk, Programming the Raspberry Pi: Getting Started with Python, McGraw Hill Professional, January 2012.
2. Vijay Madisetti and Arshdeep Bahga, Internet of Things (A Hands-on-Approach), 1st Edition,VPT, 2016.
3. Jain, Prof. Satish, Singh, Shashi, Internet of Things and its Applications, 1st Edition, BPB, 2020.
4. Eben Upton and Gareth Halfacree, “Raspberry Pi User Guide”, 4th edition, John Wiley & Sons., August 2016.
5. Alex Bradbury and Ben Everard, “Learning Python with Raspberry Pi”, John Wiley & Sons., Feb 2014.

Web-based/Online Resources:

- https://archive.nptel.ac.in/courses/106/105/106105166/
- https://www.raspberrypi.com/documentation/computers/getting-started.html
- https://projects.raspberrypi.org/en/collections/python
- https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started
- https://randomnerdtutorials.com/projects-raspberry-pi/

1124236132	**IoT AND APPLICATION**	L	T	P	C
PRACTICUM		1	0	4	3

Equipment / Facilities required to conduct the Practical Course. (Batch Strength: 30 Students)

S.No	Name of the Equipment's	Quantity Required
1.	Desktop Computer	30 Nos
2.	Raspberry Pi Kit with Accessories	6 Nos
3.	Switches, LDR, LEDs and Sensors	As required

1124236133	Installation, Maintenance & Maintenance of Renewable Power Plants	L	T	P	C
THEORY		2	0	2	3

COURSE OUTCOMES

CO1: Explain the fundamentals of electrical safety, trade tools, electrical signs, and preventive measures for electrical accidents, along with basic English tense usage for documentation and communication.

CO2: Apply electrical wiring, crimping, soldering, and conductor measurement techniques to construct and maintain electrical joints and connections safely and efficiently.

CO3: Analyze electrical and magnetic circuits by measuring voltage, current, resistance, power, and energy in DC and AC circuits, and verify electrical laws such as Ohm's Law and Kirchhoff's Law.

CO4: Assemble, install, and test wiring systems, control panels, and electrical accessories including switches, sockets, fuses, MCBs, ELCBs, lamp holders, and conduct two-way and control circuit wiring.

CO5: Perform electrical energy calculations and understand transmission, distribution, and transformer efficiency by measuring power consumption, performing OC/SC tests, and preparing load calculation charts and substation circuit diagrams.

CO–PO MAPPING

(3 = Strong, 2 = Moderate, 1 = Low)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	–	1	3	2	2
CO2	2	3	2	2	2	–	2
CO3	2	3	3	2	1	2	2
CO4	2	3	3	3	2	2	2
CO5	2	3	3	2	2	2	3

1124236133	Installation, Maintenance & Maintenance of Renewable Power Plants	L	T	P	C
THEORY		2	0	2	3

Syllabus Contents

Unit I	Introduction	
Identify the trade tools; practice their uses with safety, care & maintenance. Identification of danger, warning, caution & safety signs. Preventive measures for electrical accidents and use of fire extinguishers - Tenses		
Unit II	Prepare electrical wire joints, carry out soldering and crimping	
Practice on skinning, twisting and crimping. Identify various types of cables and measure conductor size using SWG and micrometer. Make joints on single strand conductors. Practice in crimping and soldering of joints / lugs..		
Unit III	Construct and test various characteristics of electrical and magnetic circuits.	
Measure parameters in combinational DC circuits by applying Ohm's Law for different resistor values and voltage sources. Measure current and voltage in DC circuits to verify Kirchhoff's Law. Verify laws of series and parallel circuits with voltage source in different combinations. Measure current and voltage and analyse the effects of shorts and opens in series and parallel circuits. Measure power, energy for lagging and leading power factors in single phase circuits.		
Unit IV	Assemble, install and test wiring system.	
Identification of various conduits and different electrical accessories. Practice cutting, threading of different sizes & laying Installations. Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB.		

1124236133	Installation, Maintenance & Maintenance of Renewable Power Plants	L	T	P	C
THEORY		2	0	2	3

Wire up PVC conduit wiring to control one lamp from two different places using two way switches. Practice control panel wiring using wiring accessories and mounting of control elements, e.g. meters, fuses, relays, switches, push buttons, MCB, ELCB etc.		
UNIT V	Perform basic Electric energy calculations and understand transmission and distribution of electrical power.	
Measure power consumption for different loads with various times of use and calculate watt-hour. Find out power ratings from product label and prepare a load calculation chart. Perform OC and SC test to determine and efficiency of single phase transformer. Draw circuit diagram of substation and indicate various components.		

LIST OF PRACTICALS

1. Coil Winding Machine: Bench mounted, power driven with clutch and brake built into winding head, electromagnetic traverse clutch system for setting winding length of wire range .05 to 1.5 mm dia.
2. Bench Drilling Machine: Drilling capacity 13 mm, slotted and adjustable drilling, Table size 250 x 250 mm app. Belt driven with 4 speed ranges from 50 to 2000 rpm
3. Portable Drilling Machine: Hand electric drill machine with speed control.
4. Multi meter: Laboratory service type with large and easy to read mirrorscale with over head protection high accuracy.

1124236133	**Installation, Maintenance & Maintenance of Renewable Power Plants**	L	T	P	C
THEORY		2	0	2	3

Reference Books:

1. Electricity from Renewable Resources: Status, Prospects, and National Research Council.

2. Solar Power Generation Problems, Solutions and Monitoringbooks.google.co.in › books Peter Gevorkian.

3. Advanced Concepts for Renewable Energy Supply of Data Centres books Jaume Salom, Thorsten Urbaneck, Eduard Oró · 2017.

1124236241	**ELECTRICAL CAD DESIGN**	L	T	P	C
PRACTICUM		1	0	4	3

Introduction:

A technician working in design and shop floor must possess the skill of preparing electrical estimation and drawings with the evolution of Computer software. The Computer Aided Drafting software will be used to perform various practical exercises in this course. This will enable the students to become competent for working in the fast-growing information technology environment by enhancing their computer aided drawing, designing skills in the field of electrical engineering.

Course Objectives:

The objective of this course is to enable the student to

- Understand I.E Rules 1956 and learn Toolbars in AutoCAD Software.
- Draw Electrical Symbols used in Electrical and Electronics circuits using AutoCAD.
- Practice Electrical Estimation for Residential and Industrial wirings.
- Practice in AutoCAD Software to draw the Single Line Diagrams of various Panels and Distribution Board.
- Practice in AutoCAD to draw Motor Winding Diagram, Substation Layout and Fire Alarm arrangements.

Course Outcomes:

CO1: Interpret and organize electrical drawings, load details, circuit arrangements, and protection schemes for effective electrical system planning.

CO2: Validate CAD-based electrical designs for functionality, safety, clarity, and compliance with practical installation requirements including substations and fire alarm systems.

CO3: Prepare a residential, commercial and industrial electrical wiring drawings and layouts by following Indian Electricity Rules and standard installation practices.

1124236241	ELECTRICAL CAD DESIGN	L	T	P	C
PRACTICUM		1	0	4	3

CO4: Develop and examine electrical estimates by calculating material quantities, load requirements, and project costs for residential, street lighting, irrigation, and industrial installations.

CO5: Create and modify standard electrical symbols, wiring diagrams, panel layouts, winding diagrams, and substation single line diagrams using AutoCAD.

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	-	3	-	-	-
CO2	-	1	-	3	-	-	-
CO3	-	-	1	3	-	-	-
CO4	-	-	2	3	-	-	-
CO5	-	-	2	3	-	-	-

Assessment Methodology:

	Continuous Assessment (40 Marks)				End Semester Examination (60 Marks)
	CA1	CA2	CA3	CA4	
Mode	Practical Test	Practical Test	Written Test Theory	Model Practical Examination	Practical Examination
Portion	Ex. 1 to 6	Ex. 7 to 12	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 Hours

1124236241	**ELECTRICAL CAD DESIGN**	L	T	P	C
PRACTICUM		1	0	4	3

Exam Marks	60	60	100	100	100
Converted to	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	-

Note:

- CA1 and CA2: All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.
  Practical document (Hand written document / Notebook consists of Aim, Apparatus Required, Drawing, Printout, Procedure and Result) should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise / experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

1124236241	**ELECTRICAL CAD DESIGN**	L	T	P	C
PRACTICUM		1	0	4	3

SCHEME OF EVALUATION – Practical Test

Part	Description for CAD Ex.	Marks	Description for Ex: 5 to 8	Marks
A	Aim & Apparatus Required	05	Aim & Apparatus Required	05
B	Manual Drawing	10	Pipe Layout & Load Calculation	10
C	Circuit using CAD Software	30	Wiring Diagram & Material Calculation	20
D	Printout	05	Schedule of Materials with Cost	15
TOTAL		50	TOTAL	50
E	Practical Documents	10	Practical Documents (as per portions)	10
EXAM MARKS		60	EXAM MARKS	60

- CA 3: Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment. The question setting details are as follows.

	Description	Pattern	Marks
PART-A	30 Multiple Choice Questions (MCQ)	30 x 1 Mark	30
PART-B	7 Questions to be answered out of 10 Questions	7 x 10 Mark	70
TOTAL MARKS			100

1124236241	**ELECTRICAL CAD DESIGN**	L	T	P	C
PRACTICUM		1	0	4	3

- CA 4: All the exercises/experiments should be completed and kept for the Model Practical Examination. The students shall be permitted to select any one by lot for the exam. The model practical examination should be conducted as per the End Semester Examination question pattern as given below. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical and End Semester Examination- Practical Exam

Part	Description for CAD Ex.	Marks	Description for Ex: 5 to 8	Marks
A	Aim & Apparatus Required	05	Aim & Apparatus Required	05
B	Manual Drawing	10	Pipe Layout & Load Calculation	15
C	Circuit using CAD Software	45	Wiring Diagram & Material Calculation	25
D	Printout	10	Schedule of Materials with Cost	25
E	MCQ from Theory Portions	20	MCQ from Theory Portions	20
F	Viva Voce	10	Viva Voce	10
TOTAL MARKS		100	TOTAL MARKS	100

Note: Practical Document with Bonafide certificate must be submitted to Model Practical Examination and End Semester Practical Examination.

1124236241	**ELECTRICAL CAD DESIGN**	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion :		
UNIT I	ELECTRICAL SYMBOLS	Period
Need of Electrical symbols – List of Symbols – Brief study of Indian Electricity Rules 1956 (IE Rule : 28, IE Rule 30, IE Rule 31, IE Rule 54, IE Rule 56 and IE Rule 87) - Overview of Computer Aided Electrical Drafting – Overview of Various Toolbars in AutoCAD Software.		4
Practical Exercises:		
Ex.No.	Name of the Experiment	Period
1.	Draw the following Electrical Symbols using AutoCAD: Relay, Fluorescent Lamp, Ceiling Fan, Exhaust Fan, One Way Switch, 5A Socket Outlet with Switch, Energy Meter, Star Delta Starter, DC Shunt Motor, Step Down Transformer, PN Junction Diode, BJT, AND Gate, OR Gate.	5
2.	Draw the single line diagram of Three phase MCB Distribution Board.	5
3.	Draw the panel wiring diagram of Horizontal busbar arrangement with Incoming and Outgoing Switches using AutoCAD.	5
4.	Draw the single line diagram of typical Medium Voltage (MV Panel) with following feeders using AutoCAD. Incoming: One from EB and Another from DG with Interlock. Outgoing: 12 Outgoing feeders with various loads.	5

1124236241	ELECTRICAL CAD DESIGN	L	T	P	C
PRACTICUM		1	0	4	3

UNIT II	RESIDENTIAL AND INDUSTRIAL WIRING	Period
Introduction about Electrical Wiring - Looping back system, Joint box system and Tree system of wiring - Types of Internal Wiring – Over Head and Under Ground Service connections - Protection of electrical installation against overload, short circuit and earth fault – General requirements of electrical installations for Residential, Commercial and Industrial Wiring – Lighting and Power sub-circuits – Location of Main Switch, Distribution Board, Switch Board and Outlets - Steps to be followed in preparing electrical estimate - Building Plan - Wiring Pipe Layout - Wiring Diagram – Load Calculation.		8
Practical Exercises:		
Ex.No	Name of the Experiment	Period
5.	Estimate the quantity of Materials and Cost required for a single Bedroom residential building (1 BHK).	5
6.	Estimate the quantity of Materials and Cost required for street light service having 12 Lamps light fittings.	5
7.	Estimate the quantity of Materials and Cost required for Irrigation Pump wiring with 5 hp Induction Motor.	5
8.	Estimate the quantity of Materials and Cost required for Industrial power wiring having four machines.	5

1124236241	**ELECTRICAL CAD DESIGN**	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion :		
UNIT III	WINDING DIAGRAM AND SUBSTATION LAYOUT	Period
Overview of AC Motor Winding Diagram and DC Motor Winding Diagram – Various components of Electrical Substation – Importance of Fire Alarm Arrangements in Multi Storey Building - Symbols used in Fire Alarm Arrangement.		3
Practical Exercises:		
Ex.No	Name of the Experiment	Period
9.	Draw the Mush Winding Diagram of a Three Phase Induction Motor using AutoCAD.	5
10.	Draw the Winding Diagram of Lap Connected DC Armature with Commutator Connections and Brush Positions using AutoCAD.	5
11.	Draw the single line diagram of 110 KV / 11 KV Receiving Substation using AutoCAD.	5
12.	Draw the Single Line Diagram of Fire Alarm Riser Arrangement in typical Multi-Storey Building using AutoCAD.	5
TOTAL PERIODS		75

Note: Common Test and Revision periods can be used for conducting Continuous Assessment.

Suggested List of Students Activity:

1. Activity 1: Collect various Electrical Schematic Layout/Drawings from A Grade Electrical Contractors and Analyse it by discussing the Types of Symbols used in

Layouts, How the cable rating is mentioned in the drawings, Additional information provided in Drawings Sheets etc.,

2. Activity 2: 3 or 4 students may be formed as a group and Prepare the Building Plan, Pipe Layout and Wiring Diagram of college class room or Laboratory building. Submit the drawings as activity report.

Text and Reference Books:

1. K.B. Raina & S.K. Battacharya, Electrical Design Estimating and Costing, New Age International (p) limited, 2017.
2. M. Yokes, B. S. Nagaraja, N. Nandan, Computer Aided Electrical Drawing, PHI Learning Pvt. Ltd, 2014.
3. Sham Tickoo, Anurag, AutoCAD 2013 for Engineers and Designers, Wiley, 2012.

Web-based/Online Resources:

- http://students.autodesk.com/ (register and get free student version of LATEST AutoCAD software for approximately 3 year)
- https://www.autodesk.in/campaigns/autocad-tutorials.

1124236241	**ELECTRICAL CAD DESIGN**	L	T	P	C
PRACTICUM		1	0	4	3

End Semester Examination- Practical Exam

SCHEME OF EVALUATION

Part	Description for CAD Ex.	Marks	Description for Ex: 5 to 8	Marks
A	Aim & Apparatus Required	05	Aim & Apparatus Required	05
B	Manual Drawing	10	Pipe Layout & Load Calculation	15
C	Circuit using CAD Software	45	Wiring Diagram & Material Calculation	25
D	Printout	10	Schedule of Materials with Cost	25
E	MCQ from Theory Portions	20	MCQ from Theory Portions	20
F	Viva Voce	10	Viva Voce	10
TOTAL MARKS		100	TOTAL MARKS	100

Equipment / Facilities required to conduct the Practical Course. (Batch Strength: 30 Students)

S.No	Name of the Equipment's	Quantity Required
1.	PC/Laptop	30 Nos.
2.	Electrical CAD Software Multi user	01 No
3.	UPS – 5KVA with half an hour battery backup	01 No

1124236242	ESTIMATION, STANDARDS AND REGULATIONS	L	T	P	C
PRACTICUM		1	0	4	3

Introduction:

In most countries, electrical installations shall comply with more than one set of regulations, issued by National Authorities or by recognized private bodies. It is essential to take into account these local constraints before starting the design. The purpose of these Regulations is to provide guidelines and technical standards that promote the installation of safe and efficient systems of wiring in buildings and other Premises. In estimating, calculation of quantity of material is estimated by the estimator. This course is meant for learning the estimation process by the final semester students.

Course Objectives:

The objective of this course is to enable the student to

- Understand regulations involved in Indian Electricity ACT.
- Familiarize to do the plan lay out using electrical symbols.
- Write down the detailed specification and numbers required of different materials.
- Select size of conductor and prepare list of materials required.
- Understand the electrical safety measures and guidelines.

Course Outcomes:

CO1: Interpret Indian Electricity Rules, BEE standards, safety regulations, and terminology related to electrical installations and energy usage.

CO2: Identify and select an appropriate wiring systems, cables, accessories, protective devices, and earthing components for residential, commercial, and industrial installations.

CO3: Estimate the material quantities and installation costs for various electrical installations such as residential buildings, computer centres, street lighting, workshops, motors, and CCTV systems.

1124236242	ESTIMATION, STANDARDS AND REGULATIONS	L	T	P	C
PRACTICUM		1	0	4	3

CO4: Analyze the electrical installation requirements by considering load calculation, protection needs, earthing standards, and safety practices.

CO5: Validate the manual & software-based electrical estimation and safety measures to ensure compliance with standards, regulations and practical installation requirements.

CO-PO MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	-	2	-	-	-
CO2	-	1	-	3	-	-	-
CO3	-	2	-	3	-	-	-
CO4	-	2	-	3	-	-	-
CO5	-	2	-	3	-	-	-

Assessment Methodology:

	Continuous Assessment (40 Marks)				**End Semester Examination (60 Marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Model Practical Examination	Practical Examination
Portion	Ex. 1 to 6	Ex. 7 to 12	All Units	All Exercises	All Exercises

1124236242	**ESTIMATION, STANDARDS AND REGULATIONS**	L	T	P	C
PRACTICUM		1	0	4	3

Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 Hours
Exam Marks	60	60	100	100	100
Converted to	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	-

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical document (Hand written document / Notebook consists of Aim, Apparatus Required, Drawing, Calculations, Schedule of Materials and Result) should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise / experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

1124236242	ESTIMATION, STANDARDS AND REGULATIONS	L	T	P	C
PRACTICUM		1	0	4	3

SCHEME OF EVALUATION – Practical Test

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Pipe Layout & Load Calculation	10
C	Wiring Diagram & Material Calculation	20
D	Schedule of Materials and Approximate Cost	15
TOTAL		50
E	Practical Documents (As per the portions)	10
EXAM MARKS		**60**

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment. The question setting details are as follows.

	Description	Pattern	Marks
PART-A	30 Multiple Choice Questions (MCQ)	30 x 1 Mark	30
PART-B	7 Questions to be answered out of 10 Questions	7 x 10 Mark	70
TOTAL MARKS			**100**

- **CA 4:** All the exercises/experiments should be completed and kept for the Model Practical Examination. The students shall be permitted to select any one by lot for the exam. The model practical examination should be conducted as per the End Semester Examination question pattern as given below. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical and End Semester Examination- Practical Exam

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Pipe Layout & Load Calculation	20
C	Wiring Diagram & Material Calculation	20
D	Schedule of Materials and Approximate Cost	25
E	MCQ from Theory Portions	20
F	Viva Voce	10
TOTAL MARKS		**100**

Note: *Practical Document with Bonafide certificate must be submitted to Model Practical Examination and End Semester Practical Examination.*

1124236242	ESTIMATION, STANDARDS AND REGULATIONS	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion:		
UNIT I	**INDIAN ELECTRICITY RULES**	Period
Definitions: Ampere - Apparatus – Accessible - Bare conductor – Cable – Circuit - Circuit Breaker - Conductor Voltage (Low, Medium, High, EH) – Live – Dead - Cut-out – Conduit – System Danger _ Installation - Earthing System – Span – Volt - Switch Gear. IE Rules 1956: 28, 30, 31, 54, 56 & 87 - BEE PAT rules 2012 - Standards and Labelling scheme of BEE.		5
UNIT II	**ELECTRICAL INSTALLATIONS**	Period
Electrical installations, domestics, industrial, Wiring System, Internal distribution of Electrical Energy - Methods of wiring - Systems of wiring - conductor materials used in cables - Types of cables used in internal wiring. ACCESSORIES: Main switch and distribution boards - conduit accessories and fittings - lighting accessories and fittings – fuses - determination of size of fuse wire, fuse units - Earthing - IS specifications regarding earthing of electrical installations - points to be earthed - Determination of size of earth wire and earth plate for domestic and industrial installations - Material required for GI pipe earthing.		5

1124236242	**ESTIMATION, STANDARDS AND REGULATIONS**	L	T	P	C
PRACTICUM		1	0	4	3

Practical Exercises:		
Ex.No	Name of the Experiment	Period
1.	Estimate the quantity of material required in Electrical Installation for Small residential building/Flat. (1BHK)	30
2.	Estimate the quantity of material required in Electrical Installation for Computer centre having 10 computers, a/c unit, UPS, light and fan.	
3.	Estimate the quantity of material required in Electrical Installation for Street Light service having 12 lamp light fitting.	
4.	Estimate the quantity of material required in Electrical Installation for Workshop with one number of 3 phase, 15hp induction motor.	
5.	Estimate the quantity of material required in Electrical Installation for Small Workshop with 3 or 4 Machines.	
6.	Estimate the quantity of material required for CCTV wiring with 4 channel DVR for commercial building.	
UNIT III	**ELECTRICAL SAFETY GUIDELINES**	
Electrical Safety in Residential, Commercial and Agricultural Installations: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances - Electrical safety sign and posters. Fire Extinguishers: Fundamentals of fire-initiation of fires, types - extinguishing techniques - prevention of fire - types of fire extinguishers - fire detection and alarm system.		5

1124236242	ESTIMATION, STANDARDS AND REGULATIONS	L	T	P	C
PRACTICUM		1	0	4	3

Practical Exercises: Estimation of Materials using Software		
Ex.No	Name of the Experiment	Period
7.	Using any supporting Software, Estimate the quantity of material required in Electrical Installation for Small residential building/Flat. (1BHK)	30
8.	Using any supporting Software, Estimate the quantity of material required in Electrical Installation for Computer centre having 10 computers, a/c unit, UPS, light and fan.	
9.	Using any supporting Software, Estimate the quantity of material required in Electrical Installation for Street Light service having 12 lamp light fitting.	
10.	Using any supporting Software, Estimate the quantity of material required in Electrical Installation for Workshop with one number of 3 phase, 15hp induction motor.	
11.	Using any supporting Software, Estimate the quantity of material required in Electrical Installation for Small Workshop with 4 Machines.	
12.	Using any supporting Software, Estimate the quantity of material required for CCTV wiring with 4 channel DVR for commercial building.	
TOTAL PERIODS		**75**

Suggested List of Students Activity:

- Presentation/Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly/fortnightly based on the course.

1124236242	ESTIMATION, STANDARDS AND REGULATIONS	L	T	P	C
PRACTICUM		1	0	4	3

Text and References Books:

1. J.B. Gupta, A course in Electrical Installation, Estimating and costing, 9th Edition, S.K. Kataria and Sons, Reprint 2022.
2. S. Rao, R.K. Jain, Prof. H.L. Saluja, Electrical Safety, Fire Safety Engineering and Safety Management, Second Edition, Khanna Publishers, 2012
3. K.B. Raina & S.K. Battacharya, Electrical Design Estimating and Costing, New age international (P) Ltd, reprint edition 2011.
4. IS 732: Code of Practice for Electrical Wiring Installations

Web-based/Online Resources

- https://cea.nic.in/old/cei_rgn.html
- https://cea.nic.in/cei-regulations/?lang=en
- https://aerc.assam.gov.in/documents-detail/indian-electricity-rule1956
- https://electricity.py.gov.in/indian-electricity-rules
- Bureau of Energy Efficiency: https://beeindia.gov.in

1124236242	ESTIMATION, STANDARDS AND REGULATIONS	L	T	P	C
PRACTICUM		1	0	4	3

End Semester Examination- Practical Exam

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Pipe Layout & Load Calculation	20
C	Wiring Diagram & Material Calculation	20
D	Schedule of Materials and Approximate Cost	25
E	MCQ from Theory Portions	20
F	Viva Voce	10
TOTAL MARKS		**100**

1124236243	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
PRACTICUM		1	0	4	3

Introduction:

The dsPIC33CH dual-core Digital Signal Controller (DSC) allows separate design teams to develop software for each core independently and then integrate the code seamlessly into one chip. The dsPIC33CH DSC family is optimized for safety-critical applications requiring functional safety compliance and security. It enables running sophisticated algorithms.

Course Objectives:

The objective of this course is to enable the student to

(a) Understand the essential knowledge and skills of basic Digital Signal Processor encountered in professional practice for diploma holders.

(b) Comprehend the fundamental concepts and scope of Digital Signal Processor.

(c) Describe the properties dsPIC33CH dual-core Digital Signal Controller (DSC) allows separate design teams to develop software for each core independently and then integrate the code seamlessly into one chip.

(d) Examine the workings and applications of power transmission drives in mechanical systems.

(e) Understand the Industrial needs with the application of dsPIC33CH.

Course Outcomes:

CO!1: Analyze and evaluate the architecture of microcontroller to design and develop efficient control solutions for embedded system applications.

CO2: Analyze and design interfacing solutions using the 8255 Programmable Peripheral Interface for basic embedded applications

CO3:. Develop and optimize microcontroller programs by analyzing instruction sets to create efficient embedded system solutions for real-world applications.

1124236243	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
PRACTICUM		1	0	4	3

CO4: Design and analyze algorithms to perform basic mathematical operations using programming

CO5: Design and implement the interfacing circuits for basic input/output devices by integrating microcontrollers

CO/PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	3	-	-	-
CO2	-	2	-	3	-	-	-
CO3	-	-	2	3	-	-	-
CO4	-	-	2	3	-	-	-
CO5	-	-	2	3	-	-	-

Legend: 3-High Correlation, 2-Medium Correlation, 1-Low Correlation

Assessment Methodology:

	Continuous Assessment (40 Marks)				**End Semester Examination (60 Marks)**
	CA1	**CA2**	**CA3**	**CA4**	
Mode	Practical Test	Practical Test	Written Test Theory	Model Practical Examination	Practical Examination
Portion	Ex. 1 to 5	Ex. 6 to 10	All Units	All Exercises	All Exercises
Duration	2 Periods	2 Periods	3 Hours	3 Hours	3 Hours

1124236243	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
PRACTICUM		1	0	4	3

Exam Marks	60	60	100	100	100
Converted to	10	10	15	15	60
Marks	10		15	15	60
Internal Marks	40				60
Tentative Schedule	7th Week	14th Week	15th Week	16th Week	-

Note:

- **CA1 and CA2:** All the exercises/experiments as per the portions mentioned above should be completed and kept for the practical test. The students shall be permitted to select any one by lot for the test. The marks awarded will be converted to 10 Marks for each assessment test. Best of one will be considered for the internal assessment of 10 Marks.

  Practical document (Hand written document / Notebook consists of Aim, Apparatus Required, Algorithm or Flow Chart, Program and Result) should be maintained for every exercise / experiment immediately after completion of the practice. The practical document should be submitted for the practical test. The same should be evaluated for 10 Marks for each exercise / experiment. The total marks awarded should be converted to 10 Marks for the practical test as per the scheme of evaluation as below.

1124236243	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
PRACTICUM		1	0	4	3

SCHEME OF EVALUATION – Practical Test

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Algorithm or Flow Chart	15
C	Program	10
D	Execution and Output/Result	20
TOTAL		50
E	Practical Documents (As per the portions)	10
EXAM MARKS		**60**

- **CA 3:** Written Test for complete theory portions should be conducted for 100 Marks as per the question pattern below. The marks scored will be converted to 15 Marks for internal assessment. The question setting details are as follows.

	Description	Pattern	Marks
PART-A	30 Multiple Choice Questions (MCQ)	30 x 1 Mark	30
PART-B	7 Questions to be answered out of 10 Questions	7 x 10 Mark	70
TOTAL MARKS			**100**

1124236243	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
PRACTICUM		1	0	4	3

- **CA 4:** All the exercises/experiments should be completed and kept for the Model Practical Examination. The students shall be permitted to select any one by lot for the exam. The model practical examination should be conducted as per the End Semester Examination question pattern as given below. The marks awarded should be converted to 15 Marks for the internal assessment.

SCHEME OF EVALUATION

Model Practical and End Semester Examination- Practical Exam

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Algorithm or Flow Chart	20
C	Program	20
D	Execution and Output/Result	25
E	MCQ from Theory Portions	20
F	Viva Voce	10
TOTAL MARKS		**100**

Note: *Practical Document with Bonafide certificate must be submitted to Model Practical Examination and End Semester Practical Examination.*

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1124236243	**MICROCONTROLLER AND EMBEDDED SYSTEMS**	L	T	P	C
PRACTICUM		1	0	4	3

Theory Portion :		
UNIT I	**INTRODUCTION TO MICROCONTROLLER**	Period
Introduction to Embedded systems and Microcontroller - Features of Microcontroller - Special Microcontroller for Power Electronics Application (PIC & as PIC) - About single-core and Multi-core systems.		2
UNIT II	**INTRODUCTION TO dsPIC33CH DUAL CORE DIGITAL SIGNAL CONTROLLER**	Period
dsPIC33 - Introduction to aspic Microcontroller - dsPIC33ch Features - Master and Slave core Features - Pin Details of dsPIC33CH512MP508 - Block diagram of aspic dsPIC33CH512MP508 - Targeted Application - Maser Module Register - Instruction set - Data Space Addressing - Addressing Modes – Programmer's Model - CPU Resources - Arithmetic Logic Unit - DSP Engine and Instruction.		3
Practical Exercises:		
Ex.No	Name of the Experiment	Period
1.	Write a Program to Blink an LED connected to a General Purpose Input / Output (GPIO) pin.	8
2.	Write a Program to Read the state of a push-button and control an LED.	
Theory Portion:		
UNIT III	**MEMORY ORGANIZATION**	Period

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PRACTICUM		1	0	4	3

Master Memory Organization - Program Address Space - Program Memory MAP For dsPIC33CH512MP508 Device - Program Memory Organization Interrupt and Trap Vectors - Unique Device Identifier (UDID) - Data Space Width - Data Memory Organization and Alignment - SFR Space MAPs - Paged Memory Scheme - Extended X Data Space.		2
UNIT IV	**ADDRESSING**	Period
Instruction Addressing Modes - File Register Instruction - MCU Instructions - MODULO Addressing - Interfacing Program and Memory Spaces.		2

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PRACTICUM		1	0	4	3

UNIT IV	INTERFACING AND PERIPHERALS	Period
Understanding the concept of peripherals -Types of Peripherals - Introduction to internal peripherals of dsPIC microcontroller - Timer / Counter - High Resolution PWM - ADC - Universal Asynchronous Receiver Transmitter (UART) - Serial Peripheral Interface (SPI) - Inter Integrated Circuit (I2C) - LED interfacing - display interfacing - Stepper motor interfacing.		6
Practical Exercises:		
Ex.No	Name of the Experiment	Period
3.	Write a Program to Read Analog data from a potentiometer and display the data by using LCD.	12
4.	Write a Program to Establish communication between the dsPIC33CH and a computer using UART.	
5.	Write a Program to generate one PWM to drive an IGBT Switch to Control a DC Motor/Stepper Motor.	
6.	Write a program to generate PWM for Buck/Boost Converter	25
7.	Write a Program to read 2 channel ADC.	
8.	Write a Program to generate Sine PWM to Drive a IGBT to get a 50Hz sine waveform.	
9.	Write a Program to generate 3 Phase output from an Inverter Module.	

1124236243	**MICROCONTROLLER AND EMBEDDED SYSTEMS**	L	T	P	C
PRACTICUM		1	0	4	3

10.	Simulate a V/F Control of Induction Motor in MATLAB-SIMULINK & down load the program to a IGBT Power Module and run a 3 phase Induction Motor at 800RPM.	
Required Practical Instruction for all the Experiments		15
TOTAL PERIODS		**75**

Note: *Common Test and Revision periods can be used for conducting Continuous Assessment.*

1124236243	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
PRACTICUM		1	0	4	3

Suggested List of Students Activity:

- Presentation/Seminars by students on any recent technological developments based on the course.
- Periodic class quizzes conducted on a weekly/fortnightly based on the course.

Text and Reference Books:

1. Beginner's Guide to Programming the PIC24/dsPIC33: Using the Micro stick and Microchip C Compiler for PIC24 and dsPIC33
2. dsPIC33F Product Overview
3. Programming dsPIC MCUs in C
4. dsPIC33 Language Tools Libraries by Microchip.
5. The Beginner’s Guide to Designing with the dsPIC33 Microcontroller

Web-based/Online Resources:

1. https://www.microchip.com/en-us/products/microcontrollers-and-microprocessors/dspic-dscs/dspic33c/dspic33ch-dual-core-dsc
2. https://www.mouser.in/new/microchip/microchip-dspic33ch-dsc/
3. https://www.youtube.com/watch?v=r19Vxd_u5MI
4. https://www.amazon.in/Microchip-Technology-DM330028-dsPIC33CH-Development/dp/B07FML7CRK
5. https://www.tme.eu/Document/4644324b87bfbc44691614b542bf4ecb/dspic33ch_1.pdf

1124236243	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
PRACTICUM		1	0	4	3

Equipment / Facilities required to conduct the Practical Course. (Batch Strength: 30 Students)

S.No	Name of the Equipment	Quantity Required
1.	dsPIC33CH Dual Core Development Board	6 Nos
2.	a. Program / Interface kit to generate Sine PWM to Drive a IGBT to get a 50Hz sine waveform b. Function Generator c. Digital Signal Oscilloscope	Each 1 No
3.	Interface kit to generate 3 Phase output from a Inverter Module	1 No
4.	MATLAB-SIMULINK software	1 No
5.	Desktop Computers	6 Nos

1124236243	**MICROCONTROLLER AND EMBEDDED SYSTEMS**	L	T	P	C
PRACTICUM		1	0	4	3

End Semester Examination- Practical Exam

SCHEME OF EVALUATION

Part	Description	Marks
A	Aim & Apparatus Required	05
B	Algorithm or Flow Chart	20
C	Program	20
D	Execution and Output/Result	25
E	MCQ from Theory Portions	20
F	Viva Voce	10
TOTAL MARKS		**100**