Shri Vile Parle Kelavani Mandal's
SHRI BHAGUBHAI MAFATLAL POLYTECHNIC
Irla juhu Road, Vile Parle (West) Mumbai-400 056
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Electrical Engineering Department

SEMESTER-VI

SCHEME -2022

Shri Vile Parle Kelavani Mandal's

SHRI BHAGUBHAI MAFATLAL POLYTECHNIC

TEACHING AND EXAMINATION SCHEME

FULL TIME

PROGRAM: ELECTRICAL ENGINEERING **With effect from Batch admitted in June, 2022(Progressively)**

SEMESTER-VI **Duration : 16 Weeks**

Sr. No	Course Name (Code)	Scheme of Instruction & Periods per week					Theory Paper Duration and Marks		Examination Scheme and Maximum Marks							Gr	Scheme L/P/Cr
		L	P	D	T	Cr (L+P+D+T)	Hrs	Mks	SSL	TA	Paper	TW	PR	OR	TOTAL		
1	# Entrepreneurship Development & Start-Up (**EDS220015**)	3	2		-	5	3	70	20	10	70	25	-	25	150	M	3/2/5
2	# Electrical Testing & Maintenance (**ETM220319**)	4	2	-	-	6	3	70	20	10	70	50	50	-	200	A	4/2/6
3	Industrial Instrumentation (**INI220320**)	4	2	-	-	6	3	70	20	10	70	25	-	25	150	A	4/2/6
4	# Project (**PRJ220321**)	-	6	-	-	6	-	-	-	-	-	50	-	50	100	A	0/6/6
5	**# Elective –II** (Any **One**)																
5.1	Electric Vehicle Technology (**EVT220322**)	3	2	-	-	5	3	70	20	10	70	25	-	50	175	A	3/2/5
5.2	Industrial Automation (**INA220323**)	3	2	-	-	5	3	70	20	10	70	25	-	50	175	A	3/2/5
6	**# Elective –III** (Any **One**)																
6.1	Traction & Drives (**TND220324**)	3	2	-	-	5	3	70	20	10	70	25	-	50	175	A	3/2/5
6.2	Emerging Trends in Electrical Technology (**ETE220325**)	3	2	-	-	5	3	70	20	10	70	25	-	50	175	A	3/2/5
		17	**16**	-	-	**33**	**No of Papers = 05**		**100**	**50**	**350**	**200**	**50**	**200**	**950**		
		Total Periods : 33							**Total Marks : 950**								17/16/33

Theory and Practical periods of 1 Hour each, *Compulsory, # Award winning subject, @ Online Examination

L-Lecture period, P-Practical period, D- Drawing Practice, T- Tutorial, Cr-Credit, ESE: End Semester Examination, SSL –Sessional,

TA- Teachers Assessment, TH- Theory, TW- Term Work, PR- Practical, OR-Oral, Gr-Group,, B-Basic, C-Core, A-Applications, M-Management,

TA-Based on attendance, MCQ/Seminar/mini Project/Assignment/Model making etc.

PR/OR- Assessed by Internal and External Examiners jointly, TW- Assessed by Internal Examiner Only

Head of Department **Controller of Examination** **Secretary CDC** **Principal**

1. COURSE DETAILS

Programme: ME/EE/EXTC/PE/CH	**Semester: IV/VI/VI/VI/VI**
Course: Entrepreneurship Development & Start-Up	**Group: M**
Course Code: EDS220015	**Duration:16 Weeks**

2. TEACHING AND EXAMINATION SCHEME

Scheme of Instructions and Periods per week					Examination Scheme and Maximum Marks								
Theory Hrs L	Practical Hrs P	Drawing Hrs D	Tutorial Hrs T	Credits (L+P+D+T)	Theory Paper Duration and marks(ESE)		SSL	TA	TH	TW	PR	OR	TOTAL
					Hours	Marks							
03	02	-	-	05	03	70	20	10	70	25	-	25	150

3. COURSE OBJECTIVE

Student will able to develop entrepreneurial abilities by providing background information about support systems, skill sets, financial and risk covering institutions and other for building an enterprise.

4. SKILL COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences.

- **Develop project proposal for start -ups.**

5. COURSE OUTCOMES(COs) At the end of the semester student will be able to: -

CO No.	COURSE OUTCOME
CO1	Recognize the qualities of an entrepreneur.
CO2	Identify the business opportunity
CO3	Analyze the financial aspects for the Start-up
CO4	Develop marketing strategy

6. CO-PO, CO-PSO MAPPING TABLE

Mechanical Engineering:

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Entrepreneurship Development & Start-Up (EDS220015)	CO1	2	2	2	2	1	1	1	3	3
	CO2	2	2	2	2	2	2	1	2	2
	CO3	2	3	-	2	2		1	2	2
	CO4	2	2	2	2	2	1	1	2	2
	CO Avg	2.00	2.25	2.00	2.00	1.75	1.33	1.00	2.25	2.25

Electrical Engineering:

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Entrepreneurship Development & Start-Up (EDS220015)	CO1	2	2	2	2	1	1	1	3	3
	CO2	2	2	2	2	2	2	1	2	2
	CO3	2	3	-	2	2		1	2	2
	CO4	2	2	2	2	2	1	1	2	2
	CO Avg	2.00	2.25	2.00	2.00	1.75	1.33	1.00	2.25	2.25

Electronics and Telecommunications:

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Entrepreneurship Development & Start-Up (EDS220015)	CO1	2	2	2	2	1	1	1	3	3
	CO2	2	2	2	2	2	2	1	2	2
	CO3	2	3	-	2	2		1	2	2
	CO4	2	2	2	2	2	1	1	2	2
	CO Avg	2.00	2.25	2.00	2.00	1.75	1.33	1.00	2.25	2.25

Plastics Engineering:

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
Entrepreneurship Development & Start-Up (EDS220015)	CO1	2	2	2	2	1	1	1	3	3	3
	CO2	2	2	2	2	2	2	1	2	2	3
	CO3	2	3	-	2	2		1	2	2	3
	CO4	2	2	2	2	2	1	1	2	2	3
	CO Avg	2.00	2.25	2.00	2.00	1.75	1.33	1.00	2.25	2.25	3

Chemical Engineering

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Entrepreneurship Development & Start-Up (EDS220015)	CO1	2	2	2	2	1	1	1	3	3
	CO2	2	2	2	2	2	2	1	2	2
	CO3	2	3	-	2	2		1	2	2
	CO4	2	2	2	2	2	1	1	2	2
	CO Avg	2.00	2.25	2.00	2.00	1.75	1.33	1.00	2.25	2.25

7. COURSE CONTENTS

Sr. No.	TOPIC/Sub-topic	CO
I	**Introduction to Entrepreneurship and Start-Up:** 1.1Definition of Entrepreneurship and Start-up 1.2 Qualities of an entrepreneur. 1.3 Functions of an entrepreneur 1.4 Intrapreneurship 1.5 Motivation: Understanding Motivation through Maslow's Need Hierarchy 1.6 Roles of entrepreneurs and managers. 1.7 Problems and Barriers faced by Entrepreneurs and Start-ups. 1.8 Types of Business Structures for start-Up: -Sole Proprietorship -Partnership firm -One-person Company -Limited Liability Partnership -Private Limited Company -Public Limited Company	CO1
II	**Business/Start-up ideas: Generation and Evaluation** 2.1 Business Idea Generation: - Creativity Process - Innovation - Value creation - Concept of Business Opportunity - Search for Business Opportunity 2.2 Idea Evaluation**:** - Dynamics of Project Identification - Design thinking for finding solutions - SWOT analysis for business idea - Prototyping - Value proposition - Test marketing & Customer validation.	CO2

III	**Business Plan** 3.1 Project Report and its contents - Information about entrepreneur - Information about project / business - Technical details of proposed project - Financial details of proposed project - Analysis on profitability and return on investments - Supplementary information 3.2 Project appraisal/feasibility - Steps in project appraisal - Aspects of project appraisal 3.3 Business Location - Primary factors for deciding business location - Secondary factors for deciding business location 3.4 Authorities to contact for Various Clearance Certificates. 3.5 Study of balance sheet 3.6 Taxation -GST, Income Tax	CO2
IV	**Institutional Support System for Micro, Small and Medium Enterprises:** 4.1 Small Industries Development Organization (SIDO) 4.2 National small Industries Corporation Limited (NSIC) 4.3 Small Scale Industries Board (SSIB) 4.4 India Investment Centre (IIC) 4.5 Micro, Small and Medium Enterprises – Development Institute (MSME- DI) 4.5 District Industries Centers (DIC) 4.6 Industrial Estates	CO3
V	**Startup Funding Stages and Institutional Finance to Entrepreneurs:** 5.1 Startup Funding Stages: - Pre-Seed Funding: The bootstrapping stage - Seed Funding: Product development stage - Series A Funding: First round of VC - Series B Funding: Second round of VC - Series C Funding: Third round of VC - Series D Funding: Special round of funding - IPO: Stock market launch 5.2 Institutional Finance to Entrepreneurs: - Industrial Development Bank of India (IDBI) -Life Insurance Corporation (LIC) - Small Industries Development Bank of India (SIDBI) -Khadi and Village Industries Commission (KVIC)	CO3

VI	**Marketing strategies for Enterprises and Start-ups** 6.1 Market - Concept, Types 6.2 Micro and Macro Market Environment 6.3 Market Research - Concept, Importance and Process 6.4 Marketing Mix 6.5 Market segmentation 6.6 Digital Marketing: - Search engine optimization - Online advertising - Social media marketing - Web analytics - Email marketing - Social media marketing	CO4

8. LIST OF PRACTICALS/ASSIGNMENTS/EXERCISES/TUTORIALS/DRAWINGS

Term Work consists of Journal containing minimum no of –10 Experiments/assignments

Sr. No.	Title of Experiment/Assignment/Exercise/Tutorial/Drawings	Approx.Hrs required	COs
1	Gather information on Entrepreneurship and Start-up	2	CO1
2	Develop Business/Start-up ideas: Generation and Evaluation	2	CO2
3	Prepared Business Plan: Case Study	4	CO2
4	Classify Institutional Support System for Micro, Small and Medium Enterprises	2	CO2
5	Identify Startup Funding Stages and Institutional Finance to Entrepreneurs	2	CO3
6	Select Marketing strategies for Enterprises and Start-ups: Case Studies	2	CO4
7	Prepare a report on Loan procedure proprietorship	2	CO3
8	Prepare Balance Sheet: Case Study	4	CO3
9	To select Product/ Services: Case Study	4	CO2
10	To prepare Project Report on any product/service.	4	CO1 CO2 CO3 CO4
11	Interaction with any two Entrepreneur to achieve the following objectives: To learn how to network with different entrepreneurs How they have grown their business? How to build product and personal brand? How to develop the values, skills? How to overcome entrepreneurial challenges?	4	CO1 CO2 CO3 CO4
	TOTAL	32	

9. TEACHERS ASSESSMENT (TA): Assessment to be based on one of the following tools and rubrics for evaluation of TA to be well defined by course teacher.

1. Micro Project
2. Seminar/Presentation
3. Model/Chart making
4. Surveys
5. Case Study
6. Quiz

10. IMPLEMENTATION STRATEGY (PLANNING)

1. Teaching/ lab Plan
2. Minimum no of practical/assignments.
3. Industry visit
4. Guest/Expert lectures
5. Demonstrations
6. Slides
7. Self-Learning Online Resources

11. SUGGESTED LEARNING RESOURCES

Sr.No.	Title of Book	Author	Publication
1	Entrepreneurship Development	Sangita Sharma	PHI Learning Publication ISBN-978-81-203-5270-4
2	Entrepreneurship and Small Business Management	Khanna S. S	S. Chand and Sons, Delhi. ISBN -978-93-5161-094-6
3	Entrepreneurship Development	S, Anil Kumar	New Age International, New Delhi.ISBN: 978-81-2241-434-9
4	Product Design and Manufacturing	Chitale A.K	PHI Learning Publication ISBN-978-81-203-4873-8

12. WEB REFERENCES

- http://www.startupindia.gov.in/
- https://www.nstedb.com/index.htm
- NSIC : National Small Industries Corporation
- https://www.startupindia.gov.in

13. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Entrepreneurship and Start-up :	06	6	4	-	10
II	Business/Start-up ideas: Generation and Evaluation	08	4	4	4	12
III	Business Plan	08	2	6	4	12
IV	Institutional Support System for Micro, Small and Medium Enterprises :	08	-	4	6	10
V	Startup Funding Stages and Institutional Finance to Entrepreneurs :	08	2	4	6	12
VI	Marketing strategies for Enterprises and Start-ups	10	2	4	8	14
	TOTAL	**48**	**16**	**26**	**28**	**70**

R Remember, U Understand, A Apply and above, (Bloom's revised taxonomy levels)

NOTE: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of COs. The actual distribution of marks at different taxonomy levels (R, U, A) in the question paper may vary from above table

14. COURSE EXPERT COMMITTEE MEMBERS

Sr. No.		NAME
1	Internal	Mr.Sachin Kamble
2	Internal	Mr.Ashutosh Shukla
3	External	Mr. Sunil Kangane
		Organisation: CEO, Invotec Automation Pvt Ltd. Mumbai

1. COURSE DETAILS

Programme: Electrical Engineering	**Semester: VI**
Course: # Electrical Testing and Maintenance	**Group: A**
Course Code: ETM220319	**Duration:16 Weeks**

2. TEACHING AND EXAMINATION SCHEME

Scheme of Instructions and Periods per Week					Examination Scheme and Maximum Marks								
Theory Hrs L	Practical Hrs P	Drawing Hrs D	Tutorial Hrs T	Credits (L+P+D +T)	Theory Paper Duration and marks(ESE)		SSL	TA	TH	TW	PR	OR	TOTAL
					Hours	Marks							
04	02	--	--	06	03	70	20	10	70	50	50	--	200

3. COURSE OBJECTIVE

The knowledge of testing, maintenance, erection and installation of electrical equipment's in industries, power plants and state electricity board is essential. This subject provides the detailed guidelines as per I.S. codes/I.E. Rules for testing, maintenance, erection and installation of electrical equipment's.

4. SKILL COMPETENCY

The aim of this course is to help the student to attain following competency through various teaching-learning experiences:

- Test, maintain, and troubleshoot various electrical machines.

5. COURSE OUTCOMES (COs) At the end of the semester student will be able to: -

CO No.	COURSE OUTCOME
CO1	Follow electrical safety measures and use fire extinguisher for fire due to electrical causes.
CO2	Install Static and Dynamic Electrical machines.
CO3	Test, troubleshoot and maintain Transformers as per I.S codes
CO4	Test, troubleshoot and maintain rotating machines such as DC machines, Synchronous machines and Induction motor as per I.S codes
CO5	Identify and test different Classes of insulation as per ISS 1271- 1958.

6. CO-PO, CO- PSO MAPPING TABLE

Course and Code	Course Outcomes (CO)	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Electrical Testing and Maintenance (ETM220319)	CO1	3	1	1	3	2	-	-	3	3
	CO2	3	2	2	-	1	-	-	3	3
	CO3	3	2	2	3	-	-	-	3	3
	CO4	3	2	2	3	-	-	-	3	3
	CO5	3	1	1	1	1	-	-	3	3
	CO Avg.	3.00	1.60	1.60	2.50	1.33	-	-	3.00	3.00

7. COURSE CONTENTS

UNIT NO.	Topic / Sub-Topics	CO
I	**Electrical Safety & Prevention of Accidents.** 1.1 Definition of terminology used in safety: safety, hazard, accident. 1.2 Steps in Hazard Identification and Risk Assessment (HIRA) 1.3 Electrical accidents, its causes preventions and rescue 1.4 Artificial respiration technique, Cardiopulmonary Resuscitation (CPR) 1.5 I.E. Act & statutory regulations for safety of persons & equipments working with electrical installation. 1.6 Electrical Fire: Causes of Fire & precautions to avoid fire, fire extinguishers.	CO1
II	**Installation of Electrical Machines.** 2.1 Concept of foundation for machinery installation. 2.2 Requirements of Foundation for static & rotating electrical machinery. 2.3 Concept and procedure of leveling & aligning. 2.4 Alignment of direct coupled drive. 2.5 Effects of misalignment. 2.6 Installation of rotating machines as per I.S. 900-1992	CO2
III	**Testing and Maintenance of Transformers.** 3.1 Listing type test, routine test & special test as per I.S. 2026-1981 3.2 Specifications of Transformers. 3.3 Parallel operation of single phase transformers 3.4 Procedure for conducting following tests: Voltage ratio test, Polarity and phasing out test, DC resistance of windings, Open circuit and short circuit test, Back to back test, Efficiency Test, Temperature rise test, Insulation resistance test, H.V. Test and impulse test. 3.5 Preventive and routine maintenance for distribution transformers as per ISS 10028-1981, Troubleshooting as per IS 10028-1981 3.6 Test before commissioning of the Transformer as per ISS 2026-1962, ISS 1886-1967.	CO3

IV	**Testing and Maintenance of D.C. Machines and Synchronous Machines.** 4.1 Objectives of testing 4.2 Types of Tests as per ISS. Roles of Bureau of Indian Standards (BIS) in testing of electrical Equipment's. 4.3 Specifications of DC machines. 4.4 Methods of testing: Brake test, Swinburne's test, Hopkinson's test, Calibrated machine test. 4.5 Concept of routine, preventive & breakdown maintenance 4.6 Trouble shooting chart of DC machines. 4.7 Testing and Maintenance of BLDC Motor. 4.8 Maintenance schedule of DC Machines. 4.9 Specifications of Synchronous machines. 4.10 Maintenance schedule of alternators & synchronous machines as per IS 4884-1968	CO4
V	**Testing and Maintenance of Induction motor** 5.1 Specifications of single phase and three phase induction motor. 5.2 Routine tests of Single phase & Three phase Induction motors: Measurement of D.C resistance, Measurement of insulation resistance, High voltage test, Reduced voltage running up test, voltage ratio test, no load and blocked rotor test, circle diagram 5.3 Type tests on Three phase induction motor: Temperature rise test, Momentary overload test, Full load test. 5.4 Trouble shooting chart of single phase and three phase induction motor. 5.5 Routine, Preventive, & breakdown maintenance of Single phase & Three phase Induction motors as per IS 9001-1992	CO4
VI	**Testing of Insulation** 6.1 Classification of insulation as per ISS 1271-1958 6.2 Factors affecting life of insulating materials. 6.3 Measurement of insulation resistance 6.4 Breakdown voltage test for transformer oil 6.5 Reconditioning of insulation 6.5.1 Cleaning and drying the insulation 6.5.2 Re-varnishing 6.6 Resin casting 6.7 Construction and working of vacuum impregnation plant.	CO5

8. LIST OF PRACTICALS/ASSIGNMENTS/EXERCISES/TUTORIALS/DRAWINGS

Sr. No.	Title of Experiment/Assignment/Exercise/Tutorial/Drawings	Approx.Hrs required	CO
1	Polarity test on single phase transformer	2	CO3
2	Open circuit and short circuit test on single phase transformer	2	CO3
3	Parallel operation of two single phase transformer	4	CO3
4	Back to back test on single phase transformer and determination of efficiency & Regulation.	4	CO3
5	Temperature rise test on single phase transformer	2	CO3
6	Swinburne's test on a D.C machine.	2	CO4
7	Calibrated machine test on D.C machine.	4	CO4
8	No-load and blocked rotor test on three phase induction motor	6	CO4
9	Brake test on Single phase induction motor.	4	CO4
10	Breakdown voltage test for transformer oil	2	CO5
Total		32	

Assignments

1	Assignment on Electrical Safety & Prevention of Accidents.	CO1
2	Assignment on Installation of Electrical Machines.	CO2

9. TEACHERS ASSESSMENT (TA):

Assessment to be based on one of the following tools and rubrics for evaluation of TA to be well defined by course teacher.

1. Micro-Project
2. Seminar/Presentation
3. Model/Chart making
4. Surveys
5. Case Study
6. Quiz

10. IMPLEMENTATION STRATEGY(PLANNING)

1. Teaching Plan.
2. Assignments.
3. Guest/Expert lectures.
4. Visit to nearby testing laboratory if any
5. Continuous assessment.
6. Slides.
7. Any other method adopted.

11. LEARNING RESOURSES

Sr. No.	Title of Book	Author	Publication
1	Electrical Technology Vol -II	B. L. Theraja	S. Chand & Co., New Delhi
2	Operation & Maintenance of Electrical Equipments Vol-I & II	B.V.S. Rao	Media promoters and publisher Ltd. Mumbai
3	Electrical Machines	Bhattacharya	Tata McGraw Hill

12. WEB REFERENCES

1. www.lanl.gov/safety/electrical/docs/skilled_worker_module_6.ppt
2. www.bis.org.in
3. www.standardsbis.in
4. www.civilengineer.co.in
5. https://www.youtube.com/@EngHanyKamel

13. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Sr.No	Topic	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Electrical Safety & Prevention of Accidents	3	3	-	06
2	Installation of Electrical Machines.	-	2	6	08
3	Testing and Maintenance of Transformers.	3	3	8	14
4	Testing and Maintenance of D.C Machines and Synchronous Machines.	6	4	8	18
5	Testing and Maintenance of Induction motor.	4	4	8	16
6	Testing of Insulation	4	4	-	08
TOTAL		**20**	**20**	**30**	**70**

R- Remembering, U - Understanding, A- Applying (Bloom's revised taxonomy levels)

NOTE: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of COs.The actual distribution of marks at different taxonomy levels (R, U, A) in the question paper may vary from above table.

14. COURSE EXPERT COMMITTEE MEMBERS

Sr. No.		NAME
1	Internal	Miss Urvi H. Sawant
2	Internal	Mr. Dinesh G. Rajmandai
3	External	Mr. A. K. Dhulshette
		Organisation: Government Polytechnic, Bandra.

1. COURSE DETAILS:

Programme: Electrical Engineering	**Semester: VI**
Course: Industrial Instrumentation	**Group: A**
Course Code: : INI220320	**Duration:16 Weeks**

2. TEACHING AND EXAMINATION SCHEME:

Scheme of Instructions and Periods per					Examination Scheme and Maximum Marks							
Theory Hrs L	Practical Hrs P	Drawing Hrs _	Tutorial Hrs _	Credits (L+P+D+T)	Theory Paper Duration and marks(ESE)		SSL	TA	TH	TW	PR	OR	TOTAL
					Hours	Marks							
04	02	-	-	06	03	70	20	10	70	25	-	25	150

3.COURSE OBJECTIVE:

In industries, there are many requirements of measuring non – electrical quantities like pressure, strain, temperature etc. this subject provides an introduction to the students of electrical engineering, regarding the measurement of such quantities.

This subject introduces different transducers, some schemes involving such transducers and it also deals with qualities of measurement like precision, reliability, and sensitivity etc. this subject also deals with indicating and recording techniques and it also gives some introduction to telemetering.

4.SKILL COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences.

- **Maintain different types of transducer used for measurement of different parameters in power industry.**

5. COURSE OUTCOMES (COs) at the end of the semester student will be able to: -

CO No.	COURSE OUTCOME
CO1	Identify different components of instrumentation system.
CO2	Describe different types of transducer use for measurement of Non Electrical quantities
CO3	Understand different signal conditioning circuits.
CO4	Understand different Data Acquisition System types and their use.

6. CO-PO, CO- PSO MAPPING TABLE

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Industrial Instrumentation (INI220320)	CO1	1	-	-	3	-	2	2	2	2
	CO2	1	-	-	3	1	2	-	2	2
	CO3	1	2	3	-	-	1	-	2	1
	CO4	1	2	3	-	-	1	-	2	1
	CO Avg.	1.00	2.00	3.00	3.00	1.00	1.50	2.00	2.00	1.50

7. COURSE CONTENTS

UNIT NO.	Topic/Sub-Topic	CO
I	**Introduction to Instrumentation system** 1.1 Facts and concept of Instrumentation 1.2 Basic block diagram of Instrumentation system & its function 1.3 Static and dynamic characteristics 1.4 Accuracy and precision 1.5 Sensitivity and Resolution 1.6 Linearity and nonlinearity 1.7 Repeatability and reproductively 1.8 Hysteresis and Drift 1.9 Speed of Response, lag, fidelity, dynamic error	**CO1**
II	**Transducers** 2.1 Concept of Transducers 2.2 Classification of Transducers 2.2.1 Primary and Secondary Transducers 2.2.2 Electrical and Mechanical Transducers 2.2.3 Analog and Digital Transducers 2.2.4 Active and passive Transducers 2.3 Construction and working principles of 2.3.1 Resistive Transducers 2.3.2 Inductive Transducers 2.3.3 Capacitive transducers 2.3.4 Piezoelectric transducer, photoconductive cell, photovoltaic cells, load cell.	**CO2**
III	**Signal Conditioning** 3.1 Concept of signal conditioning 3.2 Block diagram of AC and DC signal conditioning and working 3.3 Operational Amplifiers, OP AMP - 741, signal Operational Amplifier and its characteristic parameters Circuit Symbols and Terminals. OPAMP IC's: 741 pin diagram and pin function. Ideal op-amp: electrical	**CO3**

	characteristics. Ideal voltage transfer curve. Definitions of parameters of op-amp: Input offset voltage, input offset current, input bias current, Differential input resistance, Input capacitance, CMMR, SVRR, large signal voltage gain, output resistance, slew rate OP-AMP basic circuits Open loop and closed loop configuration of op-amp configuration: Inverting, non- inverting, differential amplifier 3.4 Integrator, Differentiator, adder, subtractor, Inverter V to I converter, I to V converter , V to F converter Instrumentation Amplifier, Differential amplifier 3.5 Filters:- Types and frequency response (No derivation) 3.6 Use of signal conditioning circuit for Instrumentation system for Industrial applications	
IV	**DATA Processors & Data transmission** 4.1 Necessity of data processing in Instrumentation. 4.2 Generalized Data acquisition system: Block diagram. & explanation 4.3 Objectives of DAS 4.4 Concept of Data transmission 4.5 Block diagram of data transmission system & explanation 4.6 Analog-to-digital and digital-to-analog conversion 4.7Advantages and disadvantages of digital data transmission over analog transmission	**CO4**
V	**Temperature and Pressure Measurement** 5.1 Non-electrical methods for Temperature Measurement. Different transducers used Liquid filled thermometers, Mercury thermometers, Vapor pressure thermometers, Gas thermometers, Bi-metal thermometers, 5.2 Electrical methods for Temperature Measurement. Resistance thermometers, Thermocouples, Optical pyrometer, radiation pyrometer. 5.3 Errors of temperature measurements and remedies 5.4Sensors used for temperature measurement. 5.5 Pressure Measurements using mechanical methods- U-tube manometer, Well type manometer, Limp diaphragm, Metal diaphragms or bellow,Bourdon tubes-spiral or helical tubes. 5.6Electric transducers used for pressure measurement The Pirani gauges, strain gauges,Linear variable differential transducers. Variable capacitance gauges ,Electro pneumatic transducers. Piezo electrical transducers. 5.7 sensors used for pressure Measurement	**CO2**
VI	**Flow and pH Measurement** Mechanical transducers, 6.1 Elbow flow meters, 6.2 Variable area meters, 6.3 Pilot tube, 6.4 Flow construction head meters, 6.5 Electrical transducers, 6.6 Magnetic flow meter, 6.7 Differential transformer transducers, 6.8 Turbine meters. 6.9 P-H measurements- 6.9.1 pH scale 6.9.2 pH Electrodes. 6.10 Principles of pH meters 6.11 sensors used for Flow Measurement	**CO2**

8. LIST OF PRACTICALS: Term Work consists of Journal containing minimum no of Eight experiments from the following.

Sr. No.	Title of Experiment	Approx.Hrs required	COs
1	Measurement of displacement using LVDT	4	CO2
2	Study of LDR	4	CO2
3	Measurement of temperature by Thermistor	4	CO2
4	Measurement of temperature by thermocouple	4	CO2
5	Measurement of load using strain gauge based load cell.	2	CO2
6	Study of Integrator	2	CO3
7	Study of Differentiator	2	CO3
8	Study of Adder and Subtractor	4	CO3
9	Study of Instrumentation Amplifier	4	CO3
10	Study of Potentiometer	2	CO3
11	Assignment on Introduction to Instrumentation System	-	CO1
12	Assignment on DATA Processors & Data transmission	-	CO4
	Total	32	

9.TEACHERS ASSESSMENT (TA): Assessment to be based on one of the following tools and rubrics for evaluation of TA to be well defined by course teacher.

1. Micro-Project
2. Seminar/Presentation
3. Model/Chart making
4. Quiz

10. IMPLEMENTATION STRATEGY(PLANNING):

In depth study and understanding of the subject will be implemented by adopting following strategy.

1. Teaching Plan/Tutorials
2. Minimum no of experiments.
3. Industry visit
4. Guest/Expert lectures
5. Demonstrations/Simulations
6. Slides
7. Self Learning Online Resources

11. SUGGESTED LEARNING RESOURCES:

Sr.No.	Title of the Book	Author	Publication
1	Electrical measurements and instruments	A.K.Sawhney	Dhanpatrai & sons
2	Industrial Instrumentation control	S.K.Singh	Tata McGraw-hill
3.	Instrumentation control	Rangan & Sharma	Tata McGraw-hill

12 WEBSITE REFFERENCES:

1.http://instrumentationtek.com
2. www.onlinelibrary.wiley.com
3. www.wikipedia.com
4 .http://www.instrumentationcontrolbox.com
5. https://www.edgefx.in/industrial-instrumentation-in-real-time-applications

13.SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Sr.No.	TOPIC	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Instrumentation system	8	4	4	-	08
II.	Transducers	10	2	6	4	12
III.	Signal Conditioning	10	2	4	6	12
IV	DATA Processors & Data transmission	8	2	2	4	08
V	Temperature and pressure Measurement	18	4	8	8	20
VI	Flow and pH Measurement	10	2	4	4	10
TOTAL		**64**	**16**	**28**	**26**	**70**

R Remembering, U Understanding, A Applying, (Bloom's revised taxonomy levels)

NOTE: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of COs.The actual distribution of marks at different taxonomy levels (R, U, A) in the question paper may vary from above table.

14.COURSE EXPERT COMMITTEE MEMBERS

Sr. No.		NAME
1	Internal	Dr.Zafar Shaikh
2	Internal	Mrs Ajayshree N. Kinhekar
3	External	Prof.Kishor Dawane
		Organisation:G.P.Mumbai

1. COURSE DETAILS:

Programme : Electrical Engineering	**Semester: VI**
Course : # PROJECT	**Group-A**
Course Code: PRJ220321	**Duration :16 Weeks**

2. TEACHING AND EXAMINATION SCHEME:

Scheme of Instructions and Periods per Week					Examination Scheme and Maximum Marks							
Theory Hrs	Practical Hrs.	Drawing Hrs D	Tutorial Hrs T	Credits (L+P+D+T)	Theory Paper Duration and marks (ESE) Hrs	Mks	SSL	TA	TH	TW	PR	OR	TOTAL
-	06	-	-	06	-	-	-	-	-	50	-	50	100

3. COURSE OBJECTIVE:

This course is introduced for the final year students in order to give them the scope to utilize their theoretical knowledge that is fundamental of electrical and electronics engineering, group projects and make them to understand the importance of team work, Leadership and time management. In order build up self-confidence and experiencing themselves before the audience are have introduce the presentation of the project is planned at the end of the term.

4. SKILL COMPETANCY:

The aim of this course is to help the students to attain following industry identified competency through various teaching-learning experiences:

- **Develop project proposals to launch small scale enterprises**

5. COURSE OURCOMES (CO's): at the end of course student will be able to:-

CO.No	COURSE OUTCOMES
CO 1	Select most contemporary subject for the project work
CO 2	Prepare project proposal with action plan and time duration scientifically before the beginning of the project
CO 3	Apply their practical skill and choose the techno economical solution to the problem identified.
CO 4	Develop team work and leadership and consider ethical and environmental issues related to project.
CO 5	Prepare and present technical report along with project demonstration

6. CO –PO CO-PSO MAPPING TABLE

Name of the Course & Course code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Project (PRJ220321)	CO 1	1	3	2	-	2	-	-	3	3
	CO 2	2	1	-	-	-	3	-	3	3
	CO 3	-	3	-	2	-	-	-	3	3
	CO 4	1	2	-	-	-	3	2	3	3
	CO 5	-	-	3	-	-	-	2	3	3
	CO Avg.	**1.33**	**2.25**	**2.50**	**2.00**	**2.00**	**3.00**	**2.00**	**3.00**	**3.00**

7. COURSE DETAILS

Activity No.	Activities	Week No
1	Formation of Group	1
2	Selection of Project: Individual/Group discussions	
3	Define Problem statement for project work	2
5	Decide Strategies/Methodology to carry out project	
6	Literature Survey/data survey	
7	Submission of synopsis: by each group	
8	Project activity plan-Defining activities, strategy, duration	3
9	Allocation of work responsibility to individual/team	4
10	Visits to Industries / Institutions / Market/field work/sites	5
11	Collection of Data /Survey/Analysis	6
12	Design of Components, preparation of drawing, estimates wherever required,printed circuits design, its checking,	7
13	Fabrication, Assembling, Model/Prototype development, Testing as per projectrequirements	8
14	Progressive presentation of work and recording in diary	9-10
15	Consolidation of work allotted to individual or team	11-12
16	Presentation of initial draft: pre submission draft	13
17	Final Project Report: Printed: Submission: soft & Hard copy	14
18	Group presentation of project work at the time of final evaluation	15-16

N.B :

- The group / student shall prepare Project Diary with Name of Project, Name of Students in group, their attendance and progress and get assessed from guide from time to time during project hours.
- The activities mentioned above shall be monitored and guided by Project Guide every week during the contact hours provided for the same.
- The Project is also included with Seminar with the aim to develop certain set communication skills (preparation of report, writing survey report writing Lab. experiment results writing conclusions of the work done and physical phenomenon observed, participating in groupdiscussions, verbally defending the project in the form of Seminar etc.)

- **AREA OF SELECTION FOR PROJECT**

  These are only guidelines; any project related to Electrical Engineering depending upon the availability of projects may be included. Preference should be given to practical oriented projects according to the local needs.

Sr.No.	Areas For Selection
1	Illumination Engineering
2	Green building Codes,
3	Hybrid Vehicles
4	Variable Voltage Variable frequency drives
5	Traction new trends
6	EHV Transmission
7	Smart Grid Applications
8	Computer application in design of Electrical Machines
9	Energy Conservation, Energy Audits
10	Smart Metering, Electricity Theft Reduction
11	Power Quality
12	Renewable Energy
13	Any other topics related to Electrical Engineering

8. TERM WORK:

The term-work shall comprise of one electrical or inter disciplinary group project (maximum 5-6 students) those who have TERM GRANTED for all award winning subjects up to 6^{h} semester will be allowed to register the subject.

Students shall note there is presentation for project work at three levels based on following points such as:
Leader ship, Understanding, Observation&Accuracy, Contribution and Timely Completion

- Phase –I – 15 Marks
- Phase –II- 15 Marks and
- Final Presentation – 20 Marks
- Total = 50 Marks

TW to be assessed by external & internal examiners.

- GUIDELINE FOR PREPARATION OF PROJECT REPORT:

1. The student shall get the initial draft copy of the project approved from the Project guide.
2. Structure: It shall be as follows :
   - Title page, Inner title page (white), Certificate, Certificate from Industry, Synopsis, Acknowledgment, Table of Contents, List of table & figures (optional), Introduction, Objectives of the Project, Methodology used, Design, Drawing of the part and assembly, Testing, Costing, Result, Conclusions & Scope for future, Merits, Demerits, Applications, Bibliography
   - Annexure consists of various designed parts and assembly drawings,photographs, charts, statistical data
   - CD of video clips /Power Point presentation
3. Each group has to submit one copy of project report to the library and one soft andhard copy to the department apart from the individual copy.
4. The project report will be of 40 to 50, A4 Size pages with 1.5 line spacing. Font: NewTimes Roman, left margin 3 cm, right margin 1.5 cm, top margin 2.5 cm, bottom margin 1.5 cm,

header & footer 1.5 cm, page numbers, size of font 12 pt, paragraphs left and right justified.

5. Chapters (to be numbered in Arabic) containing Introduction-which usually specifies scope of work and the present developments. Main body of the report divided appropriately into chapters, sections and subsections. The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc. and subsections as 2.2.3, 2.5.1 etc.
6. The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.
7. The figures and tables must be numbered chapter wise.
8. The last chapter should contain the summary of the work carried, contributions ifany, their utility along with the scope for further work.
9. Reference OR Bibliography:
   The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [4]. Thesection on references should list them in serial order in the following format.
   a. For textbooks – Dr.D .P. Kothari & Dr. I .J Nagrath, Electrical Machines, McGraw Hill Publications, New Delhi 1 Edition, 2009.
   b. For papers - David, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.
   c. Only SI units are to be used in the report. Important equations must be numbered in decimal form.

10. Each student from group shall have one copy with individual certificate only.
11. The project report and progressive assessment sheets are to be submitted before theend of term declared in the Academic Calendar of the institute.

9. SUGGESTED LEARNING RESOURCES: 1. Magazine Electrical India

2. Electronics for you

10. WEB REFERCE : 1. www.wikipedia.com
2. www.1000projects.org
3. www.projectreportstore.com
4. www.project.webcrawler.com

11. COURSE EXPERT COMMITTEE MEMBERS:

Sr. No.	Expert	NAME
1	Internal	Shri N D Adate
2	Internal	Mrs. Ajayshree Kinhekar
3	External	Mr.Sandip Dalvi
		Organisation: Adani Electricity Senior Manager, Mumbai

1. COURSE DETAILS:

Programme: Diploma in Electrical Engineering	**Semester: VI**
Course: Electrical Vehicle Technology	**Group: A (Elective-II)**
Course Code :EVT220322	**Duration : 16 Weeks**

2. TEACHING AND EXAMINATION SCHEME:

Scheme of Instructions and Periods per Week					Examination Scheme and Maximum Marks								
Theory Hrs	Practical Hrs.	Drawing Hrs D	Tutorial Hrs T	Credits (L+P+D+T)	Theory Paper Duration and arks (ESE)		SSL	TA	TH	TW	PR	OR	TOTAL
					Hrs	Mks							
03	02	-	-	05	03	70	20	10	70	25	-	50	175

3. OBJECTIVE:

Electric mobility is becoming very vibrant mode of transportation in present scenario. In order to mitigate the problem if global warming and climate change the control of carbon is imperative and hence the role of electric vehicles is most important. EV industry will generate 10 million new jobs within a decade. Hence through this course student will learn the technological growth and present technologies to drive the electric vehicle along with drives and power control devices

4. SKILL COMPETANCY:

The aim of this course is to help the students to attain the following industry identified competency through various teaching-learning experiences:

- **Maintain, control and analyse the operation of Electric Vehicle**

5. COURSE OUTCOMES (CO's) at the end of course students will be able to: -

CO. No	COURSE OUTCOME
CO1	Summaries the various electric vehicles for the clean environment
CO2	Explain the dynamics of electric vehicles
CO3	Select suitable electric motor and drive for electric vehicle
CO4	Describe EV batteries and its specifications
CO5	Maintain battery charging and battery management
CO6	Use suitable power electronic devices to control electric vehicles

6. CO-PO, CO-PSO MAPPING TABLE

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Electrical Vehicle Technology (EVT220322)	CO1	3	3	-	-	3	-	3	2	2
	CO2	3	3	-	-	-	-	-	2	3
	CO3	3	3	1	1	2	2	3	3	2
	CO4	3	-	-	1	-	-	2	2	2
	CO5	3	-	-	1	-	-	2	2	3
	CO6	3	2	-	-	-	2	-	3	3
	CO Avg.	**3.00**	**2.75**	**1.00**	**1.00**	**2.50**	**2.00**	**2.50**	**2.33**	**2.50**

7. COURSE CONTENTS:

Unit No.	Topic/Sub-Topics	CO
I	**1.0 Electric and Hybrid Vehicles: History and Environmental Impacts** 1.1 Historical journey of Hybrid and Electric Vehicles 1.2 Pollutants produced due to IC Engine Vehicles and their effect on environment 1.3 Economic and Environmental impact of using Electric Vehicles 1.4 Classification, Vehicle configuration and challenges with electric vehicles 1.4.1 Pure Electric Vehicle (PEV) : Battery Electric vehicle 1.4.2 Hybrid Electric Vehicles (HEV) 1.4.3 Conventional (HEV) : Micro, Mild and Full Hybrid , Series Hybrid, Parallel hybrid, Series parallel and Complex Hybrid 1.4.4 Gradable HEV: Plug in Hybrid (PHEV), Range Extended (REV) 1.4.5 Fuel Cell Electric Vehicle (FCEV) 1.5 Solar Electric Vehicles : Solar Electric power Train	CO1
II	**2.0 Dynamics of Electric and Hybrid Electric Vehicles** 2.1 General Description of vehicle movement, rolling resistance and its equation, rolling resistance coefficient, Factors affecting rolling resistance, typical values of rolling resistances 2.2 Aerodynamic drag and its equation, typical values 2.3 Grading resistance, Road resistance , Acceleration resistance and Total driving resistance 2.4 Dynamic equation only (No Derivation) 2.5 Electrical Propulsion System : Drive Systems	CO2
III	3.0 **Electric Motors used for EV and EHV** 3.1 Difference between industrial motors and electric vehicle **motors** 3.2 Classification of electric motors used for electric vehicles applications: Induction Motors, Permanent Magnet motors, Switched reluctance motor, 3.2.1 Construction, working and control of induction motor **3.2.2** Construction, working and control of Permanent Magnet motors 3.2.3 Construction, working and control of Switched reluctance motor 3.3 Factors to be considered for selection of motors 3.4 Regenerative braking in EVs 3.5 Configuration of motor layout: Single motor, configuration, Duel motor configuration, In Wheel motor configuration	CO3
IV	**4.0 EV Batteries and Parameters** 4.1 Electrochemical batteries: Lead acid and nickel based batteries, Lithium based batteries 4.2 Battery Parameters: Physical Dimensions, Voltage and Current rating, Capacity and Power 'C Rate, Battery efficiency, Energy Density, Power Density, State of Charge (SoC), Depth of Discharge (DoD) , State of Health (SoH), Operating Temperature, Lifetime 4.3 Construction and working of lithium based batteries, merits and demerits 4.4 Comparison of batteries with respect to specific energy, specific power, life cycle and cost 4.5 Brief introduction to Ultra capacitors, Ultra flywheel and Fuel cell	CO4

V	**5.0 Charging EV& EHV and Battery Management System:** 5.1 AC Charging 5.2 DC Charging 5.3 Battery Swapping 5.4 Smart Charging 5.5 Wireless Charging 5.7 Battery Management System (BMS) : Need of Battery management system and Block Diagram of BMS	CO5
VI	**6.0 Use of Power Electronics in EV and EHV** 6.1 EV and EHV configuration based on power electronics 6.2 converter requirement for on board charger, battery pack, motor drive, auxiliary battery 6.3 Commonly used DC to DC converter in EV and HVE 6.4 Isolated converter 6.5 Non isolated converter 6.6 Unidirectional and Bidirectional converter 6.7 DC to AC converters: 6.8 Three phase DC to AC converter, Voltage Control using PWM.	CO6

8. LIST OF PRACTICALS/ASSIGNMENTS/EXERCISE/TUTORIALS/DRAWINGS

The term work consists of journals consisting of minimum 8-10 experiments and 3-4 assignments with approx. number of hours required with corresponding CO's

Sr. No	Title of Experiments/Assignments/Exercise/Tutorials/Drawings	Approx. Hrs. Required	CO
1	• Search Electrical vehicle diagram on internet showing internal parts • Take print out of the same • Write function of each part	4	CO1
2	• Search Hybrid Electrical vehicle diagram on internet showing internal parts • Take print out the same • Write the function of each part	4	CO1
3	• Search Plug in Hybrid Electrical vehicle diagram on internal showing internal parts • Take print out of the same • Write function of each part	4	CO1
4	• Presentation in group of five/ six on the • Characteristics of motors required for electric vehicles • Working and control of motors that can be used for the EV applications • Regenerative braking	4	CO3
5	• Compare electrical vehicles available in India with respect to Motor used, Power in KW, Torque.	4	CO3
6	• Visit to electrical vehicle charging station prepare the report on the following • Type of charging used. • Charging standard used.	4	CO4

	• Safety precaution followed • Maintenance procedure followed.		
7	• Make a presentation on charging specifications used in India and charging standard used in world. Present the same in group of two	4	CO5
8	• Make a presentation on startups working in battery swapping techniques. What are the advantages and challenges in battery swapping method? Present the same in group of two	4	CO5
9	• Assignment of use of Power Electronics devices and circuits in Electric Vehicle	-	CO6
TOTAL		**32**	

9. TEACHERS ASSESSMENT (TA): -

Assessment to be based on one of the following tools and rubrics for evaluation of TA to be well defined by the course teacher.

1. Micro Projects
2. Seminar-Presentation
3. Model/Chart Making
4. Surveys
5. Case studies
6. Quiz

10. IMPLEMENTATION STRATEGY: (Planning)

1. Teaching plan
2. Minimum no of Practical's/Assignments
3. Industrial Visit
4. Guest/Expert Lectures
5. Demonstrations
6. Slides
7. Continuous assessment for lab works
8. Self-learning Online Resources

11. SUGGESTED LEARNING RESOURCES:

Sr.No.	Title of Book	Author	Publisher & address
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Fundamentals, Theory and Design	Mehrdad Eshani, Yimin Gao, Sebastien E.Gay , Ali Emadi,	CRC Press LLC, 2005 ISBN 0-8493-3154-4
2.	Advanced Electric Drive Vehicles	Ali Emadi ,	CRC Press LLC , 2015 ISBN 978-1-4665-9770-9
3	Electric Vehicle Machines and Drives Design, Analysis and Application	K.T. Chau	IEEE Press, John Wiley & Sons Singapore Pte.Ltd. 2015 ISBN 978-1-118-7534-9
4.	Hybrid Vehicles and The Future of Personal Transportation	A.E. Fuhs ,	CRC Press, 2009 ISBN-10:1-4200-7534-9
5.	Electric Vehicle Battery Systems	Sandeep Dhameja, Butterworth	Heinemann 2002 ISBN 0-7506-9916-7

6	Electric Vehicle Technology Explained	James Larminie, John Lowry John	Wiley & Sons Ltd, 2003 ISBN 0-470-85163-5
7	Hybrid Electric Vehicles Principles and Applications With Practical Perspectives	Chris MI, Abul Masrur , David Wenzhong 2011,	John Wiley &Sons, Ltd ePub ISBN : 978-1-119-97011-8
8	Power Electronics: Circuits, Devices and Applications	M.H. Rashid , 4th Edition,	Pearson, 2013 ISBN 10:0133125904
9	Power Electronics: Devices, Circuits and Industrial Applications	V.R. Moorthi ,	Oxford University Press, 2005 ISBN 10 : 0195670922 / ISBN
10	Electric & Hybrid Vehicles	A K Babu	Khanna Publishing

12. WEB REFERENCES:

1. https://nptel.ac.in/course.html
2. https://www.edx.org/
3. https://emobility.araiindia.com/
4. https://afdc.energy.gov/vehicles/electric_basics_hev.html
5. https://makermax.ca/makermax-electricvehiclecourses/

13. SUGGESTED SPECIFICATION TABLE:

Sr.No	Topics	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Electric and Hybrid Vehicles : History and Environmental Impacts	10	4	6	4	14
II	Dynamics of Electric and Hybrid Electric Vehicles	07	2	4	4	10
III	Electric Motors used for EV and EHV	10	4	2	8	14
IV	Battery Charging and Energy storage management	08	2	4	6	12
V	Charging EV& EHV and Battery Management System :	06	2	2	4	08
VI	Use of Power Electronics in EV and EHV	07	2	4	6	12
TOTAL		**48**	**16**	**22**	**32**	**70**

R Remembering, U Understanding, A Applying, (Bloom's revised taxonomy levels)

NOTE: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of COs.The actual distribution of marks at different taxonomy levels (R, U, A) in the question paper may vary from above table.

14. COURSE EXPERT COMMITTEE MEMBERS:

Sr.No		Name
1.	Internal	Shri N D Adate
2.	Internal	Ms. Urvi Sawant
3.	External	Mrs. Deepali Kirtane
		Organization : Government Polytechnic, Mumbai

1. COURSE DETAILS:

Programme : Electrical Engineering	**Semester: VI**
Subject: # Industrial Automation	**Group: A (Elective-II)**
Code: INA220323	**Duration 16 Weeks**

2. TEACHING AND EXAMINATION SCHEME:

Scheme of Instructions and Periods per Week					Examination Scheme and Maximum Marks								
Theory Hrs L	Practical Hrs P	Drawing Hrs D	Tutorial Hrs T	Credits (L+P+D+T)	Theory Paper Duration and marks(ESE)		SSL	TA	TH	TW	PR	OR	TOTAL
					Hours	Marks							
03	02	--	--	05	03	70	20	10	70	25	-	50	175

3. CURSE OBJECTIVE:

This course aims to Aquent students with vital components of automation such as motors control circuits, typical input or output devices, PLC, distributed control system, SCADA and HMI, This will facilitate students to develop understanding and skills related with operation and maintenance of basic building blocks of industrial automation witch will in turn enable them to effectively upkeep the automated systems in industry

4. SKILL COMPENTANCY:

The aim of this course is to help the students to attain the following industry identified competency through various teaching lea ringing experiences.

- **Maintain PLC & SCADA based industrial automation systems**

5. COURSE OUTCOME: - At the end of the semester student will be able to: -

CO No.	COURSE COUTCOMES
CO1	Maintain the relevant input output components in industrial control circuits
CO2	Wire PLC's for different applications
CO3	Troubleshoot the PLC ladder programmers for simple applications
CO4	Test the PLC programmer in different applications
CO5	Maintain the DCS and SCADA for different applications.

6. CO-PO, CO-PSO MAPPING TABLE

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Industrial Automation (INA220323)	CO1	3	3	-	-	3	-	3	2	2
	CO2	3	3	-	-	-	-	-	2	3
	CO3	3	3	1	1	2	2	3	3	2
	CO4	3	-	-	1	-	-	2	2	2
	CO5	3	-	-	1	-	-	2	2	3
	CO Avg.	**3.00**	**2.75**	**1.00**	**1.00**	**2.50**	**2.00**	**2.50**	**2.33**	**2.50**

7. DETAILED CONTENTS:

Unit. No.	Topic/Sub-Topics	CO
I	**Industrial Control Circuits** 1.1 Need and benefit of automation, Different input devices, such as Push button, selector switch, limit switch, proximity switch, pressure switch, 1.2 Different output devices such as relay, contactor, solenoid valve, solid state relays (SSR), 1.3 Different symbols used in industrial control circuits. Concept of control and power circuit diagram 1.4 Commonly used motor control circuits diagram such as 1.4.1 DOL starting 1.4.2 Star-Delta starter 1.4.3 FWD-STOP-REV control and random reversing of induction motor 1.5 Soft starters	CO1
II	**PLC Fundamentals** 2.1 Function of different parts of PLC such as CPU, memory, power, supply and IO modules. 2.2 Digital IO modules of PLC, Block diagram and specification 2.3Analog IO module of PLC, Block diagram and specification 2.4 Special modules of PLC: Communication module PID controller module, Stepper motor control module 2.5 PLCs in market based on CPU type, no of IOS, speed and memory	CO2
III	**PLC Programming Basics** 3.1 Binary system. bit, byte, word, logic gates 3.2 Programming PLC using ladder diagram, Components of ladder diagram, Program scan process applied to single run. 3.3 Ladder diagram for different logic gates. 3.4 Relay type instructions: If- CLOSED If- OPEN Output energies instructions, input relay instructions Internal relay instructions 3.5 Timer/ Counter module: types of timers and counter	CO3
IV	**PLC Wiring Diagram and Ladder Logic:** 4.1 seal in circuits using PLC 4.2 Ladder and wiring diagram of DOL starter with OLR 4.3 Latching Relay using PLC 4.4 PLC based Water level controller	CO4

	4.5 Forward Reverse control of three phase IM using PLC 4.6 Temperature control control ON/OFF 4.7 Stepper motor control 4.8 Bottle filing system 4.9 Traffic light control	
V	**SCADA and DCS:** 5.1 SCADA overview, 5.2 Use of HMI 5.3 SCADA architecture, Monolithic, Distributed and networked 5.4 Concept of DCS	CO5

8. LIST OF PRACTICALS/ASSIGNMENTS/EXERCISE/TUTORIALS/DRAWINGS

The term work consists of journals consisting of minimum 8-10 experiments and 3-4 assignments with approx. number of hours required with corresponding CO's

Sr.No	Title of Experiments/Assignments/Exercise/Tutorial/Drawings	Approx. Hrs. required	CO
1.	Identify Symbols in industrial control diagram	2	CO 1
2.	Connect of DOL starter control and power circuit for small rating 3-Phase induction motors	2	CO1
3.	Connect- FOR-STOP-REV control and power Circuit for small rating of IM	2	CO1
4.	Connect- star –Delta control and power Circuit for small rating of IM	2	CO1
5.	Simulate a simple seal in circuit using PLC simulator.	2	CO2
6.	Connect PLC to PC and test execution of ladder program for basic logic operations using two input switches and one output indicating lamp	2	CO2
7.	Execute a PLC program using timer to turn on a lamp 10 seconds after push button press	2	CO4
8.	Execute the PLC Program by to count number of push button press events and display the same on screen	2	CO4
9.	Connect PLC for STAR –DELTA starting of 3-Phase induction motor and test the ladder diagram for the same	2	CO2
10.	Connect PLC for FOR-STOP-REV starting of 3-Phase induction motor and test the ladder diagram for the same	2	CO3
11.	Use the PLC for running a Stepper motor in clockwise and anti-clockwise direction	2	CO3
12.	Use the PLC for sensing the level of water in tank using float switch and control level of water using ON/OFF solenoid	2	CO4
13.	Use PLC for ON/OFFO temperature controller	2	CO4
14.	Use PLC for traffic Control system	2	CO4
15.	Use PLC HMI for display input switch status on screen	2	CO5
	Total	**32**	

Note: 1. Practical shall be performed on Allen -Bradley and Siemens PLC and RS View 32 and in Touch (Wonder ware) SCADA software.

9. TEACHERS ASSESSMENT (TA): -

Assessment to be based on one of the following tools and rubrics for evaluation of TA to be well defined by the course teacher.

7. Micro Projects
8. Seminar-Presentation
9. Model/Chart Making
10. Surveys
11. Case studies
12. Quiz

10. IMPLEMENTATION STRATEGY: (Planning)

10. Teaching plan
11. Minimum no of Practical's/Assignments
12. Industrial Visit
13. Guest/Expert Lectures
14. Demonstrations
15. Slides
16. Continuous assessment for lab works
17. Self-learning Online Resources

11. SUGGESTED LEARNING RESOURCES:

Sr. No.	Name of Book	Name of Author	Edition	Publication
1.	Programmable logic control	George Batten, Jr.	II Edition	Mc Graw Hill
2.	Introduction to Programmable logic controllers	Gary Dunning	II Edition	Thosman Asia Pvt.Ltd.
3.	SCADA: supervisory control and data acquisition	Stuart A. Boyer	II Edition	ISA Publication
4.	Programmable Logic Controller	V. R. Jadhav	I Edition	Khanna Publications
5.	Instrument Engineers Handbook	Bela G. Liptak.,Kriszta Venczel	Revised Edition	Chilton Book Company

12. WEB REFERENCES

1. www.cyber.st.dhs.gov
2. www.anshumantech.com
3. www.plcscadatraining.org

13. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Sr. No.	TOPIC	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Industrial Control Circuits	09	02	06	08	16
II	PLC Fundamentals	10	02	04	08	14
III	PLC Programming Basics	10	02	04	08	14
IV	PLC Wiring Diagrams and Ladder logics	12	04	06	08	18
V	SCADA and DCS	07	02	02	04	08
TOTAL		**48**	**12**	**22**	**36**	**70**

R Remembering, U Understanding, A Applying, (Bloom's revised taxonomy levels)

NOTE: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of COs. The actual distribution of marks at different taxonomy levels (R, U, A) in the question paper may vary from above table.

14. COURSE EXPERT COMMITTEE MEMBERS:

Sr. No.		NAME
1	Internal	N D Adate
2	Internal	Mrs. A N Kinhekar
3	External	Mr. R S Shukla
		Organization : G P Mumbai

1. COURSE DETAILS

Programme: Electrical Engineering	**Semester: VI**
Course: #Traction & Drives	**Group: A**
Course Code: TND220324	**Duration: 16 Weeks**

2. TEACHING AND EXAMINATION SCHEME

Scheme of Instructions and Periods per Week					Examination Scheme and Maximum Marks								
Theory Hrs L	Practical Hrs P	Drawing Hrs D	Tutorial Hrs T	Credits (L+P+D+T)	Theory Paper Duration and marks(ESE)		SSL	TA	TH	TW	PR	OR	TOTAL
					Hours	Marks							
03	02	--	--	05	03	70	20	10	70	25	-	50	175

3. COURSE OBJECTIVE

This is a core technology course. Electrical diploma pass outs should know the principle of generation of electricity, conventional methods of generation of electricity, their environmental impact and economics of power generation.
This course shall provide the basis for further studies in transmission, distribution and power system operations.

4. SKILL COMPETENCY

The aim of this course is to help the student to attain following competency through various teaching-learning experiences:

- **Suggest the appropriate methods/systems for traction, its electrification, Traction motor, braking and starting.**
- **Recommend appropriate drive, their mechanical features and ratings for given load conditions and applications**

5. COURSE OUTCOMES (COs) At the end of the semester student will be able to: -

CO No.	COURSE OUTCOME
CO1	Suggest appropriate electric traction systems, track electrification methods, current collection system, substation equipment and signaling mechanism.
CO2	Determine tractive efforts and specific energy consumption for given traction duty.
CO3	Elaborate traction control systems and braking of motors used for Traction
CO4	Recommend appropriate drive, their mechanical features for given load conditions and various Industrial applications.
CO5	Evaluate Size and rating of motor for a particular application

6. CO - PO, CO - PSO MAPPING TABLE

Course and Code	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
#Traction & Drives (TND220324)	CO1	3	-	-	1	2	-	-	2	2
	CO2		3	2	1	-	-	-	2	2
	CO3	3	3	1	-	-	-	-	2	2
	CO4	-	-	2	3	1	1	1	2	2
	CO5	3	2	1	-	-	1	-	2	2
	CO Avg	**3.00**	**2.67**	**1.50**	**1.67**	**1.50**	**1.00**	**1.00**	**2.00**	**2.00**

7. COURSE CONTENTS

UNIT NO.	TOPIC/Sub-topic	CO
I	**1.0 Types, Supply arrangements and signaling system for Electric traction** 1.1 Different types of traction systems 1.2 Advantages and disadvantages of electric traction 1.3 Requirements of an Ideal Traction System 1.4 Systems of track electrification 1.5 Electric Traction Services 1.5.1 Railways (Block diagram of an AC Electric locomotive) 1.5.2 Metro systems 1.5.3 Monorail systems 1.6 Overhead supply arrangement for railways 1.7 Current collection systems in Electric traction 1.8 Major Traction substation equipment 1.8.1 Transformer 1.8.2 Circuit breaker 1.8.3 Interrupter 1.9 Signaling Systems 1.9.1 Two aspect signalling 1.9.2 Three aspect signalling 1.9.3 Four aspect signalling	CO1

II	**2.0 Traction mechanics** 2.1 Definitions: Maximum or Crest speed, Average speed and Schedule speed 2.2 Speed time curve for different Services 2.3 Factors affecting Schedule speed 2.4 Trapezoidal Speed- Time curve and Quadrilateral Speed-Time curve(Derivation and Numericals) 2.5 Tractive effort 2.6 Coefficient of adhesion, factors affecting coefficient of adhesion 2.7 Specific energy consumption 2.8 Factors affecting specific energy consumption	CO2
III	3.0 **Traction Motor** 3.1 Desirable Characteristics of Traction Motors 3.2 Traction Control Systems 3.2.1 Chopper Control of Motors 3.2.2 Tap Changer control 3.2.3 PWM Control of Induction Motors. 3.3 Braking 3.3.1 Requirements of Ideal braking system 3.3.2 Advantages and Disadvantages of Electric braking 3.3.3 Types of electric braking 3.3.4 Plugging, Rheostatic braking and regenerative braking applied to DC and Three phase induction motor 3.3.5 Conditions to be satisfied for regenerative braking	CO3
IV	**4.0 Electric drive** 4.1 Concept of an electric drive 4.2 Advantages of electric drive 4.3 Factors Governing selection of Electric drives 4.4 Multi-Quadrant operation of drives 4.5 Classification of electric drives 4.5.2 Group Drive 4.5.2 Individual Drive 4.5.3 Multimotor Drive 4.6 DC Drives: Speed control with single phase and three phase half and full controlled converter, Chopper Drives. 4.7 AC Drives: Methods of speed control of three phase Induction Motor using converters and choppers	CO4
V	**5.0 Industrial applications of Electric Drives** Descriptive study of electrical drives needed for 5.1 Steel mills 5.2 Paper mills 5.3 Textile mills 5.4 Sugar mills 5.5 Coal mills 5.6 Cement mills	CO4

VI	**6.0 Size and Rating of Motors** 6.1 Factors to be considered while deciding size and rating of motor for a particular application 6.2 Steady state stability 6.3 Nature of Load 6.4 Standard ratings as per IS 6.4.1 Continuous Rating 6.4.2 Continuous Maximum Rating 6.4.3 Short Time rating 6.5 Load Cycles 6.6 Estimation of Size/Rating of Motor 6.6.1 Equivalent current method(Numericals) 6.6.2 Equivalent torque method(Numericals) 6.7 Concept of Load equalization	CO5

8. LIST OF PRACTICALS/ASSIGNMENTS/TUTORIALS/DRAWINGS

Term work consist minimum number of 5 Assignments and 1 Mini project/Study project/Project based on Industry visit

Sr. No.	Title of Experiment/Assignment/Exercise/Tutorial/Drawings	Approx. Hrs required	CO
1	Supply and signaling system for Electric traction	2	CO1
2	Traction mechanics	3	CO2
3	Traction Motor controls and braking	2	CO3
4	Electric drive and its Industrial applications	3	CO4
5	Size and rating of Motors	2	CO5
6	Mini project/Study project/Project based on Industry visit	20	CO1/ CO2/ CO3/ CO4/ CO5
TOTAL		32	

9. TEACHERS ASSESSMENT (TA): Assessment to be based on one of the following tools and rubrics for evaluation of TA to be well defined by course teacher

1. Micro project
2. Seminar/Presentation
3. Model/Chart making
4. Surveys
5. Case Study
6. Quiz

10. IMPLEMENTATION STRATEGY(PLANNING)

1. Teaching Plan.
2. Assignments.
3. Industrial visit.
4. Guest/Expert lectures.
5. Continuous assessment
6. Slides.
7. Any other method adopted.

11. SUGGESTED LEARNING RESOURSES

Sr. No.	Title of Book	Author	Publication
1	Modern electric traction	H.Partap	Pritam surat & brothers
2	Utilization of electrical power and electric traction	J.B.Gupta	S.Chand
3	Art & science of electric drives	H.Partap	Khanna publications
4	Electrical drives	S.K.Pillai	Wiley eastern limited
5	Fundamentals of electrical drives	G.K.Dubey	Narosa publishing house
6	Modern electric traction	M. A. Chaudhari, S. M. Chaudhari	Nirali Prakashan

12. WEB REFERENCES

1. www.irieen.indianrailways.gov.in
2. www.wikipedia.com
3. www.techeduhry.nii
4. www.aast.edu
5. www.electrical4u.com

13. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Types, Supply arrangements and signaling system for Electric traction	09	4	4	6	14
II	Traction mechanics	08	4	4	4	12
III	Traction Motor	08	4	4	4	12
IV	Electric drive	08	2	4	6	12
V	Industrial applications of Electric drives	08	2	2	6	10
VI	Size and rating of Motors	07	2	4	4	10
TOTAL		**48**	**18**	**22**	**30**	**70**

R- Remembering, U - Understanding, A- Applying (Bloom's revised taxonomy levels)

NOTE: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of COs.The actual distribution of marks at different taxonomy levels (R, U, A) in the question paper may vary from above table.

14. COURSE EXPERT COMMITTEE MEMBERS

SR.NO.		NAME
1	Internal	Mr.Dinesh G Rajmandai
2	Internal	Miss. Urvi H. Sawant
3	External	Mr. Milind Kale
		Organization: Western Railway, Mumbai

1.COURSE DETAILS:

Programme : Electrical Engineering	**Semester : VI**
Course: Emerging Trends in Electrical Engineering	**Group: A (Elective-III)**
Course Code :ETE220325	**Duration : 16 Weeks**

2. TEACHING AND EXAMINATION SCHEME:

Scheme of Instructions and Periods per Week					**Examination Scheme and Maximum Marks**								
Theory Hrs L	**Practical Hrs P**	**Drawing Hrs D**	**Tutorial Hrs T**	**Credits (L+P+D+T)**	**Theory Paper Duration and marks(ESE)**		**SSL**	**TA**	**TH**	**TW**	**PR**	**OR**	**TOTAL**
					Hours	**Marks**							
03	02	--	--	05	03	70	20	10	70	25	50	--	175

3. OBJECTIVE:

Every technological area is developing at an exponential rate. New applications are coming up and its necessary for all technocrats to be well versed in these areas to provide satisfactory and quality services to the society. This course aims to prepare the diploma graduates to be conversant with such new emerging trends for keeping update. The main areas include smart systems, intelligent motor controls, tariff and digitization beyond automation.

4. SKILL COMPETANCY:

The aim of this course is to help the students to attain the following industry identified competency through various teaching learning experiences.

- **Use the trending practices in Electrical Engineering fields**

5. COURSE OUTCOMES (CO's) at the end of course students will be able to: -

CO. No	**COURSE UTCOMES**
CO1	Suggest the relevant IoT technologies for electrical systems
CO2	Suggest the relevant components for implementing a smart grid
CO3	Suggest different electrical system for smart city
CO4	Suggest the relevant MCC or IMCC for given applications
CO5	Propose the relevant improved tariff for the specified type of consumers
CO6	Propose the relevant improved metering for the specified type of consumers

6. CO-PO, CO-PSO MAPPING TABLE

CO.No	Course Outcomes	Programme Outcomes							Programme Specific Outcomes	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
Emerging Trends in Electrical Engineering (ETE220325)	CO1	3	2	2	2	2	2	1	1	3
	CO2	3	2	3	1	1	1	1	2	2
	CO3	2	3	2	1	1	1	-	2	3
	CO4	3	-	1	2	-	-	-	2	2
	CO5	2	2	-	3	-	-	1	3	3
	CO6	2	2	-	3	-	-	1	3	3
	CO Avg.	**2.50**	**2.20**	**2.00**	**2.00**	**1.33**	**1.33**	**1.00**	**2.17**	**2.67**

7. COURSE CONTENTS:

Unit No.	Topic/Sub-Topics	CO
I	**1.0 Digitization beyond Automation:** 1.1 Industrial Revolutions: 1.1.1 Versions 1.0,2.0,3.0 and 4.0 the driving energies/Powers for these revolutions 1.2 Components of industrial revolutions 4.0 1.2.1 Cyber physical system (CPS), Internet of Things (IoT), Cloud competing and Cloud manufacturing 1.3 IoT principles and features 1.4 IoT Applications in Electrical Systems: Building automation SCADA, smart metering, Illumination systems (Public Lighting) 1.5 Iot Initiatives in Power Distribution systems: Mobile App, Geo coordinates of the network as well as consumer's premises, various digital services platforms for consumers.	CO1
II	**2.0 Smart Grid:** 2.1 Need and evolution, Layout and its components 2.1.1 Advantages and its barriers 2.1.2 Smart grid projects in India 2.2 Micro-Grid & Distributed Energy Resources: 2.2.1 Need and formation of micro-Grid, 2.2.2 Distributed Generation Systems and Technologies 2.2.3 Smart Substation: need 2.2.4 Layout and components 2.2.5 Typical Specifications of existing substations	CO2
III	**3.0 Smart City: (Electrical Features only)** 3.1 **Smart City:** features and Components 3.1.1 Objectives and challenges of smart city in India 3.2 **E-Car:** Role of Electric vehicles in energy transition. 3.2.1 Basics of Electric Car, working principle 3.2.2 Charging station 3.2.3 Fuel cel for e-cars,	CO3

	3.2.4 Types, features and limitations 3.3 **Smart Home:** 3.3.1 Features and Components 3.3.2 Illumination and smart appliance control principles (Block Diagrams	
IV	**Intelligent Motor Control Centers:** 4.1 Traditional Motor Control Centers: 4.1.1 role of motor protections and motor management 4.1.2 Typical block diagrams and general architecture or arrangement 4.1.3 Components: Symbols and functions: 4.1.4 Traditional MCC merits and Demerits 4.2 Intelligent or smart MCCs: 4.2.1 Need and requirements that lead to have IMCCs. 4.2.2 role as compared to traditional MCCs 4.2.3 Functional block diagrams with general arrangement 4.3Devices and components of IMCCs 4.3.1 Intelligent relays fuses, control devices, effective security and dedicated software's 4.4 Basic components pf Intelligent systems: 4.4.1 Control by microprocessor /Microcontrollers based systems 4.4.2 networking/technology replaces hard wiring and enhanced diagnostic /Preventive functionality 4.5 Selection of MCC: Intelligent ad conventional types for typical applications	CO4
V	**5.0 Tariff:** 5.1 Tariff: Power Purchase, Power Purchase Agreement (PPA), Power Purchase Cost 5.1.1 **Tariff design**: Key factors for tariff design, 5.2 Major components of an electricity Bill 5.3 Various slabs in billing, electricity duty, tax on electricity and cross subsidy **5.2 Special Tariffs**: Average Billing rate (ABR), 1.1. Average Revenue requirement (ARR), 1.2. Availability based tariff (ABT), time of Day (ToD) Tariff 1.3. Recent ToD structure **5.3** KVAh tariff: KVA billing method for HT and LT consumers, **5.4** KVAh metering methodology **5.5** KVAh based billing calculations	CO5
VI	**6.0 Metering and Bill Management:** 6.1 Working of NET metering and Cross metering, 6.2 MERC rules for net metering (Regulations 2015) 6.3 Applications of Net metering for integration of micro-Generators with grid systems 6.4 Recent meter reading techniques- MRI/AMR reading	CO6

8. LIST OF PRACTICALS/ASSIGNMENTS/EXERCISE/TUTORIALS/DRAWINGS

The term work consists of journals consisting of minimum 7-8 assignments/Mini projects with approx. number of hours required with corresponding CO's

Sr.No	Title of Experiments/Assignments/Exercise/Tutorials/Drawings	Approx Hrs. Required	CO
1	Perform general survey regarding the recent electrical technologies	02	CO 1
2	Prepare a visit report on IMCC	04	CO 1
3	Prepare a report on existing automation in an industry and suggest improvements	02	CO 1
4	Prepare a power point presentation on IMCC	02	CO 2
5	Prepare a report on smart grid	02	CO 3
6	Prepare a report on any four electrical applications in smart cities	04	CO 3
7	Prepare a report on the procedure of meter reading by MRI and AMR technologies	04	CO 3
8	Conduct a survey and prepare a report on IMCC in one industry	02	CO 3
9	Prepare a report on mobile apps used for energy billing procedures.	04	CO4
10	Prepare a power point presentation on IoT Applications	04	CO 5
11	Perform group discussion on new electricity tariff approaches	02	CO 5
	TOTAL	32	

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9. TEACHERS ASSESSMENT (TA): -

Assessment to be based on one of the following tools and rubrics for evaluation of TA to be well defined by the course teacher.

1. Micro Projects
2. Seminar-Presentation
3. Model/Chart Making
4. Surveys
5. Case studies
6. Quiz

10. IMPLEMENTATION STRATEGY: (Planning)

1. Teaching plan/MOOC
2. Minimum no of Practical's/Assignments
3. Industrial Visit
4. Guest/Expert Lectures
5. Demonstrations
6. Slides
7. Continuous assessment for lab works
8. Self-learning Online Resources

11.SUGGESTED LEARNING RESOURCES:

Sr.No.	Title of Book	Author	Publisher & address
1	Fundamentals of smart grid Technology	Bharat Modi, Anu Prakash , Yogesh Kumar	S.K KAtaria & sons : 2012 Edition ISBN- 10: 9350144859, 13:978-9350144855
2.	Smart Grid : Technology and Applications	Janaka Ekanayake, Kithsiri Liyange	Wiely, 2015 Edition ISBN-10: 9788126557356 13:978-8126557356
3	Sustainable smart cities in India: Challenges and Future Perspectives	Sharma, Poonam, Rajput , Swati	Springer, ISBN 978-3-319-47145-7
4.	Control of Electrical Machines	S K Bhattacharya	New Age international ISBN 8122409970, 9788122409970
5.	Handbook of Electrical Motor control Systems	U S Eshwar	Tata McGraw-Hill Education ISBN: 0074601113, 9780074601112
6	Applied Intelligent Control of Induction motor Drives	Keli Shi and Tze Fun Chan	Wiely ISBN 10: 0470825561, 13:9780470825563
7	Art of Reading Electricity Bills	Mr. Yogendra Talwae	Strom Energie Pvt.Ltd. Pune (Stromenergie.pune@gmail.com)

12. WEB REFERENCES:

1.http://www.slideshare,net.in
2. www.utube.com
3.https://en.m.wikipedia.org/wiki/Technological_revolution#Potential_future_technological_revolutions
4. https://www.plm.automation.siemens.com/global/en/our-story/glossary/industry-4.0/29278
5. https://www.trendmicro.com/vinfo/us/security/definition/industrial-internet-of -things-iiot
6. https//mercindia.org.in/pdf/Order%2058%2042/Order-195%20of%202017-12092018.pdf

13. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit .No	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Digitization beyond Automation	08	02	02	04	08
II	Smart Grid	08	02	04	06	12
III	Smart City (Electrical Features Only)	08	02	06	08	16
IV	Intelligent Motor control centers	12	04	06	08	18
V	Tariff systems	08	02	04	04	10
VI	Metering and Bill Management	04	02	04	-	06
TOTAL		**48**	**14**	**26**	**30**	**70**

R- Remembering, U - Understanding, A- Applying (Bloom's revised taxonomy levels)

NOTE: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of COs. The actual distribution of marks at different taxonomy levels (R, U, A) in the question paper may vary from above table.

14. COURSE EXPERT COMMITTEE MEMBERS:

Sr.NO		**Name**
1.	Internal	Shri N D Adate
2.	Internal	Ms. Urvi Sawant
3.	External	Mrs. Jyoti Waghmare
		Organization : G. P. Mumbai,