Government Polytechnic, Mumbai

Department of Electrical Engineering

P-19 Curriculum (Sandwich Pattern)

Semester-IV

(Course Contents)

GOVERNMENT POLYTECHNIC MUMBAI

(Academically Autonoums Institute, Government of Maharashtra)

Teaching and Examination Scheme (P19)

With effect from AY 2019-20

Programme: Diploma in Electrical Engineering (Sandwich Pattern) **Term / Semester - IV**

Course Code	Course Title	Teaching Hours/Contact Hours				Credits	Examination Scheme (Marks)						
							Theory			PR	OR	TW	Total
		L	P	TU	Total		TH	TS1	TS2				
EE 19 304	Electrical Estimation & Costing	4	--	2	06	06	60	20	20	--	50*	25	175
EE 19 305	Utilization of Electrical Energy	4	--	2	06	06	60	20	20	--	50*	--	150
EE 19 306	AC Machines	4	2	2	08	08	60	20	20	50*	--	50	200
EE 19 401	Fundamentals of Power Electronics	4	2		06	06	60	20	20	50*	--	--	150
EE 19 402	Special Machines (Optional)	4	2	--	06	06	60	20	20	50*	--	25	175
EE 19 403	Illumination Engineering (Optional)	4	2	--	06	06	60	20	20	50*	--	25	175
EE 19 404	Arduino# (Spoken Tutorial)	--	--	3	03#	03#	--	--	--	--	--	--	--
	Total	**20**	**06**	**09**	**35**	**35**	**300**	**100**	**100**	**150**	**100**	**100**	**850**
Total Contact Hours					**35**								

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment)

***** Indicates assessment by External Examiner else internal assessment, # indicates Self, on- line learning Mode, @ indicates on line examination

Note: Duration of Examination--TS1&TS2 -1 hour, TH- 2 hours, PR/OR – 3 hours per batch, SCA- Library - 1 hour, Sports- 2 hours, Creative Activity-2 hours

Self, on- line learning Mode through MOOCs /Spoken Tutorials / NPTEL / SWAYAM / FOSSEE etc.

Department Coordinator,
Curriculum Development,
Dept. of Electrical Engineering

Head of Department
Dept. of Electrical Engineering

In-Charge
Curriculum Development Cell

Principal

Programme : **Diploma in Electrical Engineering.**										
Course Code: EE 19 304				Course Title: Electrical Estimation & Costing						
Compulsory / Optional: C										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hr 30 Min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
04	**--**	**02**	**06**	**60**	**20**	**20**	**--**	**50#**	**25**	**175**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination

Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill tests are to be conducted. First skill test at mid-term and second skill test at the end of the term

Rationale:

Electrical Diploma holders should be able to collect the required information for estimating and costing of product of any given project. The student will be compatible to plan, draw layout and make survey to know current market rate of each component and material required. Knowledge of this subject will be helpful to work as a Contractor, an entrepreneur and execute different electrical installations. The knowledge of this course is also useful to do testing of any new installation. The IE rules related to an electrical installation are helpful while making an electrical installation and testing of an electrical installation.

Course Outcomes: Student should be able to

EE19 304.1	Follow National Electrical Code 2011 in electrical installations.
EE19 304.2	Estimate the electrical installation works
EE19 304.3	Estimate the work of non-industrial electrical installations.
EE19 304.4	Estimate the work of industrial electrical installations.
EE19 304.5	Prepare abstract, tender, quotation of public lighting and other installations.
EE19 304.6	Prepare abstract, tender, quotation of low tension (LT) substations.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Topic Title: Electric Installation and Safety.** 1.1 Scope and features of National electric code 2011 1.2 Types of electrical installation 1.3 Fundamental principles for electrical installation 1.4 Permit to work, safety instructions and safety practices 1.5 Purpose of estimating and costing. **Course Outcome: EE19 304.1 Teaching Hours : 06 hrs Marks:04 (R- 02, U-02, A-)**
2	**Topic Title: Estimation and Costing** 2.1 Meaning and purpose of- Rough estimate, detailed estimate, supplementary estimate, annual maintenance estimate and revised estimate 2.2 Factors to be considered while preparation of detailed estimate and economical execution of work 2.3 Contracts- Concepts of contracts, types of contracts, contractor, role of contractor 2.4 Tenders and Quotations- Type of tender, tender notice, preparation of tender document, and method of opening of tender 2.5 Quotation, quotation format, comparison between tender and quotation 2.6 Comparative statement, format comparative statement. Order format, placing of purchasing order. 2.7 Principles of execution of works, planning, organizing and completion of work, Billing of work **Course Outcome: EE19 304.2 Teaching Hours :14 hrs Marks:12 (R-04, U-04, A-04)**

3	**Topic Title: Non-Industrial Installations** 3.1 Types of Non-industrial installations-- Office buildings, shopping and commercial centre, residential installation, Electric service and supply 3.2 Design consideration of electrical installation in commercial buildings. 3.3 Design procedure of installation- steps involved in detail, Estimating and costing of unit 3.4 Earthing of commercial installation. 3.5 Design electrical installation scheme of commercial complex. 3.6 Erection, Inspection and testing of installation as per NEC **Course Outcome: EE19 304.3 Teaching Hours :10 Marks: 12 (R-04, U-04, A-04)**
4	**Topic Title: Industrial Installation** 4.1 Classification of industrial buildings Classification based on power consumption, 4.2 Drawing of wiring diagram and single line diagram for single phase and three phase Motors. 4.3 Design consideration in industrial installations Design procedure of installation-detailed steps 4.4 Design electrical installation scheme of factory/ small industrial unit, Preparation of material schedule and detailed estimation 4.5 Installation and estimation of agricultural pump and flourmill **Course Outcome: EE19 304.4 Teaching Hours : 10 Marks: 10 (R-, U-04, A-06)**
5	**Topic Title: Public Lighting Installation** 5.1 Classification of outdoor installations streetlight/ public lighting installation 5.2Street light pole structures. Selection of equipments, sources used in street light installations. 5.3 Cables, recommended types and sizes of cable. Control of street light installation. 5.4 Design, estimation and costing of streetlight

	5.5 Preparation of tenders and abstracts. **Course Outcome: EE19 304.5 Teaching Hours : 10 Marks: 12 (R-04, U-04, A-04)**
6	**Topic Title: Distribution Lines and LT Substation** 6.1 Introduction to overhead and underground distribution line. 6.2 Materials used for distribution line HT and LV 6.3 Cables used for distribution line, factors determining selection of LT/ HT power Cables, cable laying and cable termination method according to IS 6.4 Design, estimation and costing of HT LT overhead line and underground cabling. 6.5 Types of 11 KV Distribution substations their line diagram, Estimation of load, Load factor, diversity factor and determination of rating of distribution Transformer. 6.6 Design, estimation and costing of outdoor and indoor 11 KV substation. **Course Outcome: EE19 304.6 Teaching Hours : 10 Marks: 10 (R-02, U- 08, A-)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Electric Installation and Safety	06	02	02	--	04
2	Estimation and Costing	14	04	04	04	12
3	Non-Industrial Installations	10	04	04	04	12
4	Industrial Installation	10	--	04	06	10
5	Public Lighting Installation	10	04	04	04	12
6	Distribution Lines and LT Substation	10	02	08	--	10
	Total	**60**	**16**	**26**	**22**	**60**

Legends: R-Remember; U-Understand; A-Apply and above levels (Bloom's revised Taxonomy)

Notes: This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified.

List of Tutorials:

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	EE19 304.1	Draw sheet on circuit diagrams for various lamps and fans controlling circuit like Staircase and Go-down wiring, Distribution system,	02
2	3	EE19 304.3	Draw a sheet on different types of Earthing	02
3	3	EE19 304.2,3	Design electrical installation scheme for Flat/Independent bunglow / House: Draw Installation plan, single line diagram & wiring diagram Prepare material schedule & detailed estimate & costing	04
4	3	EE19 304.3	Design and draw wiring diagram for residential installation by using Inverter as backup supply	02
5	3	EE19 304.2,3	Design electrical Installation scheme for any one commercial Complex/Hospital/Drawing hall: Draw Installation plan, single line diagram & wiring diagram. Prepare material schedule & detailed estimate & costing	04
6	4	EE19 304.2,4	Design Electrical Installation scheme for agriculture pump room /Floor mill: Draw Installation plan, single line diagram & wiring diagram. Prepare material schedule & detailed estimate & costing	04
7	4	EE19 304.2,4	Design electrical Installation scheme for small unit/workshop/Machine Lab: Draw Installation plan, single line diagram & wiring diagram. Prepare material schedule & detailed estimate & costing	04
8	4	EE19 304.3	Draw Panel Wiring of the electrical laboratory / institute /control panel of electrical equipments.	02
9	5	EE19 304.5	Estimate with a proposal of the electrical Installation of streetlight scheme for small premises after designing.	02
10	6	EE19 304.6	Estimate with a proposal of the L.T. line installation. Prepare report and draw sheet	02
11	6	EE19 304.6	Estimate with a proposal of the 500 KVA, 11/0.433 KV outdoor substation and prepare a report	02
		Total		**30**

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Electrical Design Estimating and Costing	Raina K.B.; Dr. S. K. Bhattacharya New Age International Publisher First, Reprint 2010	ISBN: 978-81-224-0363-3
2	Electrical Estimating and Costing	Allagappan N. S. Ekambarram, Tata Mc-Graw Hill Publishing Co. Ltd,	ISBN 13: 9780074624784
3	Electrical Estimating and Costing.	Singh Surjit, Ravi Deep Singh, Dhanpat Rai and Sons.	ISBN 13:1234567150995
4	A Course in Electrical Installation Estimating and Costing	Gupta J.B. S.K. Kataria and Sons Reprint Edition,	ISBN 10: 935014279113: 978-9350142790.
5	Code of Practice for Electrical Wiring Installation	Bureau of Indian Standard. IS: 732-1989.	
6	National Electrical Code 2011	Bureau of Indian Standard. SP-30:2011.	

E-References:

1. www.howstuffworks.com 2.www.nptel.iitm.ac.in
3. www.philips.com

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
EE19 304.1	2	2	--	3	1	--	2	3	2	3
EE19 304.2	3	3	--	3	2	1	3	2	3	2
EE19 304.3	3	3	--	3	2	1	3	2	3	2
EE19 304.4	3	3	--	3	2	1	3	2	3	2
EE19 304.5	3	3	2	3	1	3	3	--	3	2
EE19 304.6	3	3	2	3	1	3	3	--	3	2

Industry Consultation Committee:

Sr. No	**Name**	**Designation**	**Institute/Organisation**
1	Mr. D.D. Rathod	Executive Engineer	MAHADISCOM
2	Prof. Jyothi Jagaldas	Selection Grade Lecturer	Saboo Siddiq Polytechnic Mumbai
3	Name of Faculty: Prof. S.B. Visvarupe A.K. Dhulshette Miss. A.V. Patil (Curriculum Content Designer)	 HOD Electrical Engg. Selection Grade Lecturer Senior Grade Lecturer	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of _____

Head of Department
Department of _____

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Electrical Engineering**										
Course Code:EE 19 305				Course Title: Utilization of Electrical Energy						
Compulsory / Optional: **C**										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hr 30 Min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
4	**-**	**2**	**6**	**60**	**20**	**20**	**-**	**50***	**-**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill test are to be conducted. First skill test at mid-term and second skill test at the end of the term.

Rationale:

The electrical supervisors / technicians are expected to possess knowledge of utilization of electrical energy especially in the industry. Their main job functions are to supervise the operation & control of various electrical drives, electrical furnaces, etc. Railway is one of the major employers of Electrical Diploma holders therefore Diploma holder should also study the electrical traction and Electric Traction system. This course deals with utilization of electrical energy in various industries.

Course Outcomes: Student should be able to

EE19 305.1	Identify suitable methods of Electric Heating & Welding for specific applications.
EE19 305.2	Select suitable Electric Motor for specific applications.
EE19 305.3	Understand various types of load & Electric drive system.
EE19 305.4	Identify the types of electric supply system for Electric Traction and calculate the parameters of the Electric Traction.
EE19 305.5	Understand basic concept & types of Elevator & Escalators.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Electrical Heating** 1.1 Advantages of Electric Heating. 1.2 Modes of Transfer of Heat 1.3 Resistance Heating: Construction & Operation of Direct Resistance Heating - Salt Bath Furnace, Indirect Resistance Heating: Resistance Ovens, Requirements of Heating Element Material, Causes of Failure of

	Heating Elements, Methods of Temperature Control, Applications of Resistance Heating, Design of Heating Element. (Simple Numerical problems on heating elements) 1.4 Arc Heating - Construction & Operation of Direct Arc Furnace, Indirect Arc Furnace. Applications of Arc Heating. 1.5 Induction Heating - Construction & Operation of Core Type Induction Furnaces: Ajax Wyatt Furnace, Coreless Induction Furnace, Applications of Induction Heating, High frequency eddy current heating. Radiant & infrared heating, Estimation of Heat data. (Simple Numerical problems on rating of furnace.) 1.6 Dielectric Heating: Principle of Dielectric Heating, Advantages of Dielectric Heating 1.7 Limitations of Dielectric Heating, Applications of Dielectric Heating **Course Outcome: EE19 305.1 Teaching Hours: 14 Marks: 14 (R- 2, U- 4, A-8)**
2	**Electric Welding** 2.1 Electric Welding: Principles of electric resistance welding. 2.2 Methods of Electric Welding – Electric arc welding, resistance welding. 2.3 Resistance Welding – Principles, Advantages, types of resistance welding. 2.4 Electric Arc Welding- Formation & Characteristics of electric arc, effects of arc length. 2.5 Principle of electric arc welding: Types, advantages, disadvantages & applications of all types. 2.6 Comparison with resistance welding & Electric Arc Welding 2.7 Modern welding techniques like Ultrasonic, Laser, under water welding, IGBT controlled welding. **Course Outcome: EE19 305.1 Teaching Hours: 10 Marks: 10 (R- 4, U- 6, A-0)**
3	**Electric Drives** 3.1 Definition and block diagram of Electric Drive 3.2 Advantages and Disadvantages of Electric Drive. 3.3 Factors Governing Selection of Electric Motors, Nature of Electric Supply - 3 phase& 1 phase AC and DC, Types of Electric Drive. 3.4 Nature of Load: Nature of the Mechanical Load, Matching of the Speed Torque Characteristics of the Motor with that of the Load, and Starting Conditions of the Load. 3.5 Braking Characteristics - Plugging, Rheostatic Braking and Regenerative Braking, as Applied to DC Series and Three Phase Induction Motor. 3.6 Mechanical Features - Type of Enclosure as per IS. Type of Bearings, Type of Transmission for Drive, Noise Level. 3.7 Size of Motor - Load Conditions - Continuous Loads, Short Time Loads, Intermittent Loads, Continuous Operation with Short Time Loads and

	Continuous Operation with Intermittent Loads. 3.8 Factors affecting size of Motor (Simple numerical). 3.9 Standard Ratings 3.10 Load equalization meaning & means of obtaining it (no calculations). 3.11 Duty Cycles & estimation of rating or size of motor **Course Outcome: EE19 305.2, EE19 305.3 Teaching Hours:14 Marks: 14 (R- 2, U- 4, A-8)**
4	**Electric Traction** 4.1 Introduction to Traction System, Requirements of an Ideal Traction System, Non-electric Traction Systems, Electric Traction Systems, Advantages and Disadvantages of Electric Traction Systems. 4.2 Systems of Track Electrification 4.3 Block diagram of AC locomotives by using three phase Induction Motor with description of various equipment and accessories 4.4 Single and compound catenary construction in railways. 4.5 Traction Mechanics: Units used in traction mechanics, Types of services, speed time curve, simplified speed time curve, Average speed and scheduled speed, Factors affecting schedule speed, Tractive effort, Specific energy consumption, Factors affecting specific energy consumption, coefficient of adhesion, simple numerical on simplified speed time curve 4.6 Working principal, advantages and disadvantages of Mono Rail and Metro Railways 4.7 Introduction of DMU and EMU **Course Outcome: EE19 305.2, EE19 305.4 Teaching Hours: 13 Marks: 14 (R- 2, U- 6, A-6)**
5	**Elevators & Escalators** 5.1 Introduction 5.2 Types of Electric Elevators 5.3 Types of Hoist Mechanism 5.4 Controlling Elevators 5.5 Components of Escalator 5.6 Working of escalator 5.7 Types of escalator 5.8 Advantages and Dis-advantages of Escalators 5.9 The Maharashtra Lifts, Escalators and Moving Walks Act,2017 **Course Outcome: EE19 305.5 Teaching Hours: 9 Marks: 8 (R- 2, U- 4, A-2)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Electric Heating	2	4	8	14
2	Electric Welding	4	6	0	10
3	Electric Drives	2	4	8	14
4	Electric Traction	2	6	6	14
5	Elevators & Escalators	2	4	2	08
	Total	**12**	**24**	**24**	**60**

List of experiments: Total 10-12 experiments(or turns) out of 15-16 experiments (or turns)

Sr. No.	Unit No	Cos	Title of the Experiments/Tutorial	Hours
1	1	EE19 305.1	Prepare a report on electrical heating furnace after visiting industry / laboratory.	2
2	2	EE19 305.1	Prepare a report on welding transformer after visiting industry / laboratory.	2
3	2	EE19 305.2, EE19 305.3	Select the appropriate motors and justify the selection for given different load situations. (at least two)	4
4	3	EE19 305.4	Prepare a report on your visit to nearby electric traction sub-station.	4
5	4	EE19 305.5	Prepare a report by observing different types of elevators at various sites / locations.	4
6	4	EE19 305.5	Prepare a report by observing different types of escalators at various sites / locations.	4
7	4	EE19 305.2, EE19 305.4	Prepare a report on various equipment's and accessories used in AC Locomotives	4
8	1	EE19 305.1	Demonstration of dielectric heating oven and write report on it.	2
9	2	EE19 305.1	Demonstration on welding generator and write report on it.	2

10	4	EE19 305.2, EE19 305.4	Prepare a report by comparing Metro and Mono Rail for public transport.	2
11	2	EE19 305.1	Prepare a report on Ultrasonic, Laser & under water welding	2
12	2	EE19 305.1	Demonstration of ARC welding and noting down the specifications of equipment used	2
Total				**32**

Note: Experiments No. 1 to 5 (or 6) are compulsory and should map all units and Cos. Remaining experiments are to be performed as per importance of the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Art & Science of Utilisation of Electrical Energy	H. Pratab; Dhanpat Rai & Sons,2015	ISBN-13: 9788177001440
2	Utilisation of Electric Power & Electric Traction	J. B. Gupta; S. K. Kataria & Sons ,2013	ISBN-13: 9789350142585
3	Utilisation of Electric Power & Electric Traction	G. C. Garg; S. K. Khanna Publisher, New Delhi, edition	ISBN-10: 8174091645 ISBN-13: 9788174091642
4	Fundamental of Electrical Drives	G. K. Dubey; Narosa Publishing House, New Delhi, latest edition	ISBN, 8173190410, 9788173190414.
5	Modern Electric Traction	H. Pratab; Dhanpat Rai & Sons	ISBN-13: 1234567147206

E-References:

1. https://www.electrical4u.com
2. https://ndl.iitkgp.ac.in/
3. https://nptel.ac.in
4. https://swayam.gov.in
5. www.khanacademy.org
6. www.youtube.com
7. www.slideshare.net

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
EE19 305.1	3	2	3	3	2	2	3	2	2	2
EE19 305.2	3	2	2	1	2	2	3	2	1	2
EE19 305.3	3	1	-	1	1	-	2	-	1	1
EE19 305.4	3	2	1	2	2	2	3	3	2	2
EE19 305.5	3	1	-	1	2	1	3	2	-	2

PO statements:

1. **Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
2. **Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.
3. **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.
4. **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
5. **Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
6. **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
7. **Life-long learning:** Ability to analyse individual needs and engage in updating in the context of technological changes.

PSO statements:

PSO1: The ability to operate, supervise, test and maintain the various machineries, electrical installations and power system equipments.

PSO2: The ability to carry out energy audit, prepare electrical estimates and costing and to read, interpret and implement electrical drawing.

PSO3: The ability to practice profession with attention to energy conservation, ethical principles, safety, environmental aspects and socially beneficial activities.

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr.Rahul H Shewale	Assistant Engineer	Mumbai Inspection Division Industry, Energy and Labour Dept. Govt Of Maharashtra Mumbai Central
2	Mr.Jayesh Mhatre	SSE/C/OHE/DR	Seewood electric traction substation, Navi Mumbai
3	Mr.L.S.Patil	Lecturer in Electrical Engineering	Govt. Polytechnic Nashik
4	Ms. Ashwini Patil	Lecturer in Electrical Engineering	Govt. Polytechnic, Mumbai
5	Dr. M. S. Narkhede	Lecturer in Electrical Engineering	Govt. Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of Electrical Engineering

Head of Department
Department of Electrical Engineering

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Electrical Engineering (Sandwich Pattern)**										
Course Code: EE 19 306				Course Title: AC Machines						
Compulsory / Optional: **C**										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hr 30 Min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
04	**02**	**02**	**08**	**60**	**20**	**20**	**50***	--	**50**	**200**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination

Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill tests are to be conducted. First skill test at mid-term and second skill test at the end of the term

Rationale:

This is the subject aspire to teach facts , concepts, principle and procedure for operation and testing of electrical machine, such as 3-phase induction motors, 3-phase synchronous generators, 3-phase synchronous motors and 1-phase induction motors. Students will be able to analyze the characteristics of 3-phase AC Machines and 3-phase Synchronous Machines with qualitative parameters of these machines. They also learn applications of 1-phase induction motors.

These machines are used in various fields, industries and many more utilization systems. Knowledge gained by the students will be helpful in the study of technological subjects such as testing and maintenance of electrical machines, utilization of electrical energy, switchgear & protection, power electronics & drives, special machines. Learning & the skills obtained will be helpful in discharging duties such as supervisor, controller, R & D technician and machine maintenance engineer.

Course Outcomes: Student should be able to

EE19 306.1	Explain various types of three phase induction motors.
EE19 306.2	Demonstrate starters, speed control methods & circle diagram of three phase induction motor.
EE19 306.3	Interprets the three phase alternators.
EE19 306.4	Comprehend three phase synchronous motors.
EE19 306.5	Select single phase induction motors.

Course Content Details:

Unit No	**Topics / Sub-Topics**

1	**Topic Title: Three Phase Induction Motors** 1.1 General information of three phase machines. 1.2 Working principle of 3-phase I.M. 1.3 Construction and types of 3- phase induction motor. 1.4 Comparison between squirrel-cage and slip-ring induction motor. 1.5 Production of rotating magnetic field. 1.6 Three phase induction motor speed, slip, frequency, rotor frequency and their relations. (Simple Numerical) 1.7 Equation of rotor induced emf, current, frequency, reactance, and impedance under steady and running condition. (Simple Numerical). 1.8 Torque equation of three phase induction motor. (Simple Numerical). 1.9 Starting and running torque of squirrel cage and slip ring induction motor. 1.10 Condition for maximum and starting torque. 1.11 Torque slip characteristics of three phase induction motor. 1.12 Effect of change in rotor circuit resistance on torque-slip characteristics. 1.13 Effect of change in supply voltage on torque-slip characteristics. 1.14 Torque Ratios (Numerical) 1.14.1 Starting torque to Maximum torque 1.14.2 Full load torque to Maximum torque 1.15 Power stages of three phase induction motor. 1.16 Relationship between rotor Cu loss, rotor input, rotor output (Numerical) **Course Outcome: EE19 306.1 Teaching Hours : 16 hrs Marks:16 (R- 2, U-6, A-8)**
2	**Topic Title: Starting, Speed Control & Circle Diagram of Three Phase Induction Motor** 2.1 Need of Starter. 2.2 Various starters used to start 3-phase IM. 2.2.1 Starting of squirrel cage and slip ring induction motor. 2.2.2 Compare starters with DOL starter (simple numerical) 2.3 Double cage 3-phase induction motor. 2.3.1 Construction 2.3.2 Concept of double cage 2.4 Speed control of three phase induction motor by-- 2.4.1 Pole Changing method 2.4.2 Frequency Control method 2.4.3 By Stator Voltage Control method 2.4.4 Rotor Resistance Control method 2.5 I.M. as a generalized transformer. 2.6 Equivalent Circuit of 3-phase IM. 2.7 Construction of Circle Diagram. 2.7.1 Importance of circle diagram 2.7.2 No load test and Blocked rotor test on 3-phase IM 2.7.3 Construction of the circle diagram. (Numerical) 2.8 Applications of three phase induction motor.

	Course Outcome: EE19 306.2 Teaching Hours : 12 hrs Marks: 14 (R- 2, U-6, A-6)
3	**Topic Title: Three Phase Alternator** 3.1 Construction of three phase Alternator. 3.1.1 Stator 3.1.2 Rotor - Smooth Cylindrical & Projected type 3.2 Advantages of stationary armature construction. 3.3 Derivation of e.m.f. equation of Alternator. (Numerical) 3.3.1 Chording (Pitch) Factor 3.3.2 Distribution Factor 3.4 Factors affecting the terminal voltage of 3-phase Alternator. 3.4.1 Armature resistance drop 3.4.2 Leakage reactance drop 3.4.3 Armature reaction drop 3.5 Significance of Synchronous Reactance & Synchronous Impedance. 3.6 Armature reaction and their effects. 3.7 Regulation of 3-phase Alternator & various methods to find regulation. 3.7.1 Direct method (Numerical) 3.7.2 Synchronous impedance method (Numerical) 3.7.3 Magneto Motive Flux (MMF) method (Numerical) 3.8 Need of Parallel Operation of 3-phase Alternator 3.8.1 Conditions to run 3-phase Alternators in parallel 3.9 Synchronizing Methods. 3.9.1 Synchronoscope method 3.9.2 One dark two bright lamp method
	Course Outcome: EE19 306.3 Teaching Hours :14 hrs Marks:14 (R- 2, U-6, A-6)
4	**Topic Title: Three Phase Synchronous Motors** 4.1 Construction of three phase synchronous motor. 4.2 Principle of operation. 4.3 Starting of synchronous motor. 4.3.1 Various methods of starting 4.4 Synchronous Motor on load with constant excitation. 4.5 Effect of change of excitation at constant load. 4.6 Power flow within a synchronous motor. 4.7 V curve & inverted V curve with their parameters. 4.8 Comparison between 3-phase induction motor & 3-phase synchronous motor. 4.9 Applications of 3-phase synchronous motor. 4.10 Hunting or Surging or Phase Swinging. 4.11 Different torques of a synchronous motor.

	Course Outcome: EE19 306.4 Teaching Hours : 12 Marks:10 (R-4, U-6, A-0)
5	**Topic Title: Single Phase Motors** 5.1 Broad classification of all 1-phase motors. 5.2 Double field revolving theory. 5.2.1 Split phasing principle of starting 5.3 Single phase induction motors & their types. 5.4 Principle of working, schematic diagram and applications of 1-phase induction motors. 5.4.1 Resistance split phase 5.4.2 Capacitor split phase 5.4.3 Capacitor split phase & run 5.4.4 Shaded pole 5.5 Comparison between 1-phase induction motor & 3-phase induction motor. **Course Outcome: EE19 306.5 Teaching Hours : 6 Marks:06 (R-2, U-4, A-0)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Three Phase Induction Motors	16	02	06	08	16
2	Starting, Speed Control & Circle Diagram of Three Phase Induction Motor	12	02	06	06	14
3	Three Phase Alternator	14	02	06	06	14
4	Three Phase Synchronous Motors	12	04	06	00	10
5	Single Phase Motors	06	02	04	00	06
	Total	**60**	**12**	**28**	**20**	**60**

Legends: R-Remember; U-Understand; A-Apply and above levels (Bloom's revised Taxonomy)
Notes: This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified.

List of Experiments: Total 10-12 experiments(or turns) out of 15-16 experiments (or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	EE19 306.1	To measure the value of slip of 3-phase induction motor by Tachometer method	02

2	1	EE19 306.1	To reverse the direction of rotation of 3-phase induction motor	02
3	1	EE19 306.1	To perform the direct load test on 3-phase induction motor	04
4	2	EE19 306.2	To use various types of starters to start and run 3-phase induction motor.	02
5	2	EE19 306.2	Study of Double Cage 3-phase induction motor	02*
6	2	EE19 306.2	Perform the No Load Test & Blocked Rotor Test on 3-Phase IM and construct the circle diagram to know its performance. (Determine the line current, power factor, & full load efficiency at rated output)	04
7	3	EE19 306.3	To perform O.C.C. of the 3-phase Alternator	02
8	3	EE19 306.3	To Determine Voltage Regulation of 3 Phase Alternator by Direct Loading.	02
9	3	EE19 306.3	To Determine voltage regulation of three-phase Alternator by Synchronous Impedance method (Z_s).	04
10	3	EE19 306.3	To perform parallel operation of 3-phase alternators	04
11	4	EE19 306.4	To start Synchronous motor by any one method. To Plot V & Inverted V Curves of a Synchronous Motor.	04
Total				

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Electrical Machines, Vol-I, II	G.C. Garg & P.S. Bimbhra, Khanna Book Publishing House, New Delhi.	ISBN: 978-9386173-447, 978-93-86173-607
2	Electrical Technology Vol-II	Theraja B.L, . S. Chand and Co. Ltd., New Delhi.	ISBN: 9788121924375
3	Electrical Machines.	Bhattacharya S. K., McGraw Hill Education, New Delhi.	ISBN: 9789332902855
4	Electrical Machines.	Kothari D. P. and Nagrath, I. J., McGraw Hill Education. New Delhi.	ISBN: 9780070699670
5	Principles of Electrical Machines.	Mehta V. K. and Mehta Rohit, . S. Chand and Co. Ltd., New Delhi.	ISBN: 9788121930888
6	Electrical Machines Theory and Practice.	Bandyopadhyay M. N., PHI Learning Pvt. Ltd., New Delhi.	ISBN: 9788120329973 Vi

E-References:

1. www.nptelvideos.in/electricalengineering/m
2. www.electrical4u.com
3. www.electrical-engineering-portal.com
4. www.learnerstv.com

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
EE19 306.1	3	2	1	2	3	1	3	3	--	3
EE19 306.2	2	2	2	3	3	1	3	3	--	3
EE19 306.3	2	2	1	2	3	1	3	3	--	3
EE19 306.4	2	2	1	2	3	1	3	3	1	3
EE19 306.5	2	2	--	1	3	1	3	3	--	3

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organization
1	Mr. Umesh Chendra Pal	Senior Manager, Electrical Design & Consultant	Thyssenkrupp Industrial Solution (formaly UHDE India)
2	Mr. Sandeep D. Tajane	Deputy Engineer, Testing Section Operation & Maintenance Dept. (North West Zone)	BEST Undertaking (Supply Division) Mumbai
3	Mr. Sunil Asthaputre	Selection Grade Lecturer	Govt. Polytechnic, Nasik
4	Mrs. R.U. Patil	Selection Grade Lecturer	VPM Polytechnic, Thane
5	Dr. P.N. Padghan	Selection Grade Lecturer	Govt. Polytechnic, Mumbai
6	Mr. A.K. Dhulshette	Selection Grade Lecturer	Govt. Polytechnic, Mumbai

Coordinator,
Curriculum Development,
Department of _____

Head of Department
Department of _____

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Electrical Engineering**										
Course Code: **EE 19 401**				Course Title: **Fundamentals of Power Electronics**						
Compulsory / Optional: **C**										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hr 30 Min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
4	**2**	**--**	**06**	**60**	**20**	**20**	**50***	**-**	**-**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill test are to be conducted. First skill test at mid term and second skill test at the end of the term

Rationale:

Power Electronics devices and circuits nowadays, in addition to its traditional roles in industrial automation and high-efficiency energy systems are also having important role in energy conservation, renewable energy systems, bulk utility energy storage, electric and hybrid vehicles. This course aims to impart the knowledge and skills to use power devices and converters in various applications.

Course Outcomes: Student should be able to

EE19401.1	Select appropriate power semiconductor device for specific application.
EE19401.2	Select appropriate turn on and turn off circuit of SCR for specific application
EE19401.3	Use appropriate power converter for specific application and drive .
EE19401.4	Troubleshoot simple gate drive and protection circuits for power devices
EE19401.5	Troubleshoot simple power electronics circuit

Course Content Details:

Unit No	Topics / Sub-topics
1	**Power Electronics Devices:** 1.1 Introduction to Power Electronics Power Electronics definition, Block diagram of power electronic system, Power semiconductor devices classification, power semiconductor devices ratings and application, Ideal switch characteristic, Desirable characteristic of real switch, 1.2 Structure, symbol, working and VI characteristic of power diode, Power Transistor, Power MOSFET and IGBT 1.3 Thyristor family: Definition of thyristor, SCR Construction, symbol, working two transistor analogy &V-I characteristics Definitions: Holding current, latching current, break over voltage

	Construction, symbol, V-I characteristics and application of LASCR, Triac, and Diac 1.4 Phase control using TRIAC : Light dimmer. **Course Outcome: EE19401.1 Teaching Hours: 12 Hrs Marks: (R-04 , U-06, A-00)**
3	**SCR turn on and turn off methods and protection circuits:** 2.1 SCR turn on methods: Voltage Triggering, Gate Triggering, dv/dt Triggering and Light Triggering, Temperature triggering. Gate triggering circuits for SCR - Circuit diagram, working principle, waveforms of • Resistor triggering • R-C triggering • UJT triggering. 2.2 Thyristor Turn off methods. a) Natural Commutation b) Forced Commutation : • Class A- Self commutation by resonating load • Class B- Self commutation by LC circuit • Class C- Complementary commutation • Class D – Auxiliary commutation • Class E – external pulse commutation 2.3 di/dt and dv/dt protection of SCR **Course Outcome:EE19401.2 Teaching Hours : 8 Hrs Marks: (R-02, U-06, A-02)**
3	**Phase Controlled Rectifier** 3.1 Difference between uncontrolled rectification and controlled rectification. 3.2 Phase control: firing angle , conduction angle 3.3 Circuit diagram, working, input output waveforms and equation for average output voltage of following (no derivation) Single Phase Fully Controlled Half Wave Converter - With Resistive Load, With RL Load and Freewheeling Diode , with RLE load. Single Phase Fully Controlled Full Wave Mid point Converter - With RL Load. Single Phase Fully Controlled Bridge Converter - With RL Load ,with RLE load Single phase semi converter: symmetrical and asymmetrical configuration with RL load 3.4 Circuit diagram, working and input output waveforms of Three Phase Fully Controlled Bridge Converter- With RL Load. 3.5 Comparison of 3 phase and 1 Phase Converters. 3.6 Simple Numerical 3.7 Application: DC drives, Speed control of DC series motor with single phase half and full controlled converter. **Course Outcome: EE19401.3 Teaching Hours: 12 Hrs. Marks:(R-02 ,U-08 , A-02)**

4	**Inverters** 4.1 Introduction. Classification of inverters according to nature of input source, method of commutation, connection of thyristor & commutating component. 4.2 Working principle & operation of Basic and modified Series inverter , Basic Parallel inverter 4.3 Circuit diagram , working ,waveforms of Single phase half bridge inverter Single phase full bridge inverter 4.4 Voltage control in single phase inverters (PWM Inverters):Different Techniques 4.5 Application: AC Drives Speed control of three phase Induction Motor with Variable frequency • Voltage source inverter fed induction motor drive. • Pulse width modulated inverter fed induction motor drive **Course Outcome:EE19401.3 Teaching Hours: 12Hrs Marks:(R- 02,U- 06 , A-02)**
5	**Choppers** 5.1 Chopper Principle 5.2 Control Techniques: • Constant Frequency System • Variable Frequency System 5.3 Step down (buck) chopper Step Up Chopper(boost) and 5.4 Circuit diagram and working of Class A, Class B, Class C, Class D and Class E choppers 5.5 Application :Chopper based DC drive for separately excited DC motor. **Course Outcome:EE19401.3 Teaching Hours :10 Hr. Marks:(R-02 , U- 08 ,A-02)**
6	**Gate Drive ,Protection of devices and circuits** 6.1 Simple gate drive circuit for BJT and MOSFET 6.2 Snubber circuit for transistors 6.3 Temperature control in semiconductor devices: Heat transfer, Thermal resistance and thermal model, Heat sink specifications 6.4 Electromagnetic Interference: Sources of EMI, Minimizing EMI generation, EMI shielding, EMI standard **Course Outcome: EE19401.4 Teaching Hours :6 Hr. Marks:(R-00,U-04 ,A-02)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	**Power Electronics Devices**	4	6	0	10
2	**SCR turn on and turn off methods and protection circuits**	2	6	2	10
3	**Phase Controlled Rectifier**	2	8	2	12
4	**Inverters**	2	6	2	10
5	**Choppers**	2	8	2	12
6	**Gate Drive ,Protection of devices and circuits**		4	02	06
	Total	**12**	**38**	**10**	**60**

List of experiments: Total 8 experiments(or turns) out of following experiments (or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	EE19401.5	Construct circuit & verify the V-I characteristic of SCR.	2
2	1	EE19401.5	Construct circuit & verify the V-I characteristic of TRIAC.	2
3	1	EE19401.5	Construct circuit & verify the V-I characteristics of power MOSFET.	2
4	1	EE19401.5	Construct circuit & verify the V-I characteristics of power IGBT	2
5	1	EE19401.5	Construct the circuit of light dimmer	2
6	2	EE19401.5	Construct circuit & observe firing angle (α) control of R , RC or UJT triggering	2
7	3	EE19401.3	Observe the output of single phase fully controlled bridge rectifier using R load and RL load	2
8	6	EE19401.4	Control of speed of Induction motor using v/f method	2
9	4,5	EE19401.5	Microproject: to be submitted in group of 5 to 6 students Construct boost converter using MOSFET on general purpose PCB ,use suitable IC for gate drive OR Construct Full bridge inverter using MOSFET on general purpose PCB ,use suitable IC for gate drive	16

			OR Construct Inverter using Arduino and MOSFET	
Total				**32**

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year of Publication	ISBN
1	Power Electronics	Dr. P.S. Bimbhra, Khanna Publisher,2012	978-81-7409-279-3
2	Power Electronics Essentials and Applications	L. Umanand, Wiley India Pvt. Ltd, 2009	978-81-265-1945-3
2	Power Electronics	M.D. Singh, K.B. Khanchandani ,McGraw Hill,2014	978-0-07-058389-4
3	Power electronics: devices, circuits, and applications	M.H.Rashid, Pearson Education Limited ,2014	978-0-273-76908-8
4	Power Electronics Devices Circuits and Industrial Applications	V.R. Moorthi, Oxford University Press ,2005	978-1-62-870877-6
6	Electronics Lab Manual (volume 2)	Navas, K. A, PHI learning Private Limited ,2018	978-9-38-802809-7

E-References:

1. https://nptel.ac.in/course.html
    a. Fundamentals of Power Electronics Prof. Vivek Agarwal, IISc Bangalore
    b. Power Electronics , Prof. Sabyasachi Sengupta,Prof. N.K. De,Prof. D.Prasad,Dr. D.Kastha IIT Kharagpur
    c. Power Electronics, Prof. G.Bhuvaneshwari, IIT Delhi

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
EE19401.1	3	3	-	3	1	-	-	2	2	2
EE19401.2	3	3	-	3	-	-	-	3	2	1
EE19401.3	3	3	1	3	-	3	3	3	2	1
EE19401.4	3	3	1	3	-	3	3	3	2	1
EE19401.5	3	3	1	3	-	3	3	3	2	1

Industry Consultation Committee:

Sr. No	Name	Designation	Institute/Organisation
1	Mr Kalpak Raut	Director , Kalpak Electro-tech	Kalpak Electro-tech, Badlapur.
2	Mr. Sandeep Ushkewar	Assistant Professor , Electrical Engineering	Shri Vile Parle Kelvani Mandal's Institute of technology Dhule
3	Mrs Nagargoje	Lecturer	Government Polytechnic, Thane
3	Name of Faculty (Curriculum Content Designer)	Mrs Vaishali Bhosale	Govt. Polytechnic Mumbai

Coordinator,
Curriculum Development,
Department of _____

Head of Department
Department of _____

I/C, Curriculum Development Cell

Principal

Programme : **Diploma in Electrical Engineering**										
Course Code: EE 19 402				Course Title: Special Machines						
Compulsory / Optional: **O**										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hr 30 Min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
4	**2**	**--**	**6**	**60**	**20**	**20**	**50***	--	**25**	**175**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination
Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill tests are to be conducted. First skill test at mid term and second skill test at the end of the term

Rationale:. In the changing scenario of today's highly automated world day by day the interest on special machines is increasing. These machines serve for several applications. Students are being introduced with special machines as these machines have wide applications in industry, robotic and automation. It is expected that the knowledge of construction, working principle, basic characteristics of these motor will make students understand the in an out of these machines, which will enable them to work comfortably in the highly changing industry.

Course Outcomes: Student should be able to

EE19 402.1	Explain the construction, working , starting methods, applications, advantages and disadvantages of 1ϕ Induction Motor
EE19 402.2	Describe the construction and working of 1ϕ synchronous motor
EE19 402.3	Describe working and phasor diagrams of AC Commutator (compensated and repulsion) motor.
EE19 402.4	Describe construction, working, classification and applications of LIM and stepping motor
EE19 402.5	Illustrate Principle of operation and applications of Advanced Electrical Machines

Course Content Details:

Unit No	Topics / Sub-topics
01	**Single Phase Induction Motors:** 1.1 Constructional details 1.2 Revolving field theory 1.3 Classification 1.4 Starting methods for Split Phase, Shaded Pole, Repulsion, Reluctance motors 1.5 Comparison with 3ϕ induction motors 1.6 Characteristics of split phase, shaded pole, repulsion, reluctance type 1ϕ induction motor and their applications. **Course Outcome: EE19 402.1 Teaching Hours :10 Marks: 14 (R-06 , U-04 , A-04)**

02	**Single Phase Synchronous Motors:** Working principle, construction and applications of…. 2.1 1ϕ Reluctance Motor 2.2 Hysteresis motor 2.3 2ϕ servo motor 2.4 AC tachometers **Course Outcome: EE19 402.2 Teaching Hours :08 Marks: 08 (R-02 , U-02 , A-04)**
03	**AC Commutator Machines:** 3.1 Necessity/ advantages of AC commutator motors 3.2 EMFs induced in commutator windings (E_r and E_t) 3.3 Emfs produced by rotating magnetic field E_{RT} 3.4 Torque Expression 3.5 Commutation in AC machines and EMF's under commutation 3.6 1ϕ Series Motors. 3.7 Phasor Diagram & Simplified Phasor Diagram (no derivation) 3.8 Compensated AC series motor 3.9 Phasor Diagram & Simplified Phasor Diagram (no derivation) 3.10Repulsion motor, Phasor Diagram & Simplified Phasor Diagram (no derivation) **Course Outcome: EE19 402.3 Teaching Hours :09 Marks: 12 (R-06 , U-04 , A-02)**
04	**Linear Induction and Stepper motors:** 4.1 Classification, Construction and Working of linear induction motor. 4.2 Comparison between LIM and RIM (Advantages, disadvantages of LIM) 4.3 Derivation of linear force 4.4 Applications of linear Induction motor 4.5 Construction and Working of Stepper motor 4.6 Variable reluctance type, Permanent magnet type & Hybrid stepper motor. **4.7** Applications of Stepper Motor **Course Outcome: EE19 402.4 Teaching Hours :08 Marks: 12 (R-06 , U-04 , A-02)**
05	**Advanced Electrical Machines:** 5.1 Synchronous Reluctance Motors, Constructional features – Types – Axial and radial air gap motors – Operating principle, Applications 5.2 Switched Reluctance Motors, Constructional features – Principle of operation, Applications 5.3 Permanent Magnet Brushless DC Motors, Principle of operation Types and Applications 5.4 Permanent Magnet Synchronous Motors, Principle of operation – EMF and torque equations, Applications 5.5 Amorphous core transformer 5.6 Introduction of soft starters **Course Outcome: EE19 402.5 Teaching Hours :10 Marks: 14 (R-08 , U-04 , A-02)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Single Phase Induction Motors	06	04	04	14
2	Single Phase Synchronous Motors	02	02	04	08

3	AC Commutator Machines	06	04	02	12
4	Linear Induction and Stepper motors	06	04	02	12
5	Advanced Electrical Machines	08	04	02	14
	Total	28	18	14	60

List of experiments: Total 10-12 experiments (or turns) out of 15-16 experiments (or turns)

Sr. No.	Unit No.	COs	Experiment/Assignment	Approx. Hours
1	**1**	EE19 402.1	Plot torque speed characteristics of single-phase capacitor start induction run induction motor by conducting brake test on the motor	**02**
2	**2**	EE19 402.2	Plot torque speed characteristic of reluctance motor by conducting brake test on the motor	**02**
3	**3**	EE19 402.3	Plot torque speed characteristic of repulsion motor by conducting brake test on the motor	**04**
4	**4**	EE19 402.4	Demonstration of speed and reversal of direction of stepper motor	**02**
5	**5**	EE19 402.5	Demonstration of Permanent Magnet Brushless DC Motor	**02**
6	**1**	EE19 402.1	Plot torque speed characteristic of single-phase capacitor start and run induction motor by conducting brake test on the motor.	**04**
7	**1**	EE19 402.1	Plot torque speed characteristics of shaded pole induction motor by conducting brake test on the motor.	**02**
8	**2**	EE19 402.2	Plot torque speed characteristic of Hysteresis motor by conducting brake test on the motor	**04**
9	**1**	EE19 402.1	To change the direction of Repulsion motor	**04**
10	**1**	EE19 402.1	Dismantling and reassembling of single-phase motors used for ceiling fans or universal motor for mixer	**04**
				30

Note: Experiments No. 1 to 5 are compulsory and should map all units and Cos. Remaining experiments are to be performed as per importance of the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	The Performance and Design of Alternating Current Machines	M.G.Say, CBS Publishers, New Delhi, 1st Ebook Edition 2017	eISBN: 978-93-891-8507-2
2	Generalized theory of Electrical Machines	Dr. P. S. Bimbhra, Khanna Publishers, 6th Edition	ISBN-13: 978-81-7409-225-0
3	Electrical Machines	S. K. Bhattacharya, Tata McGraw Hill, 3rd Edition	ISBN-13:978-0-07-066921-5 ISBN-10: 0-07-066921-X
4	Performance & Design Of AC Commutator Motors	E Openshaw Taylor, Ah Wheeler & Co Ltd, 2000	ISBN-13:978-81-8561-481-6
5	A Text book of Electrical Technology – Volume II	BL Theraja & AK Theraja, S Chand; Twenty Third Edition (1 January 1959)	ISBN-978-81-2192-437-5

E-References:

1. https://ndl.iitkgp.ac.in/

2. https://circuitglobe.com/working-principle-of-single-phase-induction-motor.html
3. https://www.elprocus.com/single-phase-induction-motor/

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
EE19 402.1	3	3	2	-	3	-	1	3	1	1
EE19 402.2	3	3	2	-	3	-	1	3	1	1
EE19 402.3	3	3	3	-	3	-	1	3	1	1
EE19 402.4	3	3	3	-	3	-	1	3	1	1
EE19 402.5	3	3	3	-	3	-	1	3	1	1

Industry Consultation Committee:

Sr. No	**Name**	**Designation**	**Institute/Organisation**
1	Mr. Kiran Wani	Sr Manager	Reliance communications Ltd, Nashik.
2	Mr Sanket Kalbere	Asst. Manager (Power)	KRajehja Corporation, Mumbai
3	Mr. K.L.Inamdar	COE	Pillai HOC Polytechnic, Rasayani, Raigad
4	Mrs. Papiya Chandra	LEE	MHSS Polytechnic, Bycullla, Mumbai
5	Dr.Mahesh S.Narkhede	LEE	Govt. Polytechnic Mumbai
6	Dr.P.N.Padghan	LEE	Govt. Polytechnic Mumbai

Coordinator, Head of Department
Curriculum Development, Department of Electrical Engineering
Department of Electrical Engineering
I/C, Curriculum Development Cell Principal

Programme : **Diploma in Electrical Engineering**										
Course Code: **EE 19 403**				Course Title: **Illumination Engineering**						
Compulsory / Optional: **O**										
Teaching Scheme and Credits				Examination Scheme						
L	P	TU	Total	TH (2 Hr 30 Min)	TS1 (1 Hr)	TS2 (1Hr)	PR	OR	TW	Total
4	**2**	**-**	**6**	**60**	**20**	**20**	**50***	**-**	**25**	**150**

Abbreviations: L- Theory Lecture, P-Practical, TU-Tutorial, TH- Theory Paper TS1 & TS2- Term Tests, PR-Practical, OR-Oral, TW: Term Work (progressive assessment) , * Indicates assessment by External Examiner else internal practical skill test , # indicates Self, on- line learning Mode, @ indicates on line examination

Note: For Minimum passing marks under various heads, refer, examination rule AR 26. Two practical skill test are to be conducted. First skill test at mid-term and second skill test at the end of the term.

Rationale:

This course is designed to teach students various concepts of Illumination Engineering. Students shall apply the basic illuminations laws. The students should be able to apply the acquired knowledge in designing the schemes. With changing needs of the society students shall be able to fulfil the optimized solution considering the need of energy conservation. The students should be able to take care the needs of various sectors of the society in illumination area.

Course Outcomes: Student should be able to

EE 19 403.1	State the meaning of terms used in illumination engineering.
EE 19 403.2	Describe the working of different types of lamps with the applications.
EE 19 403.3	Explain Illumination Control & Control Circuits.
EE 19 403.4	Realize the requirements of the Illumination schemes for Interior , Outdoor & special applications.
EE 19 403.5	Prepare Illumination schemes for Interior application.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Fundamentals of Illumination:** 1.1.Fundamentals of Illumination 1.2.Illumination terminology: Illumination, Light intensity, Lumen, Lux 1.3.Laws of Illumination (Simple numerical) 1.4.Concept of Photometry 1.5.Measurement of Illumination 1.6.Features of good Illumination scheme

	1.7.Biological effect of artificial illumination , Light pollution **Course Outcome: EE 19 403.1 Teaching Hours : 08 Marks: 10 (R- 4, U- 4, A-2)**
2	**Lamps & Lighting calculation methods:** 2.1 Types of Lights a. Visible light b. Ultraviolet light c. Infrared light 2.2 Construction, working principle advantages and disadvantages of all types of lamps a. Incandescent lamp b. ARC lamps – ac &dc arc lamp c. Fluorescent lamp d. Mercury vapour lamp, HPMV lamp, Mercury iodide lamp e. Sodium vapour lamp f. Neon lamp, Neon Sign Tubes g. Halogen lamp h. CFL Lamps i. Metal halides lamp j. LED lamps k. Lasers l. Selection criterion for lamps 2.3 Comparison between incandescent & Florescent lamps 2.4 Lighting schemes: selection of lamp, illumination efficiency, glare & power consumption a. Direct & Indirect b. Semi direct & semi indirect c. General lighting scheme 2.5 Lighting calculation methods a. Watt/m2 method b. Lumens or light flux method c. Point to point method (simple numerical) **Course Outcome: EE 19 403.2, EE 19 403.5** **Teaching Hours :14 Marks: 12 (R- 4,U- 4, A-4)**
3	**Illumination Control & Control Circuits:** 3.1 Purpose of lighting control 3.2 Working principle and operation of: a) Dimmer i) Resistance type dimmer ii) Salt water dimmer b) Dimmer Transformer i) Autotransformer dimmer ii) Two winding transformer dimmer c) Electronic Dimmer

	i) Thyristor operated dimmer ii) Triac operated dimmer 3.3 Control of enhance lightning 3.4 Methods used for light control 3.5 Control circuits for lamps: single lamp controlled by single switch, two switches 3.6 Single lamp controlled by two-point method, three-point method & four-point method. 3.1 Polar curve: its meaning and applications for designing the lamps **Course Outcome: EE 19 403.3 Teaching Hours : 08 Marks: 08 (R- 4, U- 4, A-0)**
4	**Illumination for Interior Applications:** 4.1 Standards for various situations in Interior Illumination 4.2 Methods for Designing illumination schemes 4.3 Design considerations for Interior location of Residential Commercial, Industrial premises 4.4 Design Illumination scheme for different Interior locations of Residential, Commercial, Industrial unit 4.5 Numericals on above sub topics **Course Outcome: EE 19 403.4, EE 19 403.5** **Teaching Hours : 12 Marks: 12 (R- 4, U- 4, A-4)**
5	**Illumination for Outdoor Applications:** 5.1. General and specific requirements for lighting schemes of a) Factory Lighting b) Street Lighting c) Flood Lighting d) Railway Platform Lighting e) Lighting for Advertisement / Hoardings f) Sports Lighting **Course Outcome: EE 19 403.4 Teaching Hours : 12 Marks: 12 (R- 4, U- 4, A-4)**
6	**Lighting for Special Applications** 6.1.Lighting schemes and general requirements for: a) Agricultural & Horticultural applications b) Health Care Centers and Hospitals c) Decorative lighting d) Stage lighting **e)** Aquariums and Shipyards **Course Outcome: EE 19 403.4 Teaching Hours : 06 Marks: 06 (R- 4, U- 2, A-0)**

Suggested Specifications Table (Theory):

Unit No	Topic Title	Distribution of Theory Marks			
		R Level	U Level	A Level	Total Marks
1	Fundamentals of Illumination	4	4	2	10
2	Lamps & Lighting Accessories	4	4	4	12
3	Illumination Control & Control Circuits	4	4	0	08
4	Illumination for Interior Applications	4	4	4	12
5	Illumination for Outdoor Applications	4	4	4	12
6	Lighting for Special Applications	4	2	0	06
	Total	**24**	**22**	**14**	**60**

List of experiments: Total 10-12 experiments (or turns) out of 15-16 experiments (or turns)

Sr. No.	Unit No	COs	Title of the Experiments	Hours
1	1	EE 19 403.1	Measure illumination by lux meter for different locations.	2
2	2	EE 19 403.2	Prepare a report on Market survey for various lighting accessories.	4
3	2	EE 19 403.2	Prepare a report on different lamps , their working & applications.	4
4	3	EE 19 403.3	Assignment to draw a control circuits for different situations as per requirement.	2
5	4	EE 19 403.4, EE 19 403.5	Design an Illumination scheme for a conference room of medium size.	4
6	4	EE 19 403.4, EE 19 403.5	Design an Illumination scheme for a workshop for fine work of medium size.	4
7	4	EE 19 403.4, EE 19 403.5	Design an Illumination scheme for a Electrical Machine Laboratory.	4
8	4	EE 19 403.4, EE 19 403.5	Design Illumination scheme for Residential Installation.	2
9	5	EE 19 403.4	Prepare a report on Illumination Scheme of Stadium.	2
10	5	EE 19 403.4	Prepare a report on Illumination Scheme of flood lighting.	2
11	5	EE 19 403.4	Prepare a report on Illumination Scheme of Street lighting.	2
12	5	EE 19 403.4	Prepare a report on Illumination Scheme of Railway platform.	2
13	6	EE 19 403.4	Prepare a report on Illumination Scheme of Agricultural & Horticultural applications.	2
14	6	EE 19 403.4	Prepare a report on Illumination Scheme of Aquariums and Shipyards.	2

15	6	EE 19 403.4	Prepare a report on Illumination Scheme of Health Care Centers and Hospitals.	4
Total				**34**

Note: Experiments No. 1 to 5 (or 6) are compulsory and should map all units and Cos. Remaining experiments are to be performed as per importance of the topic.

References/ Books:

Sr. No.	Title	Author, Publisher, Edition and Year Of publication	ISBN
1	Applied Illumination Engineering	Jack L Lindsey. The Fairmont Pres Inc.	ISBN-10: 0137428006 ISBN-13: 978-0137428007
2	Lighting Engineering and applied calculations	R.H.Simons & Robert Bean. Architectural Press	ISBN-0750650516
3	Handbook of Industrial Lighting	Butterworths, Styanley N Lyons	ASIN: B01D8T1N3C
4	Lighting Control Technology and Applications	Robert S Simpson. Focal Press	ISBN-10: 0240515668 ISBN-13: 978-0240515663
5	Energy Management in Illuminating systems	Kao Chen. CRC Press	ISBN-10: 0849326281 ISBN-13: 978-0849326288
6	Electrical Power System	Dr. S. L. Uppal ,Prof. S. Rao , Khanna Publisher, New Delhi.	ISBN-10: 8174092382 ISBN-13: 978-8174092380
7	A course in Electrical Power	Soni, Gupta, Bhatnagar , Dhanpat Rai & Sons	ISBN-10: 8177000209 ISBN-13: 978-8177000207

E-References:

1. https://www.electrical4u.com/electrical-engineering-articles/illumination-engineering/
2. https://ndl.iitkgp.ac.in/
3. https://nptel.ac.in
4. https://swayam.gov.in
5. www.khanacademy.org
6. www.youtube.com
7. www.bee-india.nic.in/ecourses.aec.edu.in

CO Vs PO and CO Vs PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
EE 19 403.1	3	-	-	2	-	-	1	1	-	1
EE 19 403.2	3	1	-	-	-	-	3	2	-	3

EE 19 403.3	3	1	-	2	2	-	2	2	3	3
EE 19 403.4	3	2	2	1	2	2	2	3	3	3
EE 19 403.5	3	3	3	1	2	1	2	3	3	3

Industry Consultation Committee:

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Head of Department
Department of Electrical Engineering

I/C, Curriculum Development Cell

Principal

Programme: Electrical Engg. **Semester-IV**

EE 19 404 Arduino (17)

1. **Overview of Arduino**

   Outline: Learning objectives of Arduino Prerequisites for learning Basic level Arduino tutorials Prerequisites for learning Intermediate level Arduino tutorials Who can use Arduino? Gli.

2. **Electronic components & connections**

   Outline: Breadboard and its internal connections LED and its connections Tri-color LED Resistor Simple circuit using LED, resistor and breadboard Common mistakes when using breadboard.

3. **Introduction to Arduino**

   Outline: About Arduino device Features of Arduino Components of Arduino board Description of Microcontrollers Few examples where a Microcontroller is used Installation of Arduino IDE o.

4. **Arduino components & IDE**

   Outline: Set up a physical connection between Arduino and a computer Connect the Arduino board to the computer using the USB cable Various components available in Arduino hardware.

5. **First Arduino Programme**

   Outline: Write an Arduino program to blink an LED Arduino program is saved as Sketch Default program environment with two empty functions - void setup - functi.

6. **Arduino with Tricolor LED & Push button**

   Outline: Tricolor LED - Common Cathode Tricolor LED Other external devices that are required for this experiment Understand the connection circuit details Connect a tricolor LED to Ardu.

7. **Arduino with LCD**

   Outline: Connect an LCD to Arduino board See the details of the circuit connection See how to do the soldering Setup the components as per th.

8. **Display counter using Arduino**

   Outline: Connect an LCD and a Push button to Arduino board. Use the same circuit created earlier using Arduino and LCD Add a pushbutton and make a simple counter Learn the connection ci.

9. **Seven Segment Display**

Outline: Connect a seven segment display to Arduino board Types of seven segment display Connection details of common cathode seven segment display Connection details of common anode sev.

10. Pulse Width Modulation

Outline: About Pulse Width Modulation About duty cycle and frequency Formula to calculate the duty cycle Experiment to control the brightness of LED by varying the duty cycle Experiment.

11. Analog & Digital Conversion

Outline: About DHT11 sensor Arduino resolution concepts Circuit connection details of DHT11 sensor and Arduino Features of DHT11 Live setup of the connection Download the DHT11 Arduino.

12. Wireless Connectivity to Arduino

Outline: About ESP8266-01 WiFi module Various pins of ESP8266-01 WiFi module Circuit connection of ESP8266 - 01 module with Arduino Live setup of the connection Setup the read-write per.

13. Assembly programming through Arduino

Outline: Write an assembly program to display a digit on seven segment display Arduino - Assembly code reference Arduino ATmega328 Pin mapping Connection circuit details Installing AVR.

14. Digital Logic Design with Arduino

Outline: Write an assembly to verify the logical AND operation Use the m328Pdef.inc file that is available in the code files link of this tutorial. Explanation of the Source code for logi.

15. AVR-GCC programming through Arduino

Outline: Write an assembly program to display a digit on seven segment display Arduino - Assembly code reference Arduino ATmega328 Pin mapping Connection circuit details Installing AVR.

16. Interfacing LCD through AVR-GCC programming

Outline: Interface a LCD to Arduino board Pin connections details of the Arduino and LCD Image showing the connections Live set up of the connections Write an AVR-GCC program to display.

17. Mixing Assembly & C-programming

Outline: Combining Assembly and C programming Explanation of the circuit connections Live setup of the connection Assembly routine program which initialises and sets pin 13 of Arduino as.