DEPARTMENT OF TECHNICAL EDUCATION (DIPLOMA SECTOR)
UTTAR PRADESH

CURRICULUM FOR DIPLOMA PROGRAMME
IN
ELECTRICAL ENGINEERING

(3rd to 4th Semester)

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Semester System

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YEAR 2025-2026

Prepared By:

INSTITUTE OF RESEARCH DEVELOPMENT & TRAINING, U.P., KANPUR

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THIRD SEMESTER

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PREFACE

An important issue generally debated amongst the planners and educator's world over is how technical education can contribute to sustainable development of the societies struggling hard to come in the same bracket as that of the developed nations. The rapid industrialization and globalization has created an environment for free flow of information and technology through fast and efficient means. This has led to shrinking of the world, bringing people from different culture and environment together and giving rise to the concept of world turning into a global village. In India, a shift has taken place from the forgettable years of closed economy to knowledge based and opens economy in the last few decades. To cope with the challenges of handling new technologies, materials and methods, we have to develop human resources having appropriate professional knowledge, skills and attitude. Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Now it is time to consolidate and infuse quality aspect through developing human resources, in the delivery system. Polytechnics play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives are being taken by the State Board of Technical Education, UP to revise the existing curricula as per the needs of the industry and make NSQF compliant.

In order to meet the requirements of future technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of diploma programmes. The curricula for diploma programmes have been revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of diploma programme.

The real success of the diploma programme depends upon its effective implementation. However best the curriculum document is designed, if that is not implemented properly, the output will not be as expected. In addition to acquisition of appropriate physical resources, the availability of motivated, competent and qualified faculty is essential for effective implementation of the curricula.

It is expected of the polytechnics to carry out job market research on a continuous basis to identify the new skill requirements, reduce or remove outdated and redundant courses, develop innovative methods of course offering and thereby infuse the much-needed dynamism in the system.

F.R. Khan
Director
Institute of Research Development & Training

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2. SALIENT FEATURES

1. Name of the Programme	➢ Diploma in Electrical Engineering
2. Duration of the Programme	➢ Three years (Six Semesters)
3. Entry Qualification	➢ Matriculation or equivalent NEP-2020/NSQF Level 5 as Prescribed by State Board of Technical Education, U.P.
4. Pattern of the Programme	➢ Semester System
5. Ratio between theory and Practice	➢ 40% (Theory) / 60% (Practical)

1) <u>Industrial Training/Internship:</u>

Four and six weeks of industrial training is made mandatory after the II and IV semesters during summer vacation. Total marks allotted to industrial training will be respectively 50 & 100.

In the last (6^{th} Semester) we have made the one semester Industrial training/Internship as optional along with usual classroom training.

2) <u>Audit & Pathways</u>:

As per AICTE and NEP-2020 directives, Essence of Indian Knowledge & Tradition, Indian Constitution, Entrepreneurship & Startup, subjects on Environmental Studies have been incorporated in the curriculum.

3) <u>Student Centered Activities</u>:

A provision of 4-8 hrs. per week has been made for organizing Student Centered Activities for overall personality development of students. Such activities will comprise co– curricular activities such as expert lectures, classroom seminars, games, hobby club like photography, painting, singing etc. declamation contests, field visits, NCC, NSS and other cultural activities, etc.

4) <u>Project work:</u>

Micro/Mini/Major project work has been included in the curriculum to enable the student to get familiarized with the practices and procedures being followed in the industries and provide an opportunity to work on some live projects in the industry.

3. EMPLOYMENT OPPORTUNITIES OF DIPLOMA HOLDERS IN ELECTRICAL ENGINEERING

Keeping present scenario in view following employment opportunities are visualized in different sectors of employment for diploma holders in Electrical Engineering

1. MANUFACTURING INDUSTRY

The Electrical diploma holder will be able to execute following activities:

- Planning and execution for Electrical installation
- Electrical installations and Maintenance of DG Set
- Electrical Power Distribution and Maintenance
- Maintenance of Industrial Electrical System
- Repair and Maintenance of Electrical Machines and Equipment
- Quality Control for Electrical systems
- Energy Conservation
- Assistance in Research and Development
- Assistance in Planning, Designing and Detailing
- Shop-floor Management
- Electrical Safety Measures
- Estimate for Electrical Installations
- Inventory Management
- Marketing and Sales
- Use of PLC and Microcontrollers.

2. GOVERNMENT DEPARTMENTS SUCH AS ELECTRICITY BOARD, MES, PWD, RAILWAYS, AIRBASES, AIRPORTS, DEFENCE, THERMAL, HYDRO AND NUCLEAR POWER STATIONS AND OTHER BOARDS AND CORPORATIONS

The Electrical diploma holder will be able to execute following type of activities in above mentioned Government Departments:

- Assistance in Planning and Design of Electrical generation, transmission, distribution and protection system including testing, quality control
- Estimating for electrical installation
- Construction, erection and commissioning of lines and Sub-stations
- Electrical Safety measures
- Operation and Maintenance of Lines and Sub-stations/underground cables
- Tariffs and Calculations of bills for consumption of electricity
- Inventory Management
- Repair and Maintenance of Electrical Machines/Equipment
- Assist in Operation and maintenance of Generating and sub-stations
- Preventive maintenance and condition monitoring
- Programming of PLC
- Electric Traction Systems
- Hospitals, Commercial Complexes, Service Sector Organizations like Hotels, Tourist-Resorts, high-rise buildings, Cinema/Theater Halls etc.
- The diploma holder in electrical engineering will be involved in following type of activities in above mentioned Service Sector Organizations:
- Lay out of wiring circuit, planning and execution for Electrical Installation
- Standby or captive Power Generation and its Distribution
- Maintenance of Electrical and Electronic Equipment

- Preventive maintenance of Electrical Systems of Lifts, Air-Conditioning Plants etc.
- Inventory Management
- Estimation for electrical repair and maintenance work

3. SELF-EMPLOYMENT

Following type of self-employment opportunities are available to the diploma holder in electrical engineering:

- Trading of Electrical Goods
- Establishing Repair and Maintenance Unit/Centre
- Free Lancer for Repair and Maintenance of House-hold Electrical and Electronic Gadgets such as: Washing Machines, Geysers, Air Conditioners, Coolers and electrical installations etc.
- Electrical contractor
- Motor Winding Unit
- Auto-electrical Work
- Service sector (AMC)
- Micro controller-based systems for different applications

4. (A) PROGRAM OUTCOMES (POS)

PO1: Basics and Discipline specific Knowledge
Assimilate knowledge of basic mathematics, science, engineering fundamentals, and Electrical Engineering.

PO2: Problem's Analysis and solution
Identify, analyze and solve problems using standard methods and established techniques.

PO3: Design and Development
Design solutions for technical problems.
Assist in designing components, systems, or processes to meet specific requirements.

PO4: Engineering Tools, Experimentation, and Testing

Use modern engineering tools and appropriate techniques to conduct experiments as per BIS standard.

PO5: Socio/ Economic /Environmental impact assessment/remedy.

Apply relevant technologies while considering societal needs, environmental impact keeping in view sustainable and ethical responsibilities.

PO6: Project Management and Communication
Apply engineering management principles, work effectively as an individual or in a team, and communicate clearly on activities.

PO7: Lifelong Learning
Recognize the importance of continuous learning and actively pursue self-improvement to keep pace with technological developments.

4. (B) LEARNING OUTCOMES OF THE PROGRAM

After undergoing this program, students will be able to:	
1.	Maintain the efficient operation of various types of Biomass and Micro hydro power plants.
2.	Repair and maintain of Electric Vehicles and Hybrid Electric Vehicles.
3.	Understand the precautions and awareness regarding various disasters
4.	Prepare accounting records and summarize and interpret the accounting data for managerial decisions.
5.	Understand the history, principles, and key interpretations of the Indian Constitution.
6.	Use cutting tools and tooling for fabrication of jobs by following safe practices during work
7.	Use appropriate procedures for preventing environmental pollution and energy conservation
8.	Analyse AC circuits and apply electromagnetic induction principles in various Electrical equipment and machines
9.	Test various active and passive components like resistor, inductor, capacitor, diode, transistor and use the amplifier and voltage stabilizer
10.	Select and use right kind of quality of electrical material required for a particular Operation.
11.	Plan and execute given task/project as team member/leader
12.	Read and interpret drawings related to electrical machines, equipment and wiring installations
13.	Assemble distribution and extension boards and construct alarm and indicating Circuits using relays, bells and push buttons
14.	Operate and maintain DC shunt, series and compound motors and three phase transformers
15.	Use measuring instruments, tools and testing devices for varied field applications
16.	Repair and maintain UPS and storage batteries and control speed of DC shunt Motor and universal motor
17.	Design and use flip-flops, A/D and D/A converters in digital circuits
18.	Use MAT LAB, SCI LAB for designing and finding solutions to problems related To electrical systems
19.	Programme and develop micro controller-based systems with LED/SWITCH
20.	Use of PLC and make suitable ladder logic programmes for different applications
21.	Operate and maintain indoor and outdoor sub stations and prepare estimate for HT/LT (OH and underground cables) lines
22.	Operate and demonstrate micro controller and PLC based systems in electrical Control

	circuits for domestic and industrial processes
23.	Design cable trenches, lay underground cables and find faults in transmission/Distribution system
24.	Estimate and determine the cost of wiring installation, HT/LT overhead lines, Pole Mounted Substation and prepare a tender document for a particular job
25.	Plan and execute minor projects related to electrical engineering
26.	Handle electrical energy-based equipment for electric traction systems
27.	Manage resources effectively at the workplace
28.	Use measuring instruments for measurement of electrical or non-electrical quantities
29.	Apply the working principle of a mini hydro plant, fuel cells, thermos electric power, geothermal and tidal energy conversion methods
30.	Trouble shoot various auto electrical faults
31.	Apply all the knowledge and skill gained through various courses in solving a live problem/project in the industry
32.	Test and install various electrical equipment and machines

5. ABSTRACT OF CURRICULUM AREAS

5.1. PROGRAM CORE COURSES

5.1.1. Basics Of Power Generation Systems
5.1.2. Electric Machine- 1
5.1.3. Electrical Circuits
5.1.4. Electrical And Electronic Measurements
5.1.5. Electric Machine- 1 (Lab)
5.1.6. (Open Elective-1*) Advance Skill Certification

5.1.7. Summer Internship** (4 Weeks)
5.1.8. Electric Power Transmission and Distribution
5.1.9. Electric Machine- II
5.1.10. Fundamentals Of Power Electronics
5.1.11. Program Elective -1
5.1.11.1. Industrial Automation and Control
OR
5.1.11.2. Industrial Instrumentation and Condition Monitoring
5.1.12. Program Elective -2
5.1.12.1. Renewable Energy Power Plants
5.1.12.2. OR
5.1.12.3. Biomass and Micro-Hydro Power Plants
5.1.13. Electric Machine- II
5.1.14. (Open Elective-2*) Advance Skill Certification

5.1.15. Switch Gear and Protection
5.1.16. Program Elective-3
5.1.16.1. Solar Power Technologies
5.1.16.2. OR
5.1.16.3. Electric Traction

5.1.16.4. Energy Conservation And Audit

5.1.17. Program Elective-4
5.1.17.1. Electrical Estimation And Contracting
5.1.17.2. OR
5.1.17.3. Electrical Testing and Commissioning
5.1.18. Electrical Estimation and Contracting
5.1.19. Summer Internship** (6 Weeks)
5.1.20. Building Electrification
5.1.21. Entrepreneurship And Start-Up
5.1.22. (Open Elective-3*) Advance Skill Certification

5.2. PROJECT WORK, SEMINAR & INTERNSHIP IN INDUSTRY

Internship / In-House Project/ Industrial Training

5.3. AUDIT COURSES

5.3.1. Essence of Indian Knowledge and Tradition

5.3.2. Indian Constitution

6. STUDY AND EVALUATION SCHEME FOR ELECTRICALENGINEERING (328)

THIRD SEMESTER

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
3.1	BASICS OF POWER GENERATION SYSTEMS	PROGRAM CORE (THEORY)	03	-	-	3	40	-	40	60	3	-	-	60	100
3.2	ELECTRIC MACHINE- 1	PROGRAM CORE (THEORY)	04	-	-	4	40	-	40	60	3	-	-	60	100
3.3	ELECTRICAL CIRCUITS	PROGRAM CORE (PRACTICUM)	01	-	04	3	-	60	60	-	-	40	3	40	100
3.4	ELECTRICAL AND ELECTRONIC MEASUREMENTS	PROGRAM CORE (PRACTICUM)	02	-	04	4	-	60	60	-	-	40	3	40	100
3.5	ELECTRIC MACHINE- 1 (Lab)	PROGRAM CORE (PRACTICAL)	-	-	04	2	-	60	60	-	-	40	3	40	100
3.6	ADVANCE SKILL CERTIFICATION	OPEN ELECTIVE-1*	02	-	-	2	-	-	-	-	-	-	-	-	NA
3.7	SUMMER INTERNSHIP** (4 WEEKS)		-	-	04	2	-	50*	50*	-	-	-	-	-	50*
#STUDENT CENTERED ACTIVITIES			-	-	08	-	-	50	50	-	-	-	-	-	50
Total			**12**		**24**	**20**	**80**	**280**	**360**	**120**		**120**		**240**	**600**

* Students can earn 2 credits for Open Elective courses either by completing a relevant certification from recognized external platforms such as TATA Technologies, NPTEL, or similar, upon submission and verification of the certificate; or by completing the course offered by their own polytechnic institute, in which case credits will be awarded based on internal assessment. conducted by the institute.** Students will present a seminar on their summer internship along with certificate, project and report.

Student Centered Activitieswillcompriseofco-curricularactivitieslikeextensionlectures,games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C.,NSS, library, Cultural Activities and self-study etc.

FOURTH SEMESTER **(328) ELECTRICALENGINEERING**

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKSINEVALUATIONSCHEME								Total Marks of Internal & External
							INTERNALASSESSMENT			EXTERNALASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
4.1	ELECTRIC POWER TRANSMISSION AND DISTRIBUTION	PROGRAM CORE (THEORY)	03	-	-	3	40	-	40	60	3	-	-	60	100
4.2	ELECTRIC MACHINE- II	PROGRAM CORE (THEORY)	03	-	-	3	40	-	40	60	3	-	-	60	100
4.3	FUNDAMENTALS OF POWER ELECTRONICS	PROGRAM CORE (PRACTICUM)	02	-	04	4	-	60	60	-	-	40	3	40	100
4.4	PROGRAM ELECTIVE -1	PROGRAM CORE (PRACTICUM)	01		04	3	-	60	60	-	-	40	3	40	100
4.5	PROGRAM ELECTIVE -2	PROGRAM CORE (THEORY)	03		-	3	40	-	40	60	3			60	100
4.6	ELECTRIC MACHINE- II (Lab)	PROGRAM CORE (PRACTICAL)	-	-	04	2	-	60	60	-	-	40	3	40	100
4.7	ADVANCE SKILL CERTIFICATION	OPEN ELECTIVE-2*	02	-	-	2	-	-	-	-	-	-	-	-	NA
4.8	ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	AUDIT COURSE	02	-	-	-	50	-	50	-	-	-	-	-	NA
#STUDENTCENTEREDACTIVITIES			-	-	08	-	-	50	50	-	-	-	-	-	50
Total			**16**		**20**	**20**	**120**	**230**	**350**	**180**		**120**		**300**	**650**

* Students can earn 2 credits for Open Elective courses either by completing a relevant certification from recognized external platforms such as TATA Technologies, NPTEL, or similar, upon submission and verification of the certificate; or by completing the course offered by their own polytechnic institute, in which case credits will be awarded based on internal assessment. conducted by the institute.

Student Centered Activitieswillcompriseofco-curricularactivitieslikeextensionlectures,games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C.,NSS, library, Cultural Activities and self-study etc.

FIFTH SEMESTER **(328) ELECTRICALENGINEERING**

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
5.1	SWITCH GEAR AND PROTECTION	PROGRAM CORE (THEORY)	03	01	-	4	40		40	60	3	-	-	60	100
5.2	PROGRAM ELECTIVE-3	PROGRAM CORE (THEORY)	03	-	-	3	40		40	60	3	-	-	60	100
5.3	ENERGY CONSERVATION AND AUDIT	PROGRAM CORE (PRACTICUM)	01	-	06	4		60	60			40	3	40	100
5.4	PROGRAM ELECTIVE-4	PROGRAM CORE (PRACTICUM)	01	-	04	3	-	60	60	-	-	40	3	40	100
5.5	INDIAN CONSTITUTION	AUDIT COURSE	02				50		50						NA
5.6	ELECTRICAL ESTIMATION AND CONTRACTING	PROGRAM CORE (PRACTICUM)	01	-	06	4	-	60	60	-	-	40	3	40	100
5.7	SUMMER INTERNSHIP** (6 WEEKS)		-	-	04	2	-	60*	60*	-	-	40*	3	40*	100*
	#STUDENT CENTERED ACTIVITIES	-	-	-	04			50	50	-	-	-	-		50
Total			**11**	01	**24**	**20**	80	**290**	**370**	**120**		**160**		**280**	**650**

* Students will submit the certificate.

** Students will present a seminar/viva on their summer internship along with certificate, project and report.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C.,NSS, library, Cultural Activities and self-study etc.

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS INEVALUATION SCHEME								Total Marks of Internal & External
							INTERNALASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
6.1	BUILDING ELECTRIFICATION	PROGRAM CORE (PRACTICUM)	02	-	04	4	-	60	60	-	-	40	3	40	100
6.2	ENTREPRENEURSHIP AND START-UP	PROGRAM CORE (THEORY)	02	-	-	2	40	-	40	60	3	-	-	60	100
6.3	IN-HOUSE PROJECTOR	PROJECT	04	-	16	12	-	240	240	-	-	160	-	160	400
	INTERNSHIP OR	INTERNSHIP	-	-	-										
	INDUSTRIAL TRAINING	INTERNSHIP	-	-	-										
6.4	ADVANCE SKILL CERTIFICATION	OPEN ELECTIVE-3*	02	-	-	2	-	-	-	-	-	-	-	-	-
#STUDENTCENTEREDACTIVITIES			-	-	06	-	-	50	50	-	-	-	-	-	50
Total			**10**		**26**	**20**	**40**	**350**	**390**	**60**		**200**		**260**	**650**

* Students can earn 2 credits for Open Elective courses either by completing a relevant certification from recognized external platforms such as TATA Technologies, NPTEL, or similar, upon submission and verification of the certificate; or by completing the course offered by their own polytechnic institute, in which case credits will be awarded based on internal assessment. conducted by the institute.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C.,NSS, library, Cultural Activities and self-study etc.

OPEN ELECTIVE-1

SR.NO.	SUBJECT NAME
1.	ENGINEERING ECONOMICS & ACCOUNTANCY (Course offered by Polytechnic Institute) OR DISASTER MANAGEMENT (Course offered by Polytechnic Institute)
2.	PRODUCT DESIGN AND DEVELOPMENT (Course offered by TATA Technology) OR FUNDAMENTALS OF INNOVATION AND DESIGN THINKING(Course offered by TATA Technology)
3.	ANY COURSE OF MINIMUM 02 CREDIT FROM NPTEL MOOCS THROUGH SWAYAM AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES C-DAC CERTIFICATIONS CONDUCTED BY THE INSTITUTE OF NATIONAL IMPORTANCE (IIT,NIT,IIIT ETC.) ISRO E-LEARNING OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL PLATFORMS OF REPUTE NEILIT

OPEN ELECTIVE -2

SR.NO.	SUBJECT NAME
1.	ECONOMIC POLICIES IN INDIA (Course offered by Polytechnic Institute) OR MECHATRONICS (Course offered by Polytechnic Institute)
2.	ELECTRIC VEHICLE (Course offered by TATA Technology) OR INDUSTRIAL ROBOTICS(Course offered by TATA Technology)
3.	ANY COURSE OF MINIMUM 02 CREDIT FROM NPTEL MOOCS THROUGH SWAYAM AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES C-DAC CERTIFICATIONS CONDUCTED BY THE INSTITUTE OF NATIONAL IMPORTANCE (IIT,NIT,IIIT ETC.) ISRO E-LEARNING OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL PLATFORMS OF REPUTE NEILIT

OPEN ELECTIVE-3

SR.NO.	SUBJECT NAME
1.	AI & ML(Course offered by TATA Technology) OR IOT(Course offered by TATA Technology)
2.	ANY COURSE OF MINIMUM 02 CREDIT FROM NPTEL MOOCS THROUGH SWAYAM AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES C-DAC CERTIFICATIONS CONDUCTED BY THE INSTITUTE OF NATIONAL IMPORTANCE (IIT,NIT,IIIT ETC.) ISRO E-LEARNING OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL PLATFORMS OF REPUTE, NEILIT

PROGRAME ELECTIVE-1

SR.NO.	SUBJECT NAME
1.	INDUSTRIAL AUTOMATION AND CONTROL
2.	INDUSTRIAL INSTRUMENTATION AND CONDITION MONITORING

PROGRAME ELECTIVE-2

SR.NO.	SUBJECT NAME
1.	RENEWABLE ENERGY POWER PLANTS
2.	BIOMASS AND MICRO-HYDRO POWER PLANTS

PROGRAME ELECTIVE-3

SR.NO.	SUBJECT NAME
1.	SOLAR POWER TECHNOLOGIES
2.	ELCTRIC TRACTION

PROGRAME ELECTIVE-4

SR.NO.	SUBJECT NAME
1.	ELECTRICAL ESTIMATION AND CONTRACTING
2.	ELECTRICAL TESTING AND COMMISSIONING

7. DETAILED CONTENTS OF VARIOUS SUBJETS

THEORY	3.1 BASICS OF POWER GENERATION SYSTEMS	L	T	P
		3	-	-

COURSE OBJECTIVES:

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

• Maintain the efficient operation of various electric power generating plants.

LEARNING OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Maintain the optimised working of the thermal power plant.
- Maintain the optimised working of large and micro hydro power plants.
- Maintain the optimised working of solar and biomass-based power plants.
- Maintain the optimised working of wind power plants.
- Select the adequate mix of power generation based on economic operation.

COURSE CONTENTS

Unit – I: Power Plants: Coal, Gas, Diesel and Nuclear-based (08 Periods)

Schematic arrangement of power plant (coal-based, gas-based, diesel-based, nuclear-based)
Functions of the various types of power plants and their major auxiliaries.
Safe working Practices of various power plants: coal-based, gas-based, diesel-based, nuclear-based.

Unit – II: Large Hydro Power Plants and MHD (08 Periods)

Hydrology, stream flow, hydrograph, flow duration curves. Types of hydroelectric plants and their fields of use, capacity calculations for hydropower, Dams, head water control, penstocks, water turbines, specific speeds, turbine governors. Hydro plant auxiliaries, plant layout.
Concepts and principles of Magneto Hydro Dynamic (MHD) generation.

Unit – III: Solar and Wind Power Plants (08 Periods)

Solar Power Technology

a. Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors

b. Solar Photovoltaic (PV) power plant: layout, construction, working.

Wind power density in watts per square meter, Horizontal and vertical axis large wind power plant, Geared wind power plant, Direct-drive wind power plant.

Unit – IV: Other Generating Stations (08 Periods)

Biomass: Biomass conversion technologies, methods for obtaining energy from biomass.
Geothermal and Tidal Energy: Geothermal sources and its significance, geo-thermal power plant – dry steam, flash steam, and binary cycle, Tidal energy and its significance, Different types of tidal power plants: single basin, double basin.

Fuel Cells: Concept, types and principles of fuel cells.

Unit – V: Economics of Power Generation and Interconnected Power System

(10 Periods)

Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve. Base load and peak load plants; Load curve, load duration curve, integrated duration curve.

Cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor.

Choice of size and number of generator units, combined operation of power station.

Smart Grid.

INSTRUCTIONAL STRATEGY

Electric Generation Systems being a core subject of electrical diploma curriculum, where a student will deal with various types of Electric Generations which are employed in industry and power stations etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these electric generation systems and give suggestions to improve their performance. Explanation of practical aspects of the subject will make the students capable of performing various tests.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making
- Actual laboratory and practical work, model/proto type making and viva- voce

RECOMMENDED BOOKS:

1. Nag. P. K. Power Plant Engineering, McGraw Hill, New Delhi, ISBN: 978-9339204044
2. Tanmoy Deb, Electrical Power Generation, Khanna Publishing House, Delhi (Ed. 2018)
3. Gupta, B.R., Generation of Electrical Energy, S. Chand & Co. New Delhi,
4. Rachel, Sthuthi; Earnest, Joshua – Wind Power Technologies, PHI Learning, New Delhi, ISBN: 978-93-88028-49- 3; E-book 978-93-88028-50-9
5. Solanki, Chetan Singh, – Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning, New Delhi, ISBN: 9788120351110
6. Hau**,** Erich, Wind Turbines, Springer-Verlag, Berlin Heidelberg, Germany, ISBN:978-3-642-27150-2
7. Gipe, Paul, Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304
8. Wizelius, Tore; Earnest, Joshua – Wind Power Plants and Project Development, PHI
9. Gupta, J.B. A Course in Electrical Power– S. K Kataria and Sons, New Delhi. 2014,
10. Soni, Gupta, Bhatnagar, A Course in Electrical Power. – Dhanpat rai and Sons
11. System, S.Chand & Co. New Delhi, 2005, ISBN: 9788121924962

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	08	24
II	08	19
III	08	19
IV	08	19
V	10	19
Total	**42**	**100**

THEORY	3.2 ELECTRICAL MACHINES-I	L	T	P
		4	-	-

COURSE OBJECTIVES:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
• Maintain electric motors and transformers.

LEARNING OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented LOs associated with the above-mentioned competency:

- Maintain different types of DC generators.
- Maintain different types of DC motors.
- Maintain single phase transformer.
- Maintain three phase transformers.
- Maintain different types of special purpose transformers used in different applications.

COURSE CONTENTS

Unit – I: DC Generators (10 Periods)

Classification of insulating materials according to temperature, Insulating materials used in DC machines and transformers (Emery paper, mica, varnish, sleeves, cotton tape, paper and oil).
DC generator: construction, parts, materials and their functions.
Principle of operation of DC generator: Fleming's right-hand rule, schematic diagrams, e.m.f. equation of generator, armature reaction, commutation.
Applications of DC generators. Importance of DC generators in various industries

Unit – II: D.C. Motors (10 Periods)

DC motor: Types of DC motors. Fleming's left-hand rule, Principle of operation of Back e.m.f. and its significance, Voltage equation of DC motor.
Torque and Speed; Armature torque, Shaft torque, BHP, Brake test, losses, efficiency.
DC motor starters: Two Point, Three-point and Four Point starters.
Speed control of DC shunt and series motor: Flux and Armature control.
Brushless DC Motor: Construction and working.

Unit– III: Single Phase Transformers (12 Periods)

Types of transformers: Shell type and core type;
Construction: Parts and functions,
Transformer: Principle of operation, EMF equation of transformer: Derivation, Voltage transformation ratio, Significance of transformer ratings
Transformer No-load and on-load phasor diagram, Leakage reactance,
Equivalent circuit of transformer: Equivalent resistance and reactance.
Voltage regulation and Efficiency: Direct loading, OC/SC method, All day efficiency.
Polarity tests on single phase transformers.

Unit– IV: Three Phase Transformers & Special Purpose transformers (12 Periods)

Three Phase Transformers: Construction, cooling, three-phase transformers connections, three-phase to two phase conversion (Scott Connection), parallel operation of three phase transformer. Comparison between Bank of three single phase transformers & Single unit of three phase transformer
Transformer accessories: Conservator, Breather, Explosion vent, Buchholz relay –ON load and OFF load tap changer.

Distribution and Power transformers. Auto Transformer and its applications

Unit– V: Maintenance of DC Machines and Transformers (12 Periods)

Importance of Maintenance : Preventive and Breakdown Maintenance .
Causes of Sparking in Commutator, Defects in Commutator and Remedies, Resurfacing of Commutator and Brushes , Defects in DC Armature winding
Maintenance of Transformer Oil , Transformer oil tester , Acidity test, BDV test
Earthing : Measurement of earth resistance.

INSTRUCTIONAL STRATEGY

Electrical motor and transformer being a core subject of electrical diploma curriculum, where a student will deal with various types of electrical motors and transformers which are employed in industry, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these motors / tramsformer and give suggestions to improve their performance. Special care has to be taken on conceptual understanding of concepts and principles in the subject. For this purpose exposure to industry, work places, and utilization of various types of electrical motors and tramsformers for different applications may be emphasized. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-term and end-term written tests
- Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva voce.

RECOMMENDED BOOKS:

1. G.C. Garg & P.S. Bimbhra, Electrical Machines, Vol-I, II, Khanna Book Publishing House (ISBN: 978-9386173-447, 978-93-86173-607), New Delhi.
2. Mittle, V.N. and Mittle, Arvind., Basic Electrical Engineering, McGraw Hill Education, New Delhi, ISBN: 9780070593572.
3. Kothari, D. P. and Nagrath, I. J., Electrical Machines, McGraw Hill Education. New Delhi, ISBN:9780070699670
4. Bhattacharya, S. K., Electrical Machines, McGraw Hill Education, New Delhi, ISBN: 9789332902855.
5. Mehta, V. K. and Mehta, Rohit, Principles of Electrical Machines, S. Chand and Co. Ltd., New Delhi, ISBN: 9788121930888.
6. Theraja, B.L., Electrical Technology Vol-II (AC and DC machines), S. Chand and Co. Ltd., New Delhi, ISBN: 9788121924375.
7. Bandyopadhyay, M. N., Electrical Machines Theory and Practice, PHI Learning Pvt. Ltd., New Delhi, ISBN: 9788120329973.
8. Murugesh Kumar, K., DC Machines and Transformers, ISBN: 9788125916055.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	10	20
II	10	20
III	12	23
IV	12	20
V	12	17
Total	**56**	**100**

PRACTICUM	3.3 ELECTRIC CIRCUITS	L	T	P
		1	-	4

COURSE OBJECTIVES:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
• Maintain electrical systems applying AC and DC circuit fundamentals.

LEARNING OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented LOs associated with the above-mentioned competency:

- Troubleshoot problems related to single phase A.C series circuits.
- Troubleshoot problems related to single phase A.C parallel circuits.
- Troubleshoot problems related to three phase circuits.
- Use principles of circuit analysis to troubleshoot electric circuits.
- Apply network theorems to troubleshoot electric circuits.

COURSE CONTENTS

Unit – I Single Phase A.C Series Circuits (03 Periods)

Sinusoidal quantities : Instantaneous, peak, average and effective values , Form Factor , Peak factor
R, L, C circuit elements its voltage and current response.
R-L, R-C, R-L-C combination of A.C series circuit, impedance, reactance, impedance triangle, active power, reactive power, apparent power, power triangle and phasor diagram, Power factor.
Resonance, Bandwidth, Quality factor and voltage magnification in series R-L, R-C, R-L-C circuit.

Practicals: -

1. Use dual trace oscilloscope to determine A.C voltage and current response in given R, L, C circuit.
2. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L series circuit. Draw phasor diagram.
3. Use voltmeter, ammeter to determine active, reactive and apparent power consumed in given R-C series circuit. Draw phasor diagram.
4. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L-C series circuit. Draw phasor diagram.
5. Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor.

Unit – II Single Phase A.C Parallel Circuits (03 Periods)

R-L, R-C and R-L-C parallel combination of A.C. circuits. Impedance, reactance, phasor diagram, impedance triangle, active power, apparent power, reactive power, power triangle and phasor diagram, power factor.
Resonance Bandwidth, Quality factor and voltage magnification in parallel R-L, R-C, R-L-C circuit,

Practicals: -

1. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L Parallel circuit. Draw phasor diagram.
2. Use voltmeter, ammeter to determine active, reactive and apparent power consumed in given R-C Parallel circuit. Draw phasor diagram.

3. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L-C Parallel circuit. Draw phasor diagram.
4. Use variable frequency supply to create resonance in given series R-L-C Parallel or by using variable inductor or variable capacitor.

Unit– III Three Phase Circuits (03 Periods)

Concept of generation of 3-phase alternating voltage, Advantage of 3-phase system over single-phase system, Phasor representation of three phase supply, Phase sequence and polarity.

Types of three-phase connections, Relation between phase and line quantities in three phase star and delta system.

Balanced and unbalanced load, three phase power, active, reactive and apparent power in star and delta system.

Practicals : -

1. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for balanced three phase star connected load and calculate active, reactive, and apparent power. Draw phasor diagram.
2. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for balanced three phase delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram.

Unit– IV Network Reduction and Principles of Circuit Analysis (03 Periods)

Concept of voltage and current sources; symbol and graphical representation, characteristics of practical and ideal sources, Source transformation. Star/delta and delta/star transformation. Mesh Analysis. Nodal Analysis.

Practicals : -

1. Use voltmeter, ammeter to determine current through the given branch of an electric network by applying nodal analysis.
2. Use voltmeter, ammeter to determine current through the given branch of an electric network by applying mesh analysis.

Unit – V: Network Theorems (02 Periods)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem.

Practicals: -

1. Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.
2. Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Thevenin's theorem
3. Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Norton's theorem
4. Use voltmeter, ammeter to determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem.

RECOMMENDED BOOKS:

1. Ashfaq Husain, Networks & Systems, Khanna Book Publishing, New Delhi.
2. Gupta, B. R; Singhal, Vandana; Fundamentals of Electrical Network, S. Chand and Co., New Delhi, ISBN: 978-81-219-2318-7
3. Saxena, S.B Lal; Dasgupta, K; Fundamentals of Electrical Engineering, Cambridge University Press Pvt. Ltd., New Delhi, ISBN: 978-11-0746-435-3

4. Theraja, B. L.: Theraja, A. K, A Text Book of Electrical Technology Vol-I, S. Chand & Co. Ramnagar, New Delhi, ISBN: 9788121924405
5. Sudhakar, A.; Shyammohan, S. Palli; Circuit and network, McGraw Hill Education, New Delhi, ISBN: 978-93-3921-960-4
6. Bell, David A., Electric Circuits, Oxford University Press New Delhi, ISBN: 978-01-954-25246
7. Boylested, R.L., Introductory circuit Analysis, Wheeler, New Delhi, ISBN: 978-00-231-3161-5
8. Mittle, V.N.; Mittle, Arvind; Basic Electrical Engineering, McGraw Hill Education, Noida, ISBN: 978-00-705-9357-2
9. Sivanandam, S.N, Electric Circuit Analysis, Vikas Publishing House Pvt. Ltd, Noida, ISBN:978- 81259-1364-1
10. Salivahanan, S.; Pravinkumar, S; Circuit theory, Vikas Publishing House Pvt. Ltd, Noida; ISBN:978-93259-7418-0

INSTRUCTIONAL STRATEGY

Introduce the subject and make the students familiar with Maintain electrical systems applying AC and DC circuit fundamentals. R-L, R-C and R-L-C parallel combination of A.C. circuits. The inputs start with theoretical inputs to architecture, **Network Reduction and Principles of Circuit Analysis,** Star/delta and delta/star transformation small projects may identified, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Duality in electric circuits, with visits to industry.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making
- Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva voce.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	03	23
II	03	20
III	03	20
IV	03	17
V	02	20
Total	**14**	**100**

PRACTICUM	3.4 ELECTRICAL AND ELECTRONIC MEASUREMENTS	L	T	P
		2	-	4

COURSE OBJECTIVES:

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

• Use relevant measuring instrument in different electrical applications.

LEARNING OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented LOs associated with the above-mentioned competency:

- Check the working of the electrical measuring instrument.
- Use different types of measuring instruments for measuring voltage and current.
- Use different types of measuring instruments for measuring electric power and energy.
- Use different types of electrical instruments for measuring various ranges of electrical parameters.

COURSE CONTENTS

Unit – I: Fundamentals of Measurements (06 Periods)

Measurement: Significance, units, fundamental quantities and standards

Classification of Instrument Systems, Classifications of Analog Instruments (Indicating, Recording and Integrating) Essential requirements of an indicating instruments: deflecting, controlling, damping torque Static and dynamic characteristics, types of errors.

Calibration: need and procedure

Practicals:-

1. Identify measuring instruments on the basis of symbols on dial, type, accuracy, class position and scale.

Unit – II: Measurement of voltage and current (06 Periods)

Concept and working principles of moving iron (MI) and moving coil (MC) instruments.

DC Ammeter: Basic, Multi range, Universal shunt.

DC Voltmeter: Basic, Multi-range, concept of loading effect and sensitivity.

AC voltmeter: Rectifier type (half wave and full wave)

CT and PT: working principle and applications.

Clamp-on meter.

Practicals:-

1. Measure AC and DC quantities in a working circuit.
2. Use Voltmeter, Ammeter and Wattmeter for different loads to conduct an experiment to measure voltage, current and power respectively in single phase a.c circuit.
3. Use Clamp-On Meter to conduct an experiment to measure current in a.c circuit.

Unit – III: Measurement of Electric Power (06 Periods)

Analog meters: Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter, their construction, working, salient features, merits and demerits

Dynamometer type wattmeter: Construction, working, merits and demerits.

Range extension: Multiplying factor and extension of range using CT and PT. Errors and compensations.

Active and reactive power measurement: One, two and three wattmeter method.

Effect of Power factor on wattmeter reading in two wattmeter method.

Maximum Demand indicator: construction and working principle. Digital wattmeter.
Practicals:-

1. Use single wattmeter for measurement of active power and power factor of single-phase circuit.
2. Use two wattmeters for measuring active power of three-phase balanced load.
3. Extend range of ammeter and voltmeter by using (i) shunt and multiplier (ii) CT and PT.

Unit – IV: Measurement of Electric Energy (04 Periods)

Single and three phase electronic energy meter: Constructional features and working principle.
Errors and their compensations.
Calibration of single-phase electronic energy meter using direct loading.
Digital energy meter.

Practicals:-

1. Calibrate single phase energy meter by direct loading.

Unit – V: Circuit Parameter Measurement through CRO and Other Meters (06 Periods)

Measurement of resistance: (a) Low resistance: Kelvin's double bridge, (b) Medium Resistance: Voltmeter and ammeter method, and (c) High resistance: Megger and Ohm meter: Series and shunt
Measurement of inductance using Anderson bridge (no derivation and phasor diagram)
Measurement of capacitance using Schering bridge (no derivation and phasor diagram)
Measurement of voltage/ amplitude/ time period/ frequency/ phase angle delay line, through CRO.
Other meters: Earth tester, Digital Multimeter; L-C-R meter, Frequency meter (ferromagnetic and Weston type), Phase sequence indicator, power factor meter (single phase and three phase dynamometer type), Synchro scope, Tri-vector meter.

Practicals:-

1. Use digital multi-meter for measurement of AC/DC current, AC/DC voltage.
2. Use Kelvin's double bridge for measurement of low resistance.
3. Use voltmeter and ammeter method for measurement of medium resistance.
4. Use Megger for insulation resistance measurements.
5. Use earth tester for measurement of earth resistance.
6. Use CRO for the Measurement of supply frequency in single-phase circuit.
7. Use Tri-vector meter for measuring kW, kVAr and kVA of a power line.

INSTRUCTIONAL STRATEGY -

After making the students familiar with measuring instruments, they should be made conceptually clear about the constructional features and make them confident in making connection of various measuring instruments. Teacher should demonstrate the application of each measuring instrument in laboratory and encourage students to use them independently.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making
- Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva voce

RECOMMENDED BOOKS:

1. Theraja B. L., Theraja A. K., A Text Book of Electrical Technology Vol-I(Basic Electrical Engg.), S.Chand and Co. New Delhi, ISBN: 9788121924405
2. Mittle V. N., Basic Electrical Engineering, McGraw-Hill New Delhi, ISBN: 978-0-07-0088572-5,
3. Edward Hughes, Electrical Technology, Pearson Education, New Delhi, ISBN-13: 978-0582405196

4. Rajput R.K., Electrical and Electronic Measurement and Instrumentation, S.Chand and Co. New Delhi, ISBN : 9789385676017
5. Sawhney A.K., Electrical and Electronics Measurements and Instrumentation., Dhanpai Rai and Sons, New Delhi, ISBN: 9780000279744
6. Suryanarayna N.V., Electrical Measurements and Measuring Instruments, S.Chand and Co. New Delhi , ISBN :8121920116.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	06	10
II	06	23
III	06	22
IV	04	15
V	06	30
Total	**28**	**100**

PRACTICAL	3.5 ELECTRICAL MACHINES-I	L	T	P
		-	-	4

LIST OF PRACTICALS (To perform any Ten practical)

1. Reverse the direction of rotation of the DC shunt motor.
2. Perform brake test on DC shunt motor.
3. Control the speed of DC shunt motor by different methods.
4. Control the speed of DC series motor by different methods.
5. Perform the brake test of DC series motor.
6. No load and Full Load Characteristics of Self Excited DC Shunt Generator.
7. Load Characteristics of Self Excited DC Series Generator.
8. Determine regulation and efficiency of single-phase transformer by direct loading.
9. Perform open circuit and short circuit test on single phase transformer to determine voltage regulation and efficiency.
10. Finding the Equivalent Circuit Constants of Single-Phase Transformer by conducting O.C and S.C Tests.
11. Perform parallel operation of two single phase transformers to determine the load current sharing, apparent and real power load sharing.
12. Perform parallel operation of two single phase transformers and determine the apparent and real power load sharing.
13. Perform polarity test on a single-phase transformer whose polarity markings are masked.
14. Connect the autotransformer in step-up and step-down modes noting the input/output readings.
15. Breakdown Test to determine the Dielectric Strength of Transformer Oil.

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THEORY	3.6 ENGINEERING ECONOMICS & ACCOUNTANCY (OE-1)	L	T	P
		02	-	-

COURSE OBJECTIVES:

To acquire knowledge of basic economics to facilitate the process of economic decision making.

- To acquire knowledge on basic financial management aspects.
- To develop the basic skills to analyze financial statements.

LEARNING OUTCOMES:

- Understand the macro-economic environment of the business and its impact on enterprise.
- Understand cost elements of the product and its effect on decision making.
- Prepare accounting records and summarize and interpret the accounting data for managerial decisions.
- Understand accounting systems and analyze financial statements using ratio analysis.
- Understand the concepts of financial management and investment.

COURSE CONTENTS

Unit – I: Introduction (04 Periods)

Managerial Economics; Relationship with other disciplines; Firms: Types, objectives and goals; Managerial decisions; Decision analysis.

Unit – II: Demand & Supply Analysis (05 Periods)

Demand; Types of demand; Determinants of demand; Demand function; Demand elasticity; Demand forecasting; Supply; Determinants of supply; Supply function; Supply elasticity.

Unit – III: Production and Cost Analysis (06 Periods)

Production function; Returns to scale; Production optimization; Least cost input; Isoquants; Managerial uses of production function; Cost Concepts; Cost function; Types of Cost; Determinants of cost; Short run and Long run cost curves; Cost Output Decision; Estimation of Cost

Unit – IV: Pricing (05 Periods)

Determinants of Price; Pricing under different objectives and different market structures; Price discrimination; Pricing methods in practice; Role of Government in pricing control.

Unit – V: Financial Accounting (Elementary Treatment) (08 Periods)

Balance sheet and related concepts; Profit & Loss Statement and related concepts; Financial Ratio Analysis; Cash flow analysis; Funds flow analysis; Comparative financial statements; Analysis & Interpretation of financial statements; Investments; Risks and return evaluation of

investment decision; Average rate of return; Payback Period; Net Present Value; Internal rate of return

RECOMMENDED BOOKS:

1. Premvir Kapoor, Sociology & Economics for Engineers, Khanna Publishing House, New Delhi, 2018
2. McGuigan, Moyer and Harris, 'Managerial Economics; Applications, Strategy and Tactics', Thomson Southwestern, 10th Edition, 2005.
3. Prasanna Chandra. 'Fundamentals of Financial Management', Tata Mcgraw Hill Publishing Ltd., 4th edition, 2005.
4. Samuelson. Paul A and Nordhaus W.D., 'Economics', Tata Mcgraw Hill Publishing Company Limited, New Delhi, 2004.
5. Paresh Shah, 'Basic Financial Accounting for Management', Oxford University Press, New Delhi, 2007.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	04	17
II	05	20
III	06	20
IV	05	20
V	08	23
Total	**28**	**100**

THEORY	3.6 DISASTER MANAGEMENT (OE-1)	L	T	P
		02	-	-

COURSE OBJECTIVES:

Following are the objectives of this course:

- To learn about various types of natural and man-made disasters.
- To know pre- and post-disaster management for some of the disasters.
- To know about various information and organisations in disaster management in India.
- To get exposed to technological tools and their role in disaster management.

LEARNING OUTCOMES:

After competing this course, student will be:

- Acquainted with basic information on various types of disasters
- Knowing the precautions and awareness regarding various disasters
- Decide first action to be taken under various disasters
- Familiarised with organisation in India which are dealing with disasters
- Able to select IT tools to help in disaster management

COURSE CONTENTS

Unit – I: Understanding Disaster (02 Periods)

Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management.

Unit – II: Types, Trends, Causes, Consequences and Control of Disasters (05 Periods)

Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

Unit - III: Disaster Management Cycle and Framework (08 Periods)

Disaster Management Cycle – Paradigm Shift in Disaster Management. Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness. During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Stretegy, Hyogo Framework of Action.

Unit – IV: Disaster Management in India (05 Periods)

Disaster Profile of India – Mega Disasters of India and Lessons Learnt. Disaster Management Act 2005 – Institutional and Financial Mechanism, National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter Governmental Agencies 457 Open Elective Courses

Unit – V: Applications of Science and Technology for Disaster Management (08 Periods)
Geo-informatics in Disaster Management (RS, GIS, GPS and RS). Disaster Communication System (Early Warning and Its Dissemination). Land Use Planning and Development Regulations, Disaster Safe Designs and Constructions, Structural and Non-Structural Mitigation of Disasters S&T Institutions for Disaster Management in India

RECOMMENDED BOOKS:

1. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management.
2. Bhandani, R. K., An overview on natural & man-made disasters and their reduction, CSIR, New Delhi.
3. Srivastava, H. N., and Gupta G. D., Management of Natural Disasters in developing countries, Daya Publishers, Delhi.
4. Alexander, David, Natural Disasters, Kluwer Academic London.
5. Ghosh, G. K., Disaster Management, A P H Publishing Corporation.
6. Murthy, D. B. N., Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	02	10
II	05	19
III	08	28
IV	05	19
V	08	24
Total	**28**	**100**

THEORY	4.1 ELECTRICAL POWER TRANSMISSION AND DISTRIBUTION	L	T	P
		3		

COURSE OBJECTIVES:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
• Maintain the proper functioning of the electrical transmission and distribution systems.

LEARNING OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented LOs associated with the above-mentioned competency:

- Interpret the normal operation of the electric transmission and distribution systems.
- Maintain the functioning of the medium and high voltage transmission system.
- Interpret the parameters of the extra high voltage transmission system.
- Maintain the functioning of the low voltage AC distribution system.
- Maintain the components of the transmission and distribution lines.

COURSE CONTENTS

Unit – I: Basics of Transmission and Distribution (06 Periods)

Single line diagrams of the electric supply transmission and distribution systems.
Standard voltage level used in India.
Classification of Transmission lines.
Characteristics of high voltage for both AC and DC power transmission.

Unit – II: AC Transmission (10 Periods)

Typical Layout of A.C. Power supply scheme - Elements of a Transmission Line Over Head Line, Conductor materials and their properties , Line supports and their properties - Types of supports and their applications, Sag in overhead lines, Calculation of Sag - When the supports are at equal and unequal levels - Simple Numerical Problems,
Constants of a Transmission line, Transposition of Transmission lines , Skin Effect , Ferranti Effect, Corona Formation, Factors affecting Corona, Classification of O.H. Transmission lines - Voltage regulation and Transmission Efficiency (No Numerical Problems).
Concept of power factor, effects of low power factor, methods of improving low power factor: static capacitor, synchronous condenser, SVC.

Unit – III: Hvdc Transmission & Facts (08 Periods)

H.V.D.C Transmission: Layout Scheme , D.C Link configurations - Mono polar, Bipolar and Homo polar links
HVDC Convertor Station (Schematic diagram only) – Integration of HVDC & Renewable energy into existing AC grids
HVDC Locations in India.
FACTS: Definition, Need for FACTS controllers, Types of FACTS controllers, SVS, STATCOM, UPFC (Block diagram explanation only).

Unit – IV: Line Insulators and Underground Cables (10 Periods)

Natural insulating materials, properties and their applications-mica, asbestos, ceramic materials, glass, cotton, silk, jute, paper(dry and impregnated), rubber, bitumen, gaseous materials(air, hydrogen, nitrogen, SF6).

Line Insulators: Properties of Insulators , Materials , Types , Causes of failure of Insulators, Testing of Insulators

Potential Distribution over suspension Insulator string, String Efficiency - Methods of improving string Efficiency – Simple Problems.

Underground Cables: Construction of a three core cable, Classification of cables, Cables for three phase service , Construction of Belted cable, Screened cable, Pressure cables, Laying of underground cables and cable jointing, Faults in cables, fault localization using Blavier and Loop tests.

Unit – V: Sub-Stations & Distribution Systems (08 Periods)

Sub-Stations: Classification, advantages, disadvantages and applications. Single Line diagram (layout) of 33/11KV and 11KV/400V sub-station, functions of various auxiliaries and equipments associated with it.

Gas Insulated Substation (GIS)

Distribution system - Requirements and parts of Distribution system, Classification

Comparison of different distribution systems (A.C and D.C, Overhead & Underground)

A.C Distribution - Types - Connection schemes of AC Distribution system.

INSTRUCTIONAL STRATEGY

Since this is a descriptive and practice oriented subject, it is suggested that visits to different types of power transmission and distribution stations including grid stations be arranged and various equipment, accessories and components explained to the students before the actual class room teaching and make them familiar with the equipment and accessories installed over there. There should be at least 3 visits during the semester. The students may be asked to prepare notes while on visit and submit the report and give seminar. In addition, viva-voce be conducted to evaluate the knowledge gained during the field visit.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making
- Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce

RECOMMENDED BOOKS:

1. G.C. Garg, Utilization of Electric Power & Electric Traction, Khanna Book Publishing Co., New Delhi (ISBN: 978-93-86173-355)
2. Mehta, V.K., Principles of Power System, S. Chand and Co. New Delhi, ISBN: 9788121924962
3. Soni; Gupta; Bhatnagar, A Course in Electrical Power, Dhanpat Rai and Sons New Delhi, ISBN: 9788177000207
4. Gupta, J.B., A Course in Power Systems, S.K. Kataria and sons, New Delhi, ISBN: 9788188458523
5. Theraja, B.L.; Theraja, A.K., A Textbook of Electrical Technology Vol. III, S. Chand and Co. New Delhi, ISBN: 9788121924900
6. Uppal, S.L., A Course in Electrical Power, S.K. Khanna Publisher New Delhi, ISBN: 9788174092380
7. Sivanagaraju S.; Satyanarayana S., Electrical Power Transmission and Distribution, Pearson Education, New Delhi, ISBN: 9788131707913
8. Ned Mohan, Electrical Power System: A First Course, Wiley India Pvt. Ltd. New Delhi, ISBN:9788126541959
9. Gupta, B.R., Power System Analysis and Design, S. Chand and Co. New Delhi, ISBN: 9788121922388

10. Kamraju, V., Electrical Power Distribution System, Tata McGraw-Hill, New Delhi, ISBN:9780070151413

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	06	10
II	10	25
III	08	20
IV	10	25
V	08	20
Total	**42**	**100**

THEORY	4.2 ELECTRICAL MACHINES-II	L	T	P
		3	-	-

COURSE OBJECTIVES:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
• Maintain Induction, Synchronous and Special Electric Machines (SEM) used in different applications.

LEARNING OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented LOs associated with the above-mentioned competency:
a) Maintain three phase induction motor used in different applications.
b) Maintain single phase induction motor used in different applications.
c) Maintain three phase alternators used in different applications.
d) Maintain synchronous motors used in different applications.
e) Maintain SEMs used in different applications.

COURSE CONTENTS

Unit – I: Three Phase Induction Motor (10 Periods)

Working principle: production of rotating magnetic field, Synchronous speed, rotor speed and slip. Locking of rotor and stator fields.
Constructional details of 3 phase induction motors: Squirrel cage induction motor and Slip ring induction motor.
Rotor quantities: frequency, induced emf, power factor at starting and running condition.
Characteristics of torque versus slip (speed), Torques: starting, full load and maximum with relations among them.
Relationship between rotor copper losses, slip and rotor input power (Power flow diagram)
Starters: need and types; stator resistance, auto transformer, star delta, rotor resistance and soft starters.
Speed control methods: stator voltage, pole changing, rotor resistance and VVVF.
Motor selection for different applications as per the load torque-speed requirements.
Cogging and Crawling.

Unit – II: Single phase induction motors (08 Periods)

Double field revolving theory, principle of making these motors self-start.
Construction, working and Torque-speed characteristics: Resistance start induction run, capacitor start induction run, capacitor start capacitor run, shaded pole, repulsion type, series motor, universal motor, hysteresis motor.
Motor selection for different applications as per the load torque-speed requirements.

Unit– III: Three phase Alternators (10 Periods)

Principle of working, moving and stationary armatures.
Constructional details: parts and their functions, Windings: Single and Double layer.
Equivalent circuit diagram, E.M.F. equation of an Alternator with numerical by considering short pitch factor and distribution factor.
Necessary conditions of parallel operation of alternators.
Armature reaction at various power factors and synchronous impedance.
Voltage regulation: direct loading and synchronous impedance methods.
Operation of synchronous machine as a motor.

Unit– IV: Synchronous Motors (08 Periods)

Principle of working , Torques: starting torque, running torque, pull in torque, pull out torque.
Synchronous motor on load with constant excitation (numerical), effect of excitation at constant load (numerical).
Concept of synchronous condenser
V-Curves and Inverted V-Curves. Hunting and Phase swinging.
Methods of Starting of Synchronous Motor.
Losses in synchronous motors and efficiency (no numerical). Applications areas

Unit– V: Special Electric Machines (06 Periods)

Construction, working and applications: Linear Induction Motor, Synchronous Reluctance Motor, Switched Reluctance Motor, Permanent Magnet Synchronous Motors, stepper motors, AC and DC servomotors, Submersible motor..

INSTRUCTIONAL STRATEGY

Induction, Synchronous and Special Electric Machines (SEM) being a core subject of electrical diploma curriculum, where a student will deal with various types of **induction motors**, **Alternators, Synchronous Motors and Special Electric Machines** which are employed in industry, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these Induction, Synchronous and Special Electric Machines (SEM) used in different applications and give suggestions to improve their performance. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines.

MEANS OF ASSESSMENT

− Assignments and quiz/class tests, mid-term and end-term written tests

RECOMMENDED BOOKS:

1. P.S. Bimbhra, Electric Machines, Khanna Book Publishing Co., New Delhi (ISBN: 978-93-86173-294)
2. Mittle, V.N. and Mittle, Arvind., Basic Electrical Engineering, McGraw Hill Education New Delhi, ISBN :9780070593572
3. Kothari, D. P. and Nagrath, I. J., Electrical Machines, McGraw Hill Education. New Delhi, ISBN:9780070699670
4. Bhattacharya, S. K., Electrical Machines, McGraw Hill Education, New Delhi, ISBN:9789332902855
5. Theraja, B.L., Electrical Technology Vol-II (AC and DC machines), S.Chand and Co. Ltd., New Delhi, ISBN : 9788121924375
6. Sen, S. K., Special Purpose Electrical Machines, Khanna Publishers, New Delhi, ISBN: 9788174091529
7. Janardanan E. G, Special Electrical Machines, Prentice Hall India, New Delhi ISBN: 9788120348806
8. Hughes E., Electrical Technology, ELBS
9. Cotton H., Electrical Technology, ELBS

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	10	25
II	08	18
III	10	25
IV	08	18
V	06	14
Total	**42**	**100**

PRACTICUM	4.3 FUNDAMENTALS OF POWER ELECTRONICS	L	T	P
		2	-	4

COURSE OBJECTIVES:

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
• Maintain the proper functioning of power electronic devices.

LEARNING OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented LOs associated with the above-mentioned competency:

- Select power electronic devices for specific applications.
- Maintain the performance of Thyristors.
- Troubleshoot turn-on and turn-off circuits of Thyristors.
- Maintain phase-controlled rectifiers.
- Maintain industrial control circuits.

COURSE CONTENTS

Unit – I: Power Electronic Devices (08 Periods)

Definition – Scope and Applications
Power Electronic Switch Specifications : Power Diode, Power transistor, IGBT, GTO, DIAC, TRIAC
SCR – rating and their importance, Symbol, Circuit, Working, Characteristics, Protection and Applications - Battery charger using SCR, Emergency light system, Temperature controller using SCR
Working Principle of UJT

Practicals:-

1. Identification & testing of SCR , TRIAC, DIAC , MOSFET and IGBT using a digital multimeter.
2. Obtain V-I characteristics of SCR.
3. Plot the V-I characteristics of IGBT and determine the break over voltage.
4. Plot the V-I characteristics of DIAC and determine the break over voltage.
5. Determine the latching current and holding current using V-I characteristics of SCR.
6. Plot the V-I characteristics of TRIAC and determine the break over voltage.
7. Illumination control / fan speed control through TRIAC.

Unit – II: Turn-on and Turn-off Methods of Thyristors (08 Periods)

SCR Turn-On methods: Voltage triggering, Thermal triggering, Illumination triggering, dv/dt triggering, Gate triggering.
SCR triggering using UJT, PUT: Relaxation Oscillator and Synchronized UJT circuit.
Pulse transformer and opto-coupler based triggering. Application: UPS and SMPS.
SCR Turn-Off methods: Natural & Forced Commutations

Practicals:-

1. Test the variation of R, C in R and RC triggering circuits on firing angle of SCR.
2. To Study UJT Triggering Techniques for Half Wave Controlled rectifiers.
3. To Study UJT Triggering Techniques for Full Wave Controlled rectifiers.
4. Perform the operation of Class – A, B, C, turn off circuits.
5. Perform the operation of Class –D, E, F turn off circuits.

Unit – III: Phase Controlled Rectifiers (06 Periods)

Phase control: firing angle, conduction angle, extinction angle.
Single phase half controlled, full controlled and midpoint-controlled rectifier with R, RL load: Circuit diagram, working, input- output waveforms, equations for DC output and effect of freewheeling diode.
Different configurations of bridge-controlled rectifiers: Full-Wave & Half Wave

Practicals:-

1. Use CRO to observe the output waveform of half wave-controlled rectifier with resistive load and determine the load voltage.
2. Draw the output waveform of Full wave-controlled rectifier with R load, RL load, freewheeling diode and determine the load voltage.
3. Determine the firing angle using DIAC and TRIAC phase-controlled circuit on output power under different loads such as lamp, motor or heater.

Unit– IV: Inverters, Choppers, Dual Converters, Cyclo-converters (06 Periods)

Inverter: Introduction, working principles, voltage and current driven series and parallel inverters and applications
Choppers: Introduction, types of choppers and their working principles and applications
Dual converters: Introduction, working principles and applications
Cyclo-converters: Introduction, types, working principles and applications.

Practicals:-

1. Test the performance of given SMPS, UPS.
2. Performance Measurement and Analysis of DC-DC Buck Regulator.
3. Performance Measurement and Analysis of DC-DC Boost Regulator

INSTRUCTIONAL STRATEGY

The teachers may encourage students to perform practical simultaneously for better understanding of the subjects and verification of theoretical concepts. The various components must be shown to the students for identification and also tested. Practical applications of the various circuits and devices should be discussed in the class. The available video films on the subject must be shown to the students.

MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-term and end-term written tests.
- Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce

RECOMMENDED BOOKS:

1. Ramamoorty M., An Introduction to Thyristors and their applications, East-West Press Pvt. Ltd., New Delhi, ISBN: 8185336679.
2. Sugandhi, Rajendra Kumar & Sugandhi, Krishna Kumar, Thyristors: Theory and Applications, New Age International (P) ltd. Pub., New Delhi, ISBN: 978-0-85226-852-0.
3. Bhattacharya, S.K., Fundamentals of Power Electronics, Vikas Publishing House Pvt. Ltd. Noida. ISBN: 978-8125918530.
4. Jain & Alok, Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd, Mumbai, ISBN: 978-8187972228.
5. Rashid, Muhammad, Power Electronics Circuits Devices and Applications, Pearson Education India, Noida, ISBN: 978-0133125900.
6. Singh, M. D. and Khanchandani, K.B., Power Electronics, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2008 ISBN: 9780070583894.
7. Zbar, Paul B., Industrial Electronics: A Text –Lab Manual, McGraw Hill Publishing Co. Ltd., New Delhi, ISBN: 978-0070728226.

8. Grafham D.R., SCR Manual, General Electric Co., ISBN: 978-0137967711.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	08	30
II	08	26
III	06	22
IV	06	22
Total	**28**	**100**

PRACTICUM	4.4.1 INDUSTRIAL AUTOMATION AND CONTROL	L	T	P
		01	-	04

COURSE OBJECTIVES:

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

• Maintain Industrial Automation Systems

COURSE OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Identify different types of automation systems.
- Interface I/O devices with the PLC modules.
- Develop PLC ladder programs for various applications.
- Select the suitable motor drives for different applications
- Prepare simple SCADA applications.

COURSE CONTENTS

Unit – I: Introduction to Industrial Automation (02 Periods)

Need and benefits. Types of automation system: Fixed, Programmable, Flexible Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives.

Practical

1. Identify various automation systems available in different appliances/ devices/ machines in day-to-day use.

Unit – II: PLC Fundamentals Building blocks of PLC (02 Periods)

Components of PLC- CPU, Memory organization, Input- output modules (discrete and analog), I/O Modules, Power supply, Fixed and Modular PLC, Redundancy in PLC module, I/O module selection criteria, Interfacing different I/O devices with appropriate I/O modules.

Practical

1. Identify various parts of the given PLC and front panel status indicators

Unit– III: PLC Programming and Applications (05 Periods)

PLC I/O addressing PLC programming Instructions: Relay type instructions, Timer instructions: On delay, off delay, retentive, Counter instructions: Up, Down, High speed, Logical instructions, Comparison Instructions, Data handling Instructions, Arithmetic

instructions. PLC programming language: Functional Block Diagram (FBD), Instruction List. Structured text, Sequential Function Chart (SFC), Ladder Programming. Simple Programming examples using ladder logic: Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions. PLC Based Applications: Motor sequence control, Traffic light control, Elevator control, Tank Level control, Conveyor system, Stepper motor control.

Practical

1. Use PLC to test the START STOP logic using two inputs and one output.
2. Develop/Execute a ladder program for the given application using following: - timer, counter, comparison, logical, arithmetic instructions.
3. Use PLC to control the following devices like lamp, motor, push button switches, proximity sensor.
4. Measure the temperature of the given liquid using RTD or Thermocouple and PLC.
5. Develop and test ladder program to blink the LED/lamp
6. Develop ladder program for Traffic light control system.
7. Develop and test ladder program for pulse counting using limit switch /Proximity sensor.
8. Develop and test ladder program for rotating stepper motor in forward and reverse direction at constant speed.

Unit– IV: Electric Drives and special machines (02 Periods)

Electric drives: Types, functions, characteristics, four quadrant operation. DC and AC drive controls: V/F control, Parameters, direct torque control. **Drives**: Specifications, Applications- Speed control of AC motor /DC Motor.

Practical

1. Identify various front panel controls of VFD (smart drive).

Unit– V: Supervisory Control and Data Acquisition (SCADA) System (03 Periods)

Introduction to SCADA: Typical SCADA architecture/block diagram, Benefits of SCADA Various editors of SCADA Interfacing SCADA system with PLC: Typical connection diagram, Object Linking & embedding for Process Control (OPC) architecture, Steps in Creating SCADA Screen for simple object, Steps for Linking SCADA object (defining Tags and Items) with PLC ladder program using OPC. Applications of SCADA: Traffic light control, water distribution, pipeline control

Practical

1. Use various functions of SCADA simulation editors to develop simple project.
2. Develop a SCADA mimic diagram for Tank level control.

RECOMMENDED BOOKS:

a) Dunning, G., Introduction to Programmable Logic Controllers, Thomson /Delmar learning, New Delhi, 2005, ISBN 13: 9781401884260

b) Jadhav, V. R., Programmable Logic Controller, Khanna publishers, New Delhi, 2017, ISBN: 9788174092281
c) Petruzella, F.D., Programmable Logic Controllers, McGraw Hill India, New Delhi, 2010, ISBN: 9780071067386
d) Hackworth, John; Hackworth, Federic, Programmable Logic Controllers, PHI Learning, New Delhi, 2003, ISBN: 9780130607188
e) Stenerson Jon, Industrial automation and Process control, PHI Learning, New Delhi, 2003, ISBN: 9780130618900
f) Mitra, Madhuchandra; Sengupta, Samarjit, Programmable Logic Controllers and Industrial Automation - An introduction, Penram International Publication, 2015, ISBN: 9788187972174
g) Boyar, S. A., Supervisory Control and Data Acquisition, ISA Publication, USA, ISBN: 978- 1936007097

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	02	17
II	02	17
III	05	28
IV	02	19
V	03	19
Total	**14**	**100**

PRACTICUM	4.4.2 INDUSTRIAL INSTRUMENTATION AND CONDITIONING MONITORING	L	T	P
		01	-	04

COURSE OBJECTIVES:

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

• Use instrumentation equipment for condition monitoring and control.

COURSE OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Select relevant instruments used for measuring electrical and non-electrical quantities.
- Select relevant transducers/sensors for various applications.
- Use relevant instruments for measuring non-electrical quantities
- Check the signal conditioning and telemetry system for their proper functioning.
- Use data acquisition systems in various applications.
- Undertake condition monitoring for diagnostic analysis of electrical equipment

COURSE CONTENTS

Unit – I: Fundamentals of instrumentation (02 Periods)

Basic purpose of instrumentation. Basic block diagram (transduction, signal conditioning, signal presentation) and their function. Construction, working and application of switching devices- Push button, limit switch, float switch, pressure switch, thermostat, electromagnetic relay.

Practical

1. Identify different switches used in instrumentation system.

Unit – II: Transducers (02 Periods)

Comparison between Primary and Secondary, Electrical and Mechanical, Analog and Digital, Active and Passive. Advantages of electric transducers. Required characteristics of transducers. Construction and working principle of resistive transducer-Potentiometer, variac and strain gauges. Gauge factor, Types of strain gauges. Construction and principle of Inductive transducers-L.V.D.T. and R.V.D.T, their applications. Construction, principle and applications of transducers – Piezo-Electric transducer, photoconductive cells, photo voltaic cells.

Practicals:-

1. Measure linear displacement by L.V.D.T.

2. Measure the strain with the help of strain gauge.

Unit – III: Measurement of Non-Electrical Quantities (05 Periods)

Temperature measurement - RTD, Thermistor and Thermocouple, radiation pyrometer **Pressure measurement** –bourdon tube, bellow diaphragm and strain gauge, Combination of transducer- diaphragm and inductive transducer, Bourdon tube and LVDT, bellow and LVDT, diaphragm capacitance and bridge Circuit. Speed Measurement by contacting and non-Contact Type- DC tachometer, photo- electric tachometer, toothed rotor tachometer Generator - magnetic pickup and Stroboscope. Vibration measurement by accelerometer-LVDT accelerometer, Structure Piezo electric type. Flow measurement by electromagnetic and Turbine Flow meter. Liquid level measurement by resistive, inductive, capacitive gamma rays and Ultrasonic methods. Thickness measurement by resistive, inductive, capacitive, ultrasonic and nuclear methods.

Practicals

1. Measure temperature by PT-100, thermistor, thermocouple along with simple resistance bridge.
2. Use Thermocouple to control the temperature of a furnace/machine.
3. Measure pressure using pressure sensor kit
4. Measure angular speed using stroboscope and tachometer.
5. Measure the flow using flow meter

Unit – IV: Signal Conditioning (02 Periods)

Basic Concept of signal conditioning System. Pin configuration of IC 741. Ideal OP-AMP and Practical of OP-AMP. Different Parameters of op-amp: Input offset voltage, Input offset current, Input bias current, Differential input resistance, CMRR, voltage gain, output voltage, slew rate, gain bandwidth. Output, short circuit current. Use of op-amp as inverting, non-inverting mode, adder, subtractor, and Working of Differential amplifier and instrumentation amplifier.

Practicals:

1. Use op-amp as inverter, non-inverting mode, adder, differentiator and integrator.

Unit – V: Data Acquisition System and **Condition Monitoring (03 Periods)**

DAS- Block diagram and description. Difference between Single Channel and Multi-Channel DAS. Data conversion- Construction and Working of Analog to digital conversion- successive approximation method, ramp type method. Digital to Analog conversion- Construction and Working of binary weighted resistance method. Telemetry system and its type - Electrical telemetering system. Digital display device- operation and its application of seven segment display, dot matrix display and concept of 3½, 4½ digits, LED and LCD applications. Definition of condition monitoring , Insulation deterioration Mechanism- factors affecting occurrence and rate of deterioration, types of stresses responsible for deterioration Different tests on transformer, their purpose, and the necessary condition of machine. Tests on Circuit

breaker, purpose and required condition of machine Tests on CT, purpose, item to be tested and required condition of machine.

Practicals:

1. Convert digital data into analog data by using analog to digital converters and analog data into digital data by digital to analog converter.
2. Prepare a Report on various tools and equipment used for condition monitoring of electrical machines.
3.

RECOMMENDED BOOKS:

1. Sawhney, A.K. Electric and Electronic Measurement and instrumentation, Dhanpat Rai and Co. Author, Nineteenth revised edition 2011 reprint, 2014, ISBN:10: 8177001000
2. Rangan, C.S. G.R. Sharma and V.S. V. Mani, Instrumentation devices and system, Pen ram International Publishing India Pvt. Ltd. Fifth edition, ISBN:10: 0074633503
3. Mehta, V.K. Electronics and instrumentation, Third edition-S. Chand and company Pvt Ltd Reprint, 2010, ISBN:81-219-2729-3
4. Singh, S.K. Industrial instrumentation and control, Tata McGraw-Hill, 1987. ISBN: 007451914X, 9780074519141.
5. J.G. Joshi, Electronic Measurement and Instrumentation, Khanna Publishing House, New Delhi, ISBN: 978-93-86173-621.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	02	15
II	02	20
III	05	25
IV	02	15
V	03	25
Total	**14**	**100**

THEORY	4.5.1 RENEWABLE ENERGY POWER PLANTS	L	T	P
		03	-	-

COURSE OBJECTIVES:

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

• Maintain the efficient operation of various types of renewable energy power plants.

COURSE OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Maintain the optimised working of solar PV and CS power plants.
- Maintain the optimised working of large wind power plants
- Maintain the optimised working of small wind turbines.
- Maintain the optimised working of micro hydro power plants.
- Maintain the optimised working of biomass-based power plants.

COURSE CONTENTS

Unit – I: Solar PV and Concentrated Solar Power Plants (07 Periods)

Solar Map of India: Global solar power radiation.
Classification of solar thermal collectors, construction and working of (a) flat type, (b) focusing type.
Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors.
Solar Photovoltaic (PV) power plant: components layout, construction, working.
Rooftop solar PV power system, on-grid and off-grid solar PV system.

Unit – II: Large Wind Power Plants (09 Periods)

Wind Map of India: Wind power density in watts per square meter Lift and drag principle; long path theory.
Geared type wind power plants: components, layout and working.
Direct drive type wind power plants: components, layout and working.
Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG),
Wound Rotor Induction Generator (WRIG); Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG).

Unit – III: Small Wind Turbines (08 Periods)

Horizontal axis small wind turbine: direct drive type, components and working
Horizontal axis small wind turbine: geared type, components and working
Vertical axis small wind turbine: direct drive and geared, components and working
Types of towers and installation of small wind turbines on roof tops and open fields.
Electric generators used in small wind power plants

Unit – IV: Micro Hydro Power Plants (09 Periods)

Energy conversion process of hydro power plant.
Classification of hydro power plant: High, medium and low head.
Layouts of micro-hydro power plants
Construction and working of hydro turbines used in different types of hydro power plant: (a) High head – Pelton turbine, (b) Medium head – Francis turbine, (c) Low head – Kaplan turbine.
Pumped storage hydro power plants.
Safe Practices for micro hydro power plants.

Unit – V: Biomass-based Power Plants (09 Periods)

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipal waste.
Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobar gas.
Gasifier and its types.
Types of Bio-gas power plant – fixed and floating dome type.
Layout of a Bio-chemical based (e.g. biogas), Thermo-chemical based (e.g. Municipal waste), Agro-chemical based (e.g. bio-diesel) power plant.

RECOMMENDED BOOKS:

1. Deambi, Suneel: From Sunlight to Electricity: a practical handbook on solar photovoltaic application; TERI, New Delhi ISBN:9788179935736
2. David M. Buchla, Thomas E. Kissell, Thomas L. Floyd – Renewable Energy Systems, Pearson Education New Delhi, ISBN: 9789332586826.
3. Rachel, Sthuthi; Earnest, Joshua – Wind Power Technologies, PHI Learning, New Delhi, ISBN: 978-93-88028-49- 3; E-book 978-93-88028-50-9
4. Khoiyangbam, R S Navindu; Gupta and Sushil Kumar; Biogas Technology: Towards Sustainable Development; TERI, New Delhi; ISBN: 9788179934043
5. Gipe, Paul: Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304
6. Wizelius, Tore &Earnest, Joshua -PHI Learning, New Delhi, ISBN: 978-8120351660
7. Kothari, D.P. et al: Renewable Energy Sources and Emerging Technologies, PHI Learning, New Delhi, ISBN: -978-81-203-4470-9
8. Bhadra, S.N., Kastha, D., Banerjee, S, Wind Electrical Systems installation; Oxford University Press, New Delhi, ISBN: 9780195670936.
9. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi (ISBN: 978-9386173-683)

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	07	20
II	09	20
III	08	20
IV	09	20
V	09	20
Total	**42**	**100**

THEORY	4.5.2 BIOMASS AND MICRO-HYDRO POWER PLANTS	L	T	P
		03	-	-

COURSE OBJECTIVES:

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

• Maintain the efficient operation of various types of Biomass and Micro hydro power plants.

COURSE OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Select the relevant biomass power plant
- Undertake the preventive maintenance of different types of biomass gasifiers.
- Undertake the breakdown maintenance of different types of biomass gasifiers.
- Maintain the optimised working of large wind power plants.
- Maintain the optimised working of small wind turbines.
- Maintain the optimised working of micro hydro power plants.

COURSE CONTENTS

Unit – I: Basics of Biomass-based Power Plants (7 Periods)

Types of biomass fuel- bagasse, wood chips, rice husk, municipal waste, Jatropha, bio-diesel, gobar gas, Layout of a Bio-chemical based (e.g. biogas) power plant
Layout of a Thermo-chemical based (e.g. Municipal waste) power plant
Layout of an Agro-chemical based (e.g. bio-diesel) power plant
Selection of biomass power plants.

Unit – II: Biomass Gasification Power Plants (8 Periods)

The basic principle to convert Agriculture and forestry products and wood processing remains (including rick husks, wood powder, branches, offcuts, corn straws, rice straws, wheat straws, cotton straws, fruit shells, coconut shells, palm shells, bagasse, corncobs) into combustible gas.
General Construction and working of a typical gasifier.
Power generation in gas engine.

Unit – III: Different Types of Gasifiers (9 Periods)

Construction, working and limitations of the following types of gasifiers: Rice Husk Gasification Power Plant and their specifications, Straw Gasification Power Plant and their specifications.
Bamboo Waste, Bamboo Chips Gasification Power Plant and their specifications.
Coconut shell, coconut peat, coconut husk, Gasification Power Plant and their specifications.
Bagasse/Sugar Cane Trash Gasification Power Plant and their specifications.

Gobar gas plant and its specifications.

Unit – IV: Micro-hydro Power Plants **(9 Periods)**

Locations of micro-hydro power plant.
Energy conversion process of hydro power plant.
Classification of hydro power plant: High, medium and low head.
General Layouts of typical micro-hydro power plant.
Strengths and limitations of micro-hydro power plants.

Unit – V: Different types of Micro-hydro power plants **(9 Periods)**

Construction and working of High head – Pelton turbine and their specifications.
Construction and working of medium head – Francis turbines and their specifications.
Construction and working of Low head – Kaplan turbine and their specifications.
Preventive and breakdown maintenance of micro-hydro power plants.
Safe Practices for micro-hydro power plants.

RECOMMENDED BOOKS:

1. Khoiyangbam, R S Navindu; Gupta and Sushil Kumar; Biogas Technology: Towards Sustainable Development; TERI, New Delhi; ISBN: 9788179934043.
2. David M. Buchla; Thomas E. Kissell; Thomas L. Floyd - Renewable Energy Systems, Pearson Education New Delhi, ISBN: 9789332586826.
3. Kothari, D.P. et al: Renewable Energy Sources and Emerging Technologies, PHI.
4. Rachel, Sthuthi, Earnest, Joshua; -Wind Power Technologies, PHI Learning.
5. O.P. Gupta, Energy Technology, Khanna Publishing House, ISBN: 978-93-86173-683.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	7	20
II	8	20
III	9	23
IV	9	17
V	9	20
Total	**42**	**100**

PRACTICAL	4.6 ELECTRICAL MACHINES-II	L	T	P
		-	-	4

LIST OF PRACTICALS (To perform any Ten practicals)

1. Identify the different parts (along with function and materials) for the given single phase and three phase induction motor.
2. Connect and run the three-phase squirrel cage induction motors (in both directions) using the DOL, star-delta, auto-transformer starters (any two).
3. Perform the direct load test on the three-phase squirrel cage induction motor and plot the (a) efficiency versus output, (b) power factor versus output, (c) power factor versus motor current and (d) torque – slip/speed characteristics.
4. Conduct the No-load and Blocked-rotor tests on given 3-phase squirrel cage induction motor and determine the equivalent circuit parameters .
5. Control the speed of the given three phase squirrel cage/slip ring induction motor using the applicable methods: (a) auto-transformer, (b) VVVF.
6. Measure the open circuit voltage ratio of the three-phase slip ring induction motor.
7. Conduct the direct load test to determine the efficiency and speed regulation for different loads on the given single phase induction motor; plot the efficiency and speed regulation curves with respect to the output power.
8. Demonstrate that power factor of an induction motor load is improved by connecting capacitor bank.
9. Perform the direct loading test on the given three phase alternator and determine the regulation and efficiency.
10. Determine the regulation and efficiency of the given three phase alternator from OC and SC tests (Synchronous impedance method)
11. Conduct the test on load or no load to plot the ‘V’ curves and inverted ‘V’ curves (at no-load) of 3-phase synchronous motor.
12. Synchronization of 3 Phase Alternators by
    a) Lamp method. b) Synchroscope method
13. Control the speed and reverse the direction of stepper motor
14. Control the speed and reverse the direction of the AC servo motor
15. Control the speed and reverse the direction of the DC servo motor

THEORY	4.7 ECONOMIC POLICIES IN INDIA (OE-2)	L	T	P
		02	-	-

COURSE OBJECTIVES:

The objective of this course is to familiarize the students of different streams with the basic concepts, structure, problems and issues concerning Indian economy.

LEARNING OUTCOMES:

At the end of the course, the student will be able to:

- Understand Indian economics policy, planning strategies
- It will enable to students to comprehend theoretical and empirical development across countries and region for policy purposes.
- Development Economics as a discipline encompasses different approaches to the problems of unemployment, poverty, income generation, industrialization from different perspectives
- Able to identify the problems and capable to decide the application for future development
- Analyze economic issues and find solutions to complex economic problems and take correct economic judgment.

COURSE CONTENT:

Unit – 1: Basic features and problems of Indian Economy: (08 Periods)

Economic History of India; Nature of Indian Economy, demographic features and Human Development Index, Problems of Poverty, Un employment, Inflation, income inequality, Black money in India.

Unit – 2: Sectorial composition of Indian Economy: (05 Periods)

Issues in Agriculture sector in India, land reforms Green Revolution and agriculture policies of India,

(04 Periods)

Unit – 3: Industrial development, small scale and cottage industries, industrial Policy, Public sector in India, service sector in India.

Unit – 4: Economic Policies: (06 Periods)

Economic Planning in India, Planning commission v/s NITI Aayog, Five Year Plans, monetary policy in India, Fiscal Policy in India, Centre state Finance Relations, Finance commission in India. LPG policy in India.

Unit – 6: External sector in India: (05 Periods)

India's foreign trade value composition and direction, India Balance of payment since 1991, FDI in India, Impact of Globalization on Indian Economy, WTO and India.

RECOMMENDED BOOKS:

1. Dutt Rudder and K.P.M Sunderam (2017). Indian Economy. S Chand & Co. Ltd. New Delhi.
2. Mishra S.K & V.K Puri (2017). Indian Economy and –Its Development Experience. Himalaya

Publishing House.
3. Singh, Ramesh, (2016): Indian Economy, Tata-McGraw Hill Publications, New Delhi.
4. Dhingra, I.C., (2017): March of the Indian Economy, Heed Publications Pvt. Ltd.
5. Karam Singh Gill, (1978): Evolution of the Indian Economy, NCERT, New Delhi
6. Kaushik Basu (2007): The Oxford Companion to Economics of India, Oxford University Press.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
1	08	23
2	05	20
3	04	17
4	06	20
5	05	20
Total	**28**	**100**

THEORY	4.7 MECHATRONICS (OE-2)	L	T	P
		02	-	-

COURSE OBJECTIVES:

To develop the idea of project plan, from defining and confirming the project goals and objectives, identifying tasks and how goals will be achieved.

LEARNING OUTCOMES:

At the end of the course, the student will be able to:

- Understand the Mechatronics
- It will enable to students to comprehend theoretical and empirical development across the country.
- Maintain the optimised working of drivers, hydraulic & pneumatic Systems Able to identify the problems and capable to decide the application for future development

COURSE CONTENTS

Unit – I: Introduction to Mechatronics (05 Periods)

Introduction to System Concepts, Analysis and Design, Mechatronics basic definitions; systems and components; Systems with mixed disciplines, Electronics Fundamentals Review.

Unit – II: Elements in Mechatronics (08 Periods)

Data conversion devices, sensors, micro-sensors, transducers, signal processing devices, timers; Microprocessors, Microcontrollers, PID Controllers and PLCs

Unit – III: Drives (05 Periods)

Stepper Motors, Servo Drives, Linear Motion bearings, cams; Systems controlled by camshafts, electronic cams, Tool magazines and indexing mechanisms.

Unit – IV: Hydraulic Systems (05 Periods)

Flow, Pressure and Direction Control Valves, Actuators, Supporting Elements, Hydraulic Power Packs, Pumps; Design of Hydraulic circuits

Unit – V: Pneumatic System (05 Periods)

Production, Distribution and conditioning of compressed air; System Components and Graphic representations; Design of Systems.

RECOMMENDED BOOKS:

1. Analysis and design of Dynamic Systems Cochin, Era and Cadwallender, Addison Wesley, 1997
2. Mechatronics Engineering Tomkinson, D. And Horne, J. Longman McGraw Hill, 1996
3. Mechatronics Bolton, W, Pearson Prentice Hall edition, 2008.
4. Fundamental of mechatronic M. Jouaneh Cengage Learning ISBN – 978-1111569020
5. Mechatronics – An Integrated Approach Clarence W. de Silva CRC Press ISBN – 978-0849312748

SUGGESTED SOFTWARE/LEARNING WEBSITES:

1. https://youtu.be/Ro_tFv1iH6g
2. https://www.motioncontroltips.com/faq-what-are-stepper-drives-and-how-do-they-work/
3. https://science.howstuffworks.com/robot.htm
4. https://howtomechatronics.com

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	05	20
II	08	23
III	05	20
IV	05	20
V	05	17
Total	**28**	**100**

PRACTICAL	4.8 ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	L	T	P
		2	-	-

COURSE OBJECTIVE:

Understand the fundamental aspects of the Indian Knowledge System, its integration with modern science, principles of Yoga and holistic healthcare, and practical applications in contemporary contexts.

LEARNING OUTCOMES:

Upon completion of the course, the student will be able to demonstrate knowledge of the following topics:

- Overview, importance, and relevance of the Indian Knowledge System, including Vedas, Upavedas, Vedangas, and Upangas.
- Relevance of science and spirituality, and contributions of ancient Indian science and technology.
- Basic principles of Yoga, benefits of holistic healthcare, and integration with modern healthcare.
- Practical applications and case studies of the Indian Knowledge System's relevance today.

COURSE CONTENTS

Unit – I: Introduction to Indian Knowledge System (16 Periods)

Overview of Indian Knowledge System
Importance and relevance

1. Introduction to the Vedas
2. Upavedas
3. Vedangas
4. Upangas

Unit – II: Modern Science and Indian Knowledge System (06 Periods)

1. Relevance of Science and Spirituality,
2. Science and Technology in Ancient India,

Unit – III: Yoga and Holistic Healthcare (04 Periods)

1. Basic principles of Yoga
2. Benefits of holistic healthcare practices
3. Integration with modern healthcare

Unit – IV: Case Studies / Assignment (02 Periods)

Practical Applications / Case studies demonstrating the relevance of Indian Knowledge System in modern times

ASSESSMENT

Viva -Voce Exam

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	16	50
2.	06	20
3.	04	15
4.	02	15
Total	**28**	**100**

8. GUIDELINES FOR ASSESSMENT OF STUDENT-CENTRED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 50 as it involves a lot of subjectivity in the evaluation. The marks may be distributed as follows

I. 15 Marks for general behaviour and discipline

(by HODs in consultation with all the teachers of the department)

II. 10 Marks for attendance as per following:

(by HODs in consultation with all the teachers of the department)

a) 75 - 80% 06 Marks

b) 80 - 85% 08 Marks

c) Above 85% 10 Marks

III. 25 Marks maximum for Sports/NCC/Cultural/Co-curricular/NSS activities as per following:

(by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) 25 - State/National Level participation

b) 20 - Participation in two of above activities

c) 15 - Inter-Polytechnic level participation

9. RESOURCE REQUIREMENT

A. PHYSICALRESOURCES

a) Space requirement

Norms and standards laid down by All India Council for Technical Education (AICTE) are to be followed to work out space requirement in respect of class rooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

b) Equipment Requirement:

Following Laboratories are required for diploma programme in Electrical Engineering (3rd and 4th Semester):

- Electrical Machine, Electrical Traction, and Electrical Vehicles
- Building Electrification
- Fundamentals of Power Electronics

Electrical Machine, Electrical Traction, and Electrical Vehicles

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Quantity
1.	AC Ammeter	Range (0-5-10-20A), Portable analog MI type	4
2.	AC Voltmeter	Range (0-75/150/300V), Portable analog MI type	4
3.	AC Voltmeter	Range (0-150/300/600V), Portable analog MI type	4
4.	Watt meter	0-2.5/5 A, 0-75/150/300V Portable Wattmeter	2
5.	Wattmeter	0-5/10/20 A, 0-150/300/600V Portable Wattmeter	2
6.	Single phase autotransformer	a. 0-230V/0-260V, 2 Amp	2
7.	3 phase Auto transformes	3 phase,5 KVA, 0-470V, 50 Hz	2
8.	Three phase variable Lamp load	20 A, 10kW	2
9.	Three phase variable Inductive load	415 V, 0-10 Amp, 50 Hz	1
10.	Rheostat	b. (0-500 Ohm, 1.2A) c. (0-100 Ohm, 5A) d. (0-50 Ohm, 10A) e. (0- 350 Ohm,1.5A) Ni chrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact	2 each
11.	Single Phase induction motor	Capacitor start with centrifugal switch 1.5 KW	1
12.	Three phase induction motor	Cut section model, Squirrel cage type, Three phase, 3 KW, 415V, 1440 RPM	1
13.	Three phase Squirrel Cage induction motor with loading arrangement	Squirrel cage type, Three phase, 3 KW, 415V, 1440 RPM all six terminal brought out, digital voltmeter, ammeter, rpm meter, wattmeter, DOL starter on appropriate panel complete with brake loading arrangement etc.	1
14.	Three phase slip ring induction motor with external resistor bank	Three phase, slip ring type, 3KW, 415 volt, 50 Hz, 1440 RPM with stator and rotor terminals brought out , coupled with a dc shunt generator (230 volt, 3 KW) and with measuring devices (digital voltmeter, ammeter, rpm meter, wattmeter), starter and with appropriate panel.	1
15.	a. DOL Starter b. Star Delta Starter c. Autotransformer starter	a) DOL starter, suitable for 415V, 3 Phase, 50 Hz, 3kw induction motor b) Auto transformer starter for 3 phase, 415 V, 50 Hz,3 Kw induction motor with facility of	1

		tappings c) Star-delta starter suitable for 415V, 3 Phase, 50 Hz, 3 kw induction motor (i) Manual (ii) Automatic	1 1
16.	Synchronous motor	Synchronous Motor (3HP , 3Phase 415V AC 50Hz, 1440rpm)Coupled with DC Shunt Generator 2KW DC Shunt Generator 230V, 1500 rpm with ammeter, voltmeter, power Factor Meter on panel. Also provide excitation voltage controller with knob to control the Excitation Voltage. Complete panel for calculating V curve.	1
17.	Alternator	3 phase 440 volt, 3 KW, 50 HZ alternator having damper winding coupled with DC shunt motor 230 volt, 3kw, 440 RPM with 3point starter with digital voltmeter ammeter, wattmeter, RPM meter, frequency meter exciter, starter and field regulation complete on appropriate panel.	1
18.	Single phase induction motor	Capacitor start with centrifugal switch 1.5 KW, digital voltmeter, ammeter, wattmeter, RPM meter with suitable loading arrangement and appropriate panel board.	1
19	Experimental kit: control speed and direction reversal of the AC Servomotor	230V, 50 Hz, Servo motor	1
20	Experimental kit: control speed and direction reversal of the DC Servomotor		1
21	Experimental kit: control speed and direction reversal of the Stepper Motor	230V, 50 Hz, stepper motor	1
22	Tachometer	Tachometer: Digital non-contact type, 0- 10,000 rpm	2
23	Traction Motor	BLDC Motor: 3KW, 60 V	2
24	Lead Acid Batteries	12 V, 11 plates, 30 amp hour capacity	3
25	Battery Charger	SCR based automatic 12 V, AC input voltage 230 V, output dc voltage 0-12 V, 0-2 amp. capacity provided with voltmeter, Ammeter of suitable range	1
26	Inverter	12 volt, 600 VA	1

Building Electrification

S. No.	Name of Equipment	Broad Specifications	Quantity
1.	Screw driver	8 inch, 10 inch, 12 inch	10 each
2.	Combination Pliers	6 inch, 8 inch	10 each
3.	Round Nose Pliers	15 cm	10
4.	Electrical Knife	10 cm	10
5.	Heavy duty Screw driver	10 inch, 12 inch	10 each
6.	Nose Pliers	6 inch	10
7.	BP Hammer	½ Kg, ¼ Kg	10 each
8.	Cold Chisels	15 cm	10
9.	Tri square	15 cm	10
10.	Former Chisels	14 cm, 20 cm, 25 cm	10 each
11.	Poker	15 cm	10
12.	Hacksaw	30 cm	10
13.	Hand drilling machine	Motor power 435W, ac single phase 230V ac,50Hz Drilling capacity 10mm, slotted and adjustable drilling, no load speed 700 RPM,	2
14	Wire Stripper		10
15	Measuring Tape		5
16	Standard wire gauge		5
17	Meggar	Insulation tester having hand driven generator to generate 500 volts DC having effective range of measuring insulation resistance from 0 to 500 M ohm	2
18	Digital Earth Tester	10 volt, 0.10-100 ohms, 3 ½ digit (1999 counts), 14 mm LCD display. Complete with all accessories (hammers, screw driver, 3 spikes)	2
19	Single phase energy meter	Single phase, induction type, 50 Hz, 10A, 250 V, accuracy+ 1%	5
20	Clamp on meter	200 A AC and DC current measurement. Voltage: DC: 600 volts, AC: 600 volts; DC Accuracy: ± 1% + 5 digit AC Accuracy: ± 1.5% + 5 digit. 300 ohm resistance range with continuity check.	2
21	Multi-meter	0-600 V (AC and DC both), 10mA-10A (AC and DC both), 2ohm-20 Kohm	10
22	ELCB	Single phase , 16 amp	5
23	DP switch	16 amp, 32 amp	5 each

Fundamentals of Power Electronics

S.N.	Name of Equipments	Broad Specifications	Quantity
1.	SCR	12A,600V	L. S.
2.	MOSFET	VDS 650V, 35 Amp	L. S.
3.	IGBT	VCE 600V, 33-amp	L. S.
4.	TRIAC	10A,600V	L. S.
5.	DIAC	Rated current: 2 A, Power: 0.15 W	L. S.
6	Incandescent lamp	60 Watt	4
7.	Electrical Heater	Single phase , 50 Hz, 220-240 V, 1 KW	2
8.	Resistor	I k ohm to 10 k ohm, 1Watt	L. S.
9.	Inductor	300mH,2A,	L. S.
10.	Variable inductor	0-5mH- 10mH, 2 Amps	L. S.
11.	Capacitors	6.8 micro Farad, 10 micro Farad, 100V	L. S.
12.	Potentiometer	100kohm	L.S
13.	Incandescent lamp	60 Watt	LS
14.	Digital Multimeter	10 A, 600 V (AC and DC both), upto 400 M ohm	2
15.	True RMS multi-meter	10 A, 600 V (AC and DC both), upto 400 M ohm	2
16.	Dual channel CRO	25 MHZ, attenuator probe for CRO	2
17.	DC Regulated Power Supply	0-30 V,0-2 A,0-300 V,0-10 A	4
18.	Experimental Thyristor commutation circuit Kit Kits with connecting cords.	Class A,B,C,D,E,F. 220V, 50 Hz, 24 V DC.	2
19.	Resistive load	Heater Coil-500W	1
20.	Resistive- inductive load (motor)	Single phase, fractional 1/4 HP,60W/75W Motor	1
21.	Bread Board		LS
22.	UPS	600 VA,360 W	1
22.	SMPS	24V, 10A , 240W	1

B. Furniture Requirement

Norms and standards laid down by AICTE -APH (latest) be followed for working out furniture requirement for diploma courses

C. Human Resources:

Weekly work schedule, annual work schedule, student teacher ratio for various group and class size, staffing pattern, work load norms, qualifications, experience and job description of teaching staff workshop staff and other administrative and supporting staff be worked out as per norms and standards laid down by the AICTE.

10. EVALUATION STRATEGY INTRODUCTION

Evaluation plays an important role in the teaching-learning process. The major objective of any teaching-learning endeavor is to ensure the quality of the product which can be assessed through learner's evaluation.

The purpose of student evaluation is to determine the extent to which the general and the specific objectives of curriculum have been achieved. Student evaluation is also important from the point of view of ascertaining the quality of instructional processes and to get feedback for curriculum improvement. It helps the teachers in determining the level of appropriateness of teaching experiences provided to learners to meet their individual and professional needs. Evaluation also helps in diagnosing learning difficulties of the students. Evaluation is of two types: Formative and Summative (Internal and External Evaluation)

Formative Evaluation

It is an on-going evaluation process. Its purpose is to provide continuous and comprehensive feedback to students and teachers concerning teaching-learning process. It provides corrective steps to be taken to account for curricular as well as co-curricular aspects.

Summative Evaluation

It is carried out at the end of a unit of instruction like topic, subject, semester or year. The main purpose of summative evaluation is to measure achievement for assigning course grades, certification of students and ascertaining accountability of instructional process. The student evaluation has to be done in a comprehensive and systematic manner since any mistake or lacuna is likely to affect the future of students. In the present educational scenario in India, where summative evaluation plays an important role in educational process, there is a need to improve the standard of summative evaluation with a view to bring validity and reliability in the end-term examination system for achieving objectivity and efficiency in evaluation.

STUDENTS' EVALUATION AREAS

The student evaluation is carried out for the following areas:
- Theory
- Practical Work
- Project Work
- Industrial Training

A. Theory

Evaluation in theory aims at assessing students' understanding of concepts, principles and procedures related to a course/subject, and their ability to apply learnt principles and solve problems. The formative evaluation for theory subjects may be caused through sessional /class-

tests, home-assignments, tutorial-work, seminars, and group discussions etc. For end-term evaluation of theory, the question paper may comprise of three sections.

Section-I

It should contain objective type items e.g. multiple choice, matching and completion type. Total weightage to Section-1 should be of the order of 20 percent of the total marks and no choice should be given in this section. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.

Section-II

It should contain short answer/completion items. The weightage to this section should be of the order of 40 percent of the total marks. Again, no choice should be given in section-II

Section-III

It may contain two to three essay type questions. Total weightage to this section should be of the order of 40 percent of the total marks. Some built-in, internal choice of about 5

Table II : Suggested Weightage to be given to different ability levels

Abilities Weightage to be assigned
Knowledge 10-30 percent
Comprehension 40-60 percent
Application 20-30 percent
Higher than application i.e. Analysis,
Synthesis and Evaluation Upto 10 percent

B. Practical Work

Evaluation of students performance in practical work (Laboratory experiments, Workshop practicals/field exercises) aims at assessing students ability to apply or practice learnt concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behaviour and it should be followed by viva-voce.

C. Internship / In-House Project/ Industrial Training

The purpose of evaluation of project work is to assess students ability to apply, in an integrated manner, learnt knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The formative and summative evaluation may comprise of weightage to nature of project, quality of product, quality of report and quality of presentation followed by viva-voc.

Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of materials, industrial processes, practices in the industry/field and their ability to engage in activities related to problem-solving in industrial setting as well as understanding of application of learnt knowledge and skills in real life situation. The formative and summative evaluation may comprise of weightages to performance in testing, general behaviour, quality of report and presentation during viva-voce.

11. RECOMMENDATIONS FOR EFFECTIVE IMPLEMENTATION OF CURRICULUM

This curriculum document is a Plan of Action and has been prepared based on exhaustive exercise of curriculum planning and design. The representative sample comprising selected senior personnel (lecturers and HODs) from various institutions and experts from industry/field have been involved in curriculum design process.

The document so prepared is now ready for its implementation. It is the faculty of polytechnics who have to play a vital role in planning instructional experiences for the courses in four different environments viz. class-room, laboratory, library and field and execute them in right perspective. It is emphasized that a proper mix of different teaching methods in all these places of instruction only can bring the changes in stipulated student's behavior as in the curriculum document. It is important for the teachers to understand curriculum document holistically and further be aware of intricacies of teaching-learning process (T-L) for achieving curriculum objectives. Given below are certain suggestions which may help the teachers in planning and designing learning experiences effectively. These are indicative in nature and teachers using their creativity can further develop/refine them. The designers of the programme suggest every teacher to read them carefully, comprehend and start using them.

(A) Broad Suggestions:

1. Curriculum implementation takes place at programme, course and class-room level respectively and synchronization among them is required for its success. The first step towards achieving synchronization is to read curriculum document holistically and understand its rationale and philosophy.

2. An academic plan needs to be prepared and made available to all polytechnics well in advance. The Principals have a great role to play in its dissemination and, percolation upto grass-root level. Polytechnics, in turn are supposed to prepare institutional academic plan.

3. HOD of every Programme Department along with HODs and in-charge of other departments are required to prepare academic plan at department level referring to institutional academic plan.

4. All lecturers/Senior lecturers are required to prepare course level and class level lesson plans referring departmental academic plan.

(B) Course Level Suggestions

Teachers are educational managers at class room level and their success in achieving course level objectives lies in using course plan and their judicious execution which is very important for the success of programme by achieving its objectives.

Polytechnic teachers are required to plan various instructional experiences viz. theory lecture, expert lectures, lab/workshop practical, guided library exercises, field visits, study tours, camps etc. In addition, they have to carry out progressive assessment of theory, assignments, library, practical and field experiences. Teachers are also required to do all these activities within a stipulated period of time. It is essential for them to use the given time judiciously by planning all above activities properly and ensure execution of the plan effectively.

Following is the gist of suggestions for subject teachers to carry out T-L process effectively:

1. Teachers are required to prepare a course plan, taking into account departmental academic plan, number of weeks available and courses to be taught.

2. Teachers are required to prepare lesson plan for every theory class. This plan may comprise of contents to be covered, learning material for execution of a lesson plan. They may follow steps for preparing lesson plan e.g. drawing attention, state instructional objectives, help in recalling pre-requisite knowledge, deliver planned subject content, check desired learning outcomes and reinforce learning etc.

3. Teachers are required to plan for expert lectures from field/industry. Necessary steps are to plan in advance, identify field experts, make correspondence to invite them, take necessary budgetary approval etc.

4. Teachers are required to plan for guided library exercises by identification of course specific experience requirement, setting time, assessment, etc. The assignments and seminars can be thought of as terminal outcome of library experiences.

5. Concept and content-based field visits may be planned and executed for such content of course which is abstract in nature and no other requisite resources are readily available in institute to impart them effectively.

6. There is a dire need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem-based learning/activity learning/ experiential learning approach effectively. The development of lab instruction sheets for the course is a good beginning to provide lab experiences effectively.

7. Planning of progressive assessment encompasses periodical assessment in a semester, preparation of proper quality question paper, assessment of answer sheets immediately and giving constructive feedback to every student

The student-centered activities may be used to develop generic skills like task management, problem solving, managing self, collaborating with others etc.

9. Where ever possible, it is essential to use activity-based learning rather than relying on delivery based conventional teaching all the time.

10. Teachers may take initiative in establishing liaison with industries and field organizations for imparting field experiences to their students.

11. Students be made aware about issues related to ecology and environment, safety, concern for wastage of energy and other resources etc.

12. Students may be given relevant and well thought out project assignments, which are purposeful and develop practical skills. This will help students in developing creativity and confidence for their gainful employment.

13. A Project bank may be developed by the concerned department of the polytechnics in consultation with related Industry, research institutes and other relevant field organizations in the state.

12.List of Experts

1. Shri Anand Kumar, HOD Electrical Engineering, Govt. Poly. Lucknow.
2. Shri Rizwanullah, Siddiqui, HOD Electrical Engineering, MMIT, Shravasti.
3. Smt. Priyanka Tiwari, Lecturer Electrical Engineering, Govt. Poly. Kanpur.
4. Shri Sunil Kumar, Lecturer Electrical Engineering, Govt. Poly. Unnao.
6. Smt. Sakshi Mishra, Lecturer Electrical Engineering, Govt. Poly. Harak, Barabanki.
7. Dr. Preeti Sonkar, Lecturer Electrical Engineering, Govt. Poly. Kanpur.
8. Shri Anurag Agarwal, Lecturer Electrical Engineering, Govt. Poly. Unnao.
9. Shri. Anuj Banswar, Lecturer Electrical Engineering, Govt. Poly. Puranpur.
10. Shri. Ankit Kumar, Lecturer Electrical Engineering, Govt. Poly. Hapur.
11. Shri. Deep Chandra, Lecturer Electrical Engineering, Govt. Poly. Bindki, Fatehpur.
12. Shri. Praveen Kumar Tiwari, Lecturer Electrical Engineering, MMIT, Hariharpur, Gorakhpur.
13. Shri. Homendra Pal Singh, Lecturer Electrical Engineering, Govt. Poly. Debai, Bulandshahr.
14. Shri. Vivek Anand Verma, Lecturer Electrical Engineering, Govt. Poly. Jigirsand, Ballia.
15. Shri. Tilak Singh, Lecturer Electrical Engineering, Govt. Poly. Talbhet, Lalitpur.
16. Shri. Rohit Chaudhary, Lecturer Electrical Engineering, Govt. Poly. Kirthal, Bagpat.

17. EVALUATION SCHEME GUIDELINES: As Per AICTE ATTACHED (ANNEXURE- 1)

a. For Theory Courses:

(The weightage of Internal assessment is 40% and for End Semester Exam is 60%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

b. For Practical Courses:

(The weightage of Internal assessment is 60% and for End Semester Exam is 40%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

c. For Summer Internship / Projects / Seminar etc.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Note: The internal assessment is based on the student's performance in mid semester tests (two best out of three), quizzes, assignments, class performance, attendance, viva-voce in practical, lab record etc

ANNEXURE- 1

Evaluation Method For Practicum Based Course Paper (End Exam: PRACTICAL)

Internal Assessment (60 Marks)					**External Assessment (40 Marks)**
Mode	Sessional Exam (02 Best of 03)	Practical Test	Practical Documentation	Attendance and Assignment	Practical Exam
Portion	2 Units	100% Practical	All Practicals	All Units	All Practicals
Duration	1 Hr	3 Hrs	Regularly Monitored by Faculty	Regularly	4Hrs
Exam Marks	20	20	10	10	40
Tentative Schedule	6^{th} Week	12^{th} Week	13^{th} Week	14^{th} – 15^{th} Week	Semester End Exam

NOTE:

1. Complete all exercises/experiments as outlined above and keep them for the practical test. The practical test should be conducted in accordance with the evaluation scheme. The best of the two practical tests will be evaluated internally for a total of 20 marks.

2. Maintain a practical file for each exercise. Submit the document for the practical file with a valid certificate (Progress Card) and Lab/classroom attendance and evaluate it for 10 marks.

3. Submit a micro project report along with the fabrication model/analysis report. The performance of each student in the group will be evaluated by the laboratory supervisor and an internal examiner evaluate it for 10 marks.

Evaluation Method For Practical Based Course Paper (End Exam: PRACTICAL)

Internal Assessment (60 Marks)					**External Assessment (40 Marks)**
Mode	Practical Test	Practical Test	Attendance and Practical Documentation	Micro Project	Practical Exam
Portion	50% Practicals	50% Practicals	All Practicals	All Practicals	All Practicals
Duration	3Hr	3 Hrs	Regularly	Regularly	4 Hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	6^{th} Week	12^{th} Week	13^{th} Week	14^{th} – 15^{th} Week	Semester End Exam

NOTE:

1. Complete all exercises/experiments as outlined above and keep them for the practical test. The practical test should be conducted in accordance with the evaluation scheme. The best of the two practical tests will be evaluated internally for a total of 20 marks.

2. Maintain a practical file for each exercise. Submit the document for the practical file with a valid certificate (Progress Card) and Lab/class room attendance and evaluate it for 20 marks.

3. Submit a micro project report along with the fabrication model/analysis report. The performance of each student in the group will be evaluated by the laboratory supervisor and an internal examiner evaluate it for 20 marks.

Evaluation Method For THEORY Based Course Paper

Internal Assessment (40 Marks)					**External Assessment**
Mode	Sessional Exam-1	Sessional Exam-2	Sessional Exam-3	Attendance and Assignment	Written Exam
Portion	2 Units	2 Units	All Units	Regularly	All Units
Duration	1 Hr	1 Hr	1 Hr	1 Hr	3 Hrs
Exam Marks	10	10	10	10	60
Tentative Schedule	4th Week	8th Week	12-14th Week	Regularly	Semester End Exam

Evaluation Method For Practicum Based Course Paper (End Exam: THEORY)

Internal Assessment (40 Marks)					**External Assessment (60 Marks)**
Mode	Sessional Exam (02 Best of 03)	Practical Test	Practical Documentation	Attendance and Assignment	Written Exam
Portion	2 Units	100% Practical	All Practicals	All Units	All Units
Duration	1 Hr	3 Hrs	Regularly Monitored by Faculty	Regularly	3 Hrs
Exam Marks	10	10	10	10	60
Tentative Schedule	6th Week	12th Week	13th Week	14th – 15th Week	Semester End Exam