DEPARTMENT OF TECHNICAL EDUCATION (DIPLOMA SECTOR)
UTTAR PRADESH

CURRICULUM FOR DIPLOMA PROGRAMME
IN
ELECTRICAL ENGINEERING (INDUSTRIAL CONTROL)
(3rd to 4th Semester)

==========

Semester System

==========

YEAR 2025-2026

Prepared By:

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

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

CONTENTS

THIRD SEMESTER

FOURTH SEMESTER

PREFACE

An important issue generally debated amongst the planners and educators 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. In order 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

1. ACKNOWLEDGEMENTS

We gratefully acknowledge the guidance and contribution received from the following persons:

1. Sh. Narendra Kumar Bhushan, IAS Additional Chief Secretary, Technical Education Govt. of U.P. for his exemplary vision & approach.

2. Sh. F. R. Khan Director I.R.D.T. Kanpur continually motivating, guiding and taking keen interest in the review of the curriculum.

3. All the participants from Polytechnics and other technical institutions for their professional input during curriculum workshops.

4. CDC Officer and others concerning staff of IRDT for their support and assistance in conducting curriculum workshops.

(Mohd Nadeem)
Research Assistant
Curriculum In-charge
I.R.D.T. Kanpur

(Dr. Kunwer Mrityunjay Singh)
Curriculum Co-Ordinator
I.R.D.T. Kanpur

2. SALIENT FEATURES

1. Name of the Programme	➢ Diploma In Electrical Engineering (Industrial Control)
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 (IC)

3.1. EMPLOYMENT OPPORTUNITIES

Keeping present scenario in view following employment opportunities are visualized in different sectors of employment for diploma holders in Electrical Engineering (I.C)

3.2. 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.

3.3. 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

3.3. HOSPITALS, COMMERCIAL COMPLEXES, SERVICE SECTOR ORGANIZATIONS LIKE HOTELS, TOURIST-RESORTS, HIGH-RISE BUILDINGS, CINEMA/THEATER HALLS ETC.

The diploma holder in electrical engineering (i.c) 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

3.4. SELF-EMPLOYMENT

Following type of self-employment opportunities are available to the diploma holder in electrical engineering (i.c) :

- 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 (I.C).

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 programme, 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.	Analyze AC circuits and apply electromagnetic induction principles in various Electrical equipments 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 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 phases 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 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 substations 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's 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

PROGRAM CORE COURSES

Control System

Electrical circuits

Electrical and Electronic Measurements

Electric Machine- 1

Electric Machine- 1 (Lab)

(Open Elective-1*) Advance Skill Development

ENGINEERING ECONOMICS & ACCOUNTANCY (OE-1)

OR

DISASTER MANAGEMENT (OE-1)

Summer Internship** (4 Weeks)

Fundamentals of Power Electronics

Electric Power Generation, Transmission and Distribution

Electric Machine- II

Electric Machine- II (Lab)

(Open Elective-2*) Advance Skill Development

ECONOMIC POLICIES IN INDIA (OE-2)

OR

MECHATRONICS (OE-2)

PROGRAM ELECTIVE COURSES

(Program Elective -1)

Industrial Automation and Control

OR

Industrial Instrumentation and Condition Monitoring

(Program Elective -2)

Renewable Energy Power Plants

OR

Biomass and Micro-Hydro Power Plants

PROJECT WORK, SEMINAR & INTERNSHIP IN INDUSTRY

Internship / In-House Project/ Industrial Training

AUDIT COURSES

Essence of Indian Knowledge and Tradition

6. STUDY AND EVALUATION SCHEME OF ELECTRICALENGINEERING (INDUSTRIAL CONTROL)

THIRD SEMESTER **(329) ELECTRICALENGINEERING (IC)**

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	CONTROL SYSTEM	PROGRAM CORE (PRACTICUM)	02	-	02	3	40	-	40	60	3	-	-	60	100
3.2	ELECTRICAL CIRCUITS	PROGRAM CORE (PRACTICUM)	01	-	04	3	-	60	60	-	-	40	3	40	100
3.3	ELECTRICAL AND ELECTRONIC MEASUREMENTS	PROGRAM CORE (PRACTICUM)	02	-	04	4	-	60	60	-	-	40	3	40	100
3.4	ELECTRIC MACHINE- 1	PROGRAM CORE (THEORY)	04	-	-	4	40	-	40	60	3	-	-	60	100
3.5	ELECTRIC MACHINE- 1 (Lab)	PROGRAM CORE (PRACTICAL)	-	-	04	2	-	60	60	-	-	40	3	40	100
3.6	ADVANCE SKILL DEVELOPMENT	(Q)OPEN ELECTIVE -1 (THEORY)	02	-	-	2	50	-	-	-	-	-	-	-	N/A
		(Q)OPEN ELECTIVE-1 (Certification Course)					-	-	-	-	-	-	-	-	N/A
3.7	SUMMER INTERNSHIP** (4 WEEKS)		-	-	-	2	-	50	50	-	-	-	-	-	50
#STUDENT CENTERED ACTIVITIES			-	-	11	-	-	50	50	-	-	-	-	-	50
Total			11		25	20	80	280	360	120		120		240	600

NOTE: -

1. (Q) It is compulsory to appear and to pass the examination, but marks will not be included for percentage and division of obtained marks.
2. Advance skill development mention at the table provides the scope of selecting the course as per choice from the elective list provided in the syllabus conducted by various agencies of repute of duration not less than 20 Hrs (Offline/Online).

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. Photography etc., Seminars, Declamation Contests, voluntary contribution in physical activities, Educational Field Visits, NCC, NSS, Cultural Activities and Self-Study.

(329) ELECTRICAL ENGINEERING (IC)

FOURTH 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	
4.1	FUNDAMENTALS OF POWER ELECTRONICS	PROGRAM CORE (PRACTICUM)	02	-	04	4	-	60	60	-	-	40	3	40	100
4.2	ELECTRIC POWER GENERATION, TRANSMISSION AND DISTRIBUTION	PROGRAM CORE (THEORY)	03	-	-	3	40		40	60	3	-	-	60	100
4.3	ELECTRIC MACHINE- II	PROGRAM CORE (THEORY)	03	-	-	3	40		40	60	3			60	100
4.4	ELECTRIC MACHINE- II (Lab)	PROGRAM CORE (PRACTICAL)	-	-	04	2	-	60	60	-	-	40	3	40	100
4.5	PROGRAM ELECTIVE -1	PROGRAM CORE (PRACTICUM)	01	-	04	3		60	60	-	-	40	3	40	100
4.6	PROGRAM ELECTIVE -2	PROGRAM CORE (THEORY)	03	-	-	3	40		40	60	3	-	-	60	100
4.7	(Q)ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	AUDIT COURSE	02	-	-	-	50	-	50	-	-	-	-	-	N/A
4.8	ADVANCE SKILL DEVELOPMENT	(Q)OPEN ELECTIVE -2 (THEORY)	02	-	-	2	50	-	-	-	-	-	-	-	N/A
		(Q)OPEN ELECTIVE-2 (Certification Course)					-	-	-	-	-	-	-	-	N/A
#STUDENTCENTEREDACTIVITIES			-	-	08	-	-	50	50	-	-	-	-	-	50
Total			**16**		**20**	**20**	**120**	**230**	**350**	**180**		**120**		**300**	**650**

NOTE: -

(Q) It is compulsory to appear and to pass the examination, but marks will not be included for percentage and division of obtained marks.

Advance skill development mention at the table provides the scope of selecting the course as per choice from the elective list provided in the syllabus conducted by various agencies of repute of duration not less than 20 Hrs (Offline/Online).

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. Photography etc., Seminars, Declamation Contests, voluntary contribution in physical activities, Educational Field Visits, NCC, NSS, Cultural Activities and Self-Study.

OPEN ELECTIVE-1

SR.NO.	(Q) THEORY COURSES NAME
1.	ENGINEERING ECONOMICS & ACCOUNTANCY (Course offered by Polytechnic Institute)
2.	DISASTER MANAGEMENT (Course offered by Polytechnic Institute)
SR.NO.	**CERTIFICATE COURSES**
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc) (Annexure 1)
2.	COURSES CONDUCTED BY INFOSYS SPRINGBOARD
3.	COURSES CONDUCTED BY TCS ION
4.	COURSES CONDUCTED BY OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL ORGANIZATION OR PLATFORMS OF REPUTE
5.	COURSES CONDUCTED BY AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES
6.	COURSES CONDUCTED BY C-DAC
7.	COURSES CONDUCTED BY NEILIT

OPEN ELECTIVE -2

SR.NO.	(Q) THEORY COURSES NAME
1.	ECONOMIC POLICIES IN INDIA (Course offered by Polytechnic Institute)
2.	MECHATRONICS (Course offered by Polytechnic Institute)

SR.NO.	**CERTIFICATE COURSES**
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc) (Annexure 1)
2.	COURSES CONDUCTED BY INFOSYS SPRINGBOARD
3.	COURSES CONDUCTED BY TCS ION
4.	COURSES CONDUCTED BY OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL ORGANIZATION OR PLATFORMS OF REPUTE
5.	COURSES CONDUCTED BY AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES
6.	COURSES CONDUCTED BY C-DAC
7.	COURSES CONDUCTED BY 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

Annexure-1

LIST OF COURSES CONDUCTED BY TATA TECHNOLOGIES

1. Fundamentals of Innovation and Design Thinking
2. Product Design and Development
3. Product Verification and Analysis
4. Advanced Automobile
5. Electric Vehicle
6. Internet of Things
7. Advanced Manufacturing
8. Advanced Welding & Painting using Simulator
9. Industrial Automation and MES
10. Industrial Robotics
11. Inspection and Quality Control
12. Advanced Plumbing
13. AI and ML

7. DETAILED CONTENTS OF VARIOUS SUBJETS

PRACTICUM	3.1 CONTROL SYSTEM	L	T	P
		2	-	2

COURSE OBJECTIVES:

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

• Control system: frequency and time domain response.

COURSE OUTCOMES(CO):

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:
CO1 : Explain the fundamental concepts of open/closed-loop systems, classify system types, and apply Laplace transforms for mathematical modeling.
CO2 : Describe the working of control components (Synchros, Servomotors) and determine system stability using the Routh-Hurwitz criteria.
CO3 : Derive Transfer Functions for electrical (filters), thermal, and fluid systems and analyze input-output relationships.
CO4 : Analyze the Time Domain (Rise time, Peak overshoot) and Frequency Domain (Bode, Nyquist) stability of control systems.
CO5 : Compare the performance of P, PI, and PID controllers and discuss their implementation in Electronic, Hydraulic, and Pneumatic forms.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO 1	PSO 2
CO1	3	2	-	1	-	-	2	*	*
CO2	3	2	1	2	-	-	1	*	*
CO3	3	3	2	2	-	-	1	*	*
CO4	3	3	1	2	-	-	1	*	*
CO5	3	2	2	2	1	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

Unit – I: The Control System (05 Periods)

Need of automatic control, comparison of open loop and closed loop control, Block diagram of feedback control system and its basic elements, definition and explanation of following control system. (a) Linear and Non -Linear Systems, (b) Continuous and discrete Systems, (c) Static and Dynamic Systems, (d) Single Input Single Output (SISO) System and Multi-Input Multi-Output (MIMO) System, Analogy with electrical system.

Laplace Transform: Definition, Basic theorem and properties, Unit step and Periodic functions, inverse Laplace transform.

PRACTICALS

1. To study behaviour of separately excited dc motor in open loop and closed loop conditions at various loads

Unit – II: Components & Devices used in Control System (06 Periods)

Brief description and working of potentiometer, differential transformer, synchro's, servomotors, tacho-generators, Stepper motors. Concept of stability and necessary conditions, Routh-Hurwitz (R-H) criteria and limitations.

PRACTICALS

1. To determine speed-torque characteristics of an ac servomotor.
2. To determine speed-torque characteristics of an dc servomotor.
3. To study synchro (transmitter and receiver) system and output vs input characteristics

Unit – III: Input Output Relationship of System & Control system Components

(05 Periods)

Concept of transfer function and its use in control system. Derivation of transfer function of following systems and components: (a) Simple low pass and high pass filter (b) First order thermal system and fluid level system, (c) General Feedback Control System.

PRACTICALS

1. Design low pass filter and calculate the cut-off frequency.
2. Design high pass filter and calculate the cut-off frequency
3. To study the time domain response of a second order system for step input and performance parameters.

Unit – IV: Performance of Control System (05 Periods)

Step, Ramp, Pulse and sinusoidal type of inputs and their Laplace Transforms; Time domain response of First order and Second order system with step input; Definitions of Rise time, Peak overshoot, Settling time, Natural frequency and Damping Ratio pertaining to second order system; Initial value and final value theorems and their use in control systems; Types of

feedback systems and error constants; Stability of system, Bode Plot; Polar Plot, Nyquist Plot; Gain margin and phase margin.

PRACTICALS

1. To study the response of first order and second order systems for step input for various values of constant 'K' and compare results
2. To plot a Bode diagram of an open loop transfer function.
3. To draw a Nyquist plot of an open loop transfers functions and examine the stability of the closed loop system

Unit-V: Automatic Control Actions and their applications (07 Periods)

Control actions, Types of control actions, Two position control (On/Off action), Proportional, Proportional plus integral, Proportional plus derivative, Proportional plus integral plus derivative action

Electronic Controller: On-OFF controller, Proportional, PI, PID.

Hydraulic & Pneumatic Controllers: Principle and working of hydraulic controllers (P and PI), Pneumatic PID controller. Comparison of electronic, Hydraulic and Pneumatic controllers.

PRACTICALS

1. To study P, PI and PID controller and compare their performance

RECOMMENDED BOOKS:

1. Nagrath & Gopal, "Control System Engineering", New age International.
2. K. Ogata, "Modern Control Engineering", Prentice Hall of India.
3. B.C. Kuo & Farid Golnaraghi, "Automatic Control System" Wiley India Ltd.
4. D. Roy Choudhary, "Modern Control Engineering", Prentice Hall of India.
5. Norman S. Mise, Control System Engineering, Wiley Publishing Co.
6. Ajit K Mandal, "Introduction to Control Engineering" New Age International.
7. R.T. Stefani, B. Shahian, C.J.Savant and G.H. Hostetter, "Design of Feedback Control Systems" Oxford University Press.
8. Samarjit Ghosh, "Control Systems theory and Applications", Pearson Education

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	05	18
II	06	14
III	05	20
IV	05	20
V	07	28
Total	**28**	**100**

PRACTICUM	3.2 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.

COURSE OUTCOMES(CO):

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:
CO1: Analyse the behaviour of R, L, C elements in single-phase AC series circuits.
CO2: Interpret the performance of R-L, R-C, and R-L-C parallel AC circuits.
CO3: Explain the generation and configuration of three-phase systems for star and delta connections.
CO4: Apply mesh and nodal analysis techniques to simplify and solve electrical circuits.
CO5: Use fundamental network theorems to analyse electrical circuit performance.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO 1	PSO2
CO1	3	3	2	3	1	1	2	*	*
CO2	3	3	2	3	1	1	2	*	*
CO3	3	3	2	3	2	2	2	*	*
CO4	3	3	3	2	1	2	2	*	*
CO5	3	3	3	2	1	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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.

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 identify, 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.

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
11. Rahul Wadhwa, Basic of Electrical Engineering, Asian Publishers, Muzaffarnagar. ISBN: 978-93-5502-068-0

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	3.3 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.

COURSE OUTCOMES(CO):

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:

CO1: Explain the significance of measurement systems.
CO2: Demonstrate the working principles and applications of MI and MC instruments.
CO3: Analyse the construction, operation, and range extension techniques.
CO4: Describe the working principles and features of electronic energy meters.
CO5: Apply appropriate instruments and bridge methods to measure electrical parameters.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO 1	PSO 2
CO1	3	2	1	2	1	1	2	*	*
CO2	3	2	2	3	1	1	2	*	*
CO3	3	3	2	3	2	2	2	*	*
CO4	3	2	2	3	2	2	2	*	*
CO5	3	3	3	3	2	2	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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.

18. Dr. T.D. Bisht, Ashish Sahu, Pooja Yadav, Electrical Instrumentation & Measurement, Asian Publishers, Muzaffarnagar. ISBN: 978-93-91541-29-3

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**

THEORY	3.4 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.

COURSE OUTCOMES(CO):

The theory should be taught in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

CO1 : Understand the significance and operation of DC Generator.
CO2 : Understand the significance and operation of DC Motor.
CO3 : Describe Principles and applications of single-phase transformer.
CO4 : Describe the construction & operation of three-phase transformer and its accessories.
CO5 : Apply maintenance strategies for electrical equipment.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO 1	PSO2
CO1	3	2	1	1	1	-	1	*	*
CO2	3	3	2	1	1	-	1	*	*
CO3	3	3	1	1	1	-	2	*	*
CO4	3	2	2	1	1	-	2	*	*
CO5	2	2	-	2	1	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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 / transformers 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 transformers 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.
9. Dr. T.D. Bisht, Ashish Sahu, Pooja Yadav, Electrical Machine-I, Asian Publishers, Muzaffarnagar. ISBN: 978-93-91541-30-9

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**

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

COURSE OBJECTIVES

The objective of an Electrical Machines- I Practical Course is to provide hands-on experience in understanding and implementing fundamental concepts of Electrical machines. The course aims to familiarize students with the testing and operation of DC machines and Transformer. It emphasizes the practical application of DC machines and Transformer through laboratory experiments. Practical aspects of the practical will make the students capable of performing various tests on the machines as per latest BIS specifications.

COURSE OUTCOMES(CO):

After successful completion of this course, the students will be able to

CO1: Control the speed and direction of DC motors and analyze their performance using brake tests.
CO2: Interpret the load characteristics of Self-Excited DC Generators (Shunt and Series).
CO3: Determine the efficiency, regulation, and equivalent circuit parameters of single-phase transformers using direct and indirect (OC/SC) testing methods.
CO4: Demonstrate special transformer connections including parallel operation, polarity testing, and autotransformer configurations.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	1	2	1	2	2	*	*
CO2	3	2	-	3	-	2	2	*	*
CO3	3	2	1	3	1	2	2	*	*
CO4	3	1	2	2	-	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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.

INSTRUCTIONAL STRATEGY

Electrical Machine -I Practical course focuses on a hands-on, experiential learning approach. It integrates theoretical concepts with practical experiments to reinforce understanding. Initially, students are introduced to basic various types of electrical motors and transformers which are employed in industry, power stations, domestic and commercial appliances etc. through demonstrations. Following this, they engage in guided experiments and testing circuits. Interactive discussions, problem-solving sessions, and troubleshooting exercises encourage critical thinking. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications.

SUGGESTED DISTRIBUTION OF MARKS FOR INTERNAL EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Practical Test	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

Part	Description	Marks Allotted
1.	Objective	**5**
2.	Circuit Diagram	**5**
3.	Procedure and Connections	**5**
4.	Observation Table and Calculation	**5**
5.	Result and its Discussion, Conclusion	**10**
6.	Viva-Voce	**10**
	Total	**40**

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.

COURSE OUTCOMES(CO):

CO1: Explain the fundamental concepts of managerial economics, firm objectives, and the decision-making process in an engineering context.
CO2: Analyze market dynamics by applying the concepts of demand and supply elasticity and forecasting techniques.
CO3: Apply production functions and cost analysis techniques to optimize resources and estimate short-run and long-run costs.
CO4: Determine appropriate pricing strategies based on market structures (perfect/imperfect competition) and government regulations.
CO5: Interpret financial statements (Balance Sheet, P&L) and evaluate investment risks/returns using Ratio Analysis, NPV, and IRR.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	1	-	-	-	1	2	1	*	*
CO2	2	3	-	1	2	2	1	*	*
CO3	2	3	1	-	1	2	1	*	*
CO4	1	2	-	-	3	2	1	*	*
CO5	2	3	-	2	1	3	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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.

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

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.

COURSE OUTCOMES(CO):

After competing this course, student will be:

CO1: Acquainted with fundamental concepts of disaster, hazard, vulnerability, risk, and capacity, and explain their inter-relationships.

CO2 : Classify various types of disasters (Geological, Hydro-meteorological, Biological, Man-made) and analyze their causes, trends, and consequences.

CO3 : Apply the Disaster Management Cycle (Pre, During, Post) and global frameworks (Hyogo, IDNDR) to plan for risk assessment and mitigation.

CO4 : Familiarised with institutional and legal mechanism of Disaster Management in India, including the DM Act 2005 and the role of various agencies.

CO5: Able to select scientific tools (GIS, RS, GPS) and engineering practices (structural/non-structural mitigation) for disaster preparedness and safe construction.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	2	-	-	-	3	-	1	*	*
CO2	3	2	-	-	3	-	2	*	*
CO3	1	2	1	-	3	2	2	*	*
CO4	2	-	-	-	3	1	2	*	*
CO5	3	2	1	2	3	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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**

PRACTICUM	4.1 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.

COURSE OUTCOMES (CO):

On successful completion of this course, the student will be able to

CO1 : Understand the construction, working, and specifications of power electronic devices (SCR, IGBT, TRIAC, DIAC) and test their characteristics.

CO2: Analyze various Turn-on (Triggering) and Turn-off (Commutation) methods for SCRs and demonstrate them using experimental circuits and real-world applications.

CO3 : Analyze single-phase controlled rectifiers with R and RL loads to determine output voltage and waveform characteristics.

CO4 : Understand the working principles of Inverters, Choppers, Dual Converters, and Cyclo-converters and test their performance.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	-	3	-	-	1	*	*
CO2	3	3	2	3	-	1	1	*	*
CO3	3	2	1	3	1	-	2	*	*
CO4	3	2	1	3	1	-	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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**

THEORY	4.2 ELECTRIC POWER GENERATION, TRANSMISSION AND DISTRIBUTION	L	T	P
		3	-	-

COURSE OBJECTIVES:

Course Objectives: The objective of this course is to enable the student to understand various power generation methods, site selection factors and load management techniques. Analyze AC transmission systems, including components, conductor properties, and overhead line calculations. Introduce HVDC transmission principles, converter stations and integration with renewables and FACTS controllers. Explain line insulator properties, types, and methods to improve string efficiency. Describe underground cable construction and types. Understand distribution system requirements, components and classifications. Identify substation types and key equipment.

COURSE OUTCOMES (CO):

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:

CO1: Explain various methods of electrical power generation.
CO2: Describe the layout and components of AC transmission systems.
CO3: Interpret HVDC transmission configurations and converter station layouts.
CO4: Evaluate the properties, types, and testing methods of line insulators.
CO5: Analyze the structure and classification of electrical distribution systems and substations.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	2	1	3	2	2	*	*
CO2	3	3	2	3	2	2	2	*	*
CO3	3	3	3	3	3	2	3	*	*
CO4	3	2	2	3	2	1	2	*	*
CO5	3	3	3	2	3	3	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

Unit – I: Generation of Electrical Power (08 Periods)

Methods of Generation: Schematic arrangement and choice of site for Hydel, Thermal, Nuclear power plants - Block Diagram of Diesel, Solar Thermal, Solar Photovoltaic – Solar Cell Technologies – Wind & Pumped storage schemes. Load Management: Grid or Interconnected system – Smart Grid - Load curve - Demand factor - Load factor - Plant Use Factor - Diversity factor – Plant capacity factor – Load Dispatching Centre..

Unit – II: A.C 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 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 Problems).

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

H.V.D.C Transmission: Layout Scheme - D.C Link configurations (Mono polar, Bipolar and Homo polar) - 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: Distribution (06 Periods)

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. Sub stations - Classification of sub stations - Indoor and outdoor S.S - Gas insulated S.S – Layout of 110/11KV Substation and 11KV/400V Distribution Substation - Substation equipments - Bus bar - Types of bus bar arrangements.

RECOMMENDED BOOKS:

1. Gupta, B.R., Generation of Electrical Energy, S. Chand & Co. New Delhi,
2. Rachel, Sthuthi; Earnest, Joshua – Wind Power Technologies, PHI Learning, New Delhi, ISBN: 978-93-88028-49- 3; E-book 978-93-88028-50-9

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

3. Solanki, Chetan Singh, – Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning, New Delhi, ISBN: 9788120351110
4. Hau**,** Erich, Wind Turbines, Springer-Verlag, Berlin Heidelberg, Germany, ISBN:978-3-642-27150-2
5. Gipe, Paul, Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304
6. Wizelius, Tore; Earnest, Joshua – Wind Power Plants and Project Development, PHI
7. Gupta, J.B. A Course in Electrical Power– S. K Kataria and Sons, New Delhi. 2014,
8. Soni, Gupta, Bhatnagar, A Course in Electrical Power. – Dhanpat rai and Sons
9. System, S.Chand & Co. New Delhi, 2005, ISBN: 9788121924962
10. Ashish Sahu, Pooja Yadav, Transmission and Distribution Electrical Power, Asian Publishers, Muzaffarnagar. ISBN: 978-93-5502-044-4

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
I	08	24
II	10	19
III	08	19
IV	10	19
V	06	19
Total	**42**	**100**

THEORY	4.3 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.

COURSE OUTCOMES (CO) :

On successful completion of this course, the student will be able to

CO1 : Understand rotating magnetic fields, induction motor principles, construction, characteristics, starting and speed control methods.

CO2: Examine single-phase motor types, maintenance practices.

CO3 : Understand alternator principles, construction, types, EMF equation, and applications and Achieve expertise in voltage regulation, testing, load analysis, and synchronization of alternator.

CO4 : Understand synchronous motor principles, behaviours and its applications

CO5 :, Understand construction of special Electrical Machines and its applications

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	3	1	1	2	-	2	*	*
CO2	3	2	1	-	2	-	2	*	*
CO3	3	2	1	1	1	-	1	*	*
CO4	3	2	1	1	-	1	1	*	*
CO5	3	2	1	1	2	-	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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
10. Dr. T.D. Bisht, Pooja Yadav, Electrical Machines-II , Asian Publishers, Muzaffarnagar. ISBN: 978-93-91541-98-9

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**

PRACTICAL	4.4 ELECTRICAL MACHINES-II	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:

COURSE OUTCOMES (CO):

CO1: Connect and operate single-phase and three-phase induction motors using various starters (DOL, Star-Delta) and control their speed.
CO2: Analyze the performance of induction motors by conducting direct load tests and indirect tests (No-load/Blocked rotor) to determine efficiency, parameters, and power factor.
CO3: Determine the voltage regulation and efficiency of three-phase alternators using direct loading and synchronous impedance methods, and demonstrate synchronization.
CO4: Interpret the performance of synchronous motors by plotting V-curves and Inverted V-curves under varying excitation.
CO5: Demonstrate speed and direction control of special electric machines like Stepper motors and Servo motors.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO 1	PSO 2
CO1	3	1	2	3	1	2	1	*	*
CO2	3	3	2	3	1	2	1	*	*
CO3	3	3	-	3	1	2	1	*	*
CO4	3	2	-	3	-	1	1	*	*
CO5	3	1	2	3	-	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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) autotransformer, (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) Synchro scope 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

SUGGESTED DISTRIBUTION OF MARKS FOR INTERNAL EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Practical Test	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

Part	Description	Marks Allotted
1.	Objective	**5**
2.	Circuit Diagram	**5**
3.	Procedure and Connections	**5**
4.	Observation Table and Calculation	**5**
5.	Result and its Discussion, Conclusion	**10**
6.	Viva-Voce	**10**
	Total	**40**

PRACTICUM	4.5.1 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 (CO): On successful completion of this course, the student will be able to

CO1 : Explain the necessity of Industrial Automation and classify systems into Fixed, Programmable, and Flexible types.

CO2: Identify the building blocks of a PLC (CPU, I/O Modules) and select appropriate modules for interfacing with field devices.

CO3 : Develop and test PLC programs using Ladder Logic for applications like Traffic Control, Motor Sequencing, and Tank Level control.

CO4 : Demonstrate the interfacing of analog sensors (RTD/Thermocouple) with PLCs and control the speed of motors using Variable Frequency Drives (VFD).

CO5: Design SCADA Mimic diagrams, define Tags, and interface them with PLC systems using OPC architecture for process monitoring.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	2	-	-	1	2	-	1	*	*
CO2	3	1	1	2	-	-	1	*	*
CO3	3	3	3	3	1	1	2	*	*
CO4	3	2	2	3	1	-	2	*	*
CO5	3	2	3	3	-	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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.

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

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).
2.

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	4.5.2 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 (CO) : On successful completion of this course, the student will be able to

CO1 : Explain the basic block diagram of instrumentation systems and identify various switching devices used in control.
CO2: Select and demonstrate the working of suitable transducers (LVDT, Strain Gauge, Piezo, etc.) for measuring displacement and strain.
CO3 : Measure non-electrical quantities (Temperature, Pressure, Speed, Flow) using appropriate sensors (RTD, Thermocouple, Tachometer).
CO4 : Analyze signal conditioning circuits using Op-Amps (Inverting, Non-inverting, Instrumentation Amplifier) for sensor interfacing.
CO5: Interpret Data Acquisition Systems (DAS), convert data (ADC/DAC), and apply condition monitoring techniques for electrical equipment.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	-	-	1	-	-	2	*	*
CO2	3	2	1	3	1	-	1	*	*
CO3	3	2	2	3	1	-	2	*	*
CO4	3	3	2	3	-	-	2	*	*
CO5	3	2	1	2	1	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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.

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

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

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	4.6.1 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 (CO) :

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:

CO1: Explain the classification, construction, and working principles of solar thermal and PV systems.
CO2: Describe layouts, and operating principles of geared and direct-drive large wind power plants.
CO3: Analyze the design, working, and installation of horizontal and vertical axis small wind turbines.
CO4: Explain the energy conversion process, classification, and turbine selection for micro hydro power plants.
CO5: Evaluate the properties of solid, liquid, and gaseous biomass fuels.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO 1	PSO 2
CO1	3	2	2	2	3	2	2	*	*
CO2	3	3	3	3	3	2	2	*	*
CO3	3	3	3	3	2	2	2	*	*
CO4	3	3	3	3	3	2	2	*	*
CO5	3	3	3	2	3	2	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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	4.6.2 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 (CO) :

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:

CO1: Explain the types of biomass fuels and interpret the layouts of bio-chemical, thermo-chemical, and agro-chemical power plants.

CO2: Describe the principle of biomass gasification, the construction of gasifiers, and power generation using gas engines..

CO3: Analyze the specifications and working of specific gasifiers (Rice Husk, Bamboo, Coconut, Bagasse) and Gobar gas plants for appropriate selection.

CO4: Classify micro-hydro power plants based on head and explain their general layout, energy conversion process, and site selection.

CO5: Discuss the construction and working of hydraulic turbines (Pelton, Francis, Kaplan) and apply safety and maintenance practices for micro-hydro plants.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	-	1	-	3	-	2	*	*
CO2	3	1	-	-	3	-	2	*	*
CO3	3	1	2	1	3	2	2	*	*
CO4	3	1	1	-	3	-	1	*	*
CO5	3	2	1	1	3	2	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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**

AUDIT COURSE	4.7 ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	L	T	P
		2	-	-

COURSE OBJECTIVE:

To introduce the rich heritage of the Indian Knowledge System, bridging ancient wisdom with modern science and promoting holistic well-being through Yoga and traditional healthcare practices.

COURSE OUTCOMES (CO) : At the end of the course, the student will be able to:
CO1: Explain the foundational structures of the Indian Knowledge System, including the Vedas, Upavedas, Vedangas, and Upangas, and discuss their historical significance.
CO2: Relate ancient Indian scientific and technological achievements to modern science and analyze the convergence of science and spirituality.
CO3: Describe the basic principles of Yoga and Holistic Healthcare and evaluate their benefits and potential for integration with modern medicine.
CO4: Analyze case studies to demonstrate the contemporary relevance and practical application of Indian Knowledge Systems in solving modern problems.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	1	-	-	-	3	-	2	*	*
CO2	2	2	-	-	2	-	2	*	*
CO3	-	-	-	-	3	2	3	*	*
CO4	1	2	2	-	3	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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

MEANS OF 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**

THEORY	4.8 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.

COURSE OUTCOMES (CO) :

CO1: Explain the basic features of the Indian economy, including demographic trends, and analyze major economic problems like poverty, unemployment, and inflation.

CO2: Discuss the role of the agricultural sector, the impact of land reforms and the Green Revolution, and evaluate current agricultural policies.

CO3: Describe the industrial development pattern, the significance of small-scale industries, and the growth of the service sector in India.

CO4: Analyze the framework of economic planning (Planning Commission vs. NITI Aayog), and the impact of Monetary, Fiscal, and LPG policies.

CO5: Interpret India's external sector performance, including foreign trade composition, Balance of Payments, and the impact of Globalization and WTO.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	1	2	-	-	2	1	2	*	*
CO2	1	2	-	-	2	1	1	*	*
CO3	1	1	-	-	2	2	2	*	*
CO4	1	2	-	-	3	3	2	*	*
CO5	1	2	-	-	2	2	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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 – 5: 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	4.8 MECHATRONICS (OE-2)	L	T	P
		02	-	-

COURSE OBJECTIVES:

To equip with the comprehensive ability to integrate mechanical, electronic, and fluid power systems by analyzing and designing solutions using sensors, controllers (PLC/PID), drives, and hydraulic/pneumatic circuits for industrial automation.

COURSE OUTCOMES (CO) : At the end of the course, the student will be able to:
CO1: Explain the fundamentals of mechatronics systems, their architecture, and real-time applications.
CO2: Select appropriate sensors, transducers, and controllers for data conversion and signal processing in automation.
CO3: Discuss the operation and application of electrical drives and mechanical mechanisms.
CO4: Design hydraulic circuits by selecting suitable pumps, valves, and actuators to meet specific force and speed requirements.
CO5: Develop pneumatic system designs using standard graphic symbols and explain the production, distribution, and conditioning of compressed air.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	1	-	1	-	1	*	*
CO2	3	2	2	2	-	-	2	*	*
CO3	3	1	1	2	-	-	1	*	*
CO4	3	2	2	2	-	1	1	*	*
CO5	3	2	2	2	1	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

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**

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% 6 Marks

b) 80 - 85% 8 Marks

c) Above 85% 10 Marks

iii. * Even Semester:

25 Marks maximum for Sports/NCC/Cultural/Co-curricular/NSS activities as per following:
(by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) State/National Level participation

b) Participation in two of above activities

c) Inter-Polytechnic level participation

****Odd Semester:**

25 Marks maximum

a) Language Lab Practices / foreign language practices

b) Group Discussion and Personality Development

c) Industrial Visits/Industrial Talks

d) Power Point Presentations and Resume Making

e) Development of Aptitude and Reasoning Skills

f) Participation in the technical Exhibitions, Symposiums, Seminars, Workshops at the Institute /District/State/National Level.

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 classrooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

b) Equipment Requirement:

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

CONTROL SYSTEM

S. No.	Equipment Name	Broad Specification	Qty
1	Separately Excited DC Motor Setup with DC power Supply	0–220V DC, 5–10A, 220V DC, 1 HP, 1500 RPM, with loading arrangement (resistive or mechanical)	1
3	Load Bank / Dynamometer	Resistive or mechanical type with adjustable load	1
4	Tachometer / Digital RPM Meter	non-contact type; RPM range: 0–3000 RPM	1
5	AC Servomotor with Trainer with Servo Amplifier (AC)	Servo Amplifier 0–10V input, 400Hz output (compatible with AC servomotor) 90V, 400Hz, 4000 RPM, 50–100W, includes speed-torque measurement setup	1
7	DC Servomotor with Trainer including Servo Amplifier (DC)	12V/24V DC, 100–200W, includes loading and measurement instruments (Servo amplifier 0–10V input for speed control)	1
9	Synchro Pair (Transmitter & Receiver)	110V AC, 400Hz, shaft movement: 0–360°, error signal measurement	1 set
10	Synchro Trainer Kit	With features of Transmitter, receiver, dial indicators, error voltage measurement	1

11	Function Generator	Output: Sine/Square/Triangle; 1Hz–1MHz; Voltage range: 0–20V	2
12	Oscilloscope / Digital Storage Oscilloscope	20–100 MHz; 2-channel	2
13	First & Second Order System Trainer Kit	Adjustable gain (K), time constant (T), damping ratio (ζ), with built-in step input	1
14	Bode Plot Trainer / Frequency Response Kit	10Hz to 100kHz, includes input/output phase & magnitude measurement	1
15	PID Controller Trainer Kit	P, PI, PID controller with adjustable gains, analog/digital, includes plant simulation (temp, DC motor, etc.)	1
16	Low Pass Filter Components	R: 1kΩ–1MΩ or better , C: 1nF–1μF or better	LS
17	High Pass Filter Components	R: 1kΩ–1MΩ or better , C: 1nF–1μF or better	LS
18	Breadboard and Jumpers	Standard breadboard (840 points), jumper wires	LS
19	Digital Multimeter	Auto-ranging; measures V, A, Ω; 3.5 digit display	5
20	Desktop PC	Minimum i3, 4GB RAM, 500GB HDD/SSD	5
21	MATLAB / Scilab Software	MATLAB with Control System Toolbox (licensed) or Scilab (free) with XCOS	1 site
22	Op-Amps (e.g., 741, TL082)	DIP-8 packages; Dual op-amp: ±12V or ±15V supply	15
23	Resistors (Assorted Box)	Range: 1Ω–1MΩ, 0.25W and 0.5W tolerance: 1% or 5%	1 box
24	Capacitors (Assorted Box)	Range: 1nF–10μF	1 box
25	Dual Power Supply (±12V / ±15V)	For op-amp circuits; 500mA to 1A	2
26	Soldering Station	Temperature-controlled iron, solder, flux, stand	2
27	Angle Measuring Device	Rotary encoder, digital angle meter or protractor	1
28	Graph Papers / Plotting Software	Logarithmic and linear graph paper; or Excel / Scilab plotting	LS

ELECTRICAL MACHINE-I AND ELECTRICAL MACHINE-II LAB

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, digital voltmeter, ammeter, wattmeter, RPM meter with suitable loading arrangement and appropriate panel board.	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 , board for no-load and blocked rotor test	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	a) DOL starter, suitable for 415V, 3 Phase, 50 Hz, 3kw induction motor b) Auto transformer starter for 3 phase, 415 V,	1

	starter	50 Hz,3 Kw induction motor with facility of 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 with appropriate panel for OC&SC Test and calculation of efficiency and regulation.	1
18	Alternator Synchronizing panel	With synchroscope and lamp method arrangements	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

27	DC Shunt Motor	230V,3hp/3kW, 1440rpm complete with appropriate panel board with meters, switches, indicators starter and field regulator	1
28	DC Series motor	series motor with interpole/compensating winding, 230 V, kw, 1440 rpm with braking (eddy current or drum pulley) arrangement and appropriate panel board and over speed safety precautions e.g. lights hunt winding etc	1
29	Static Converter:	3-Phase, 415 V, 50 Hz, output 230 V dc 15 KW,regulation + 1%, servo controlled, transistorized	1
30	1-phase transformer	Single phase transformer,230/115 V,50Hz,3KVAhousedinametaltank	1
31	Power Factor Meter	Portable Power factor meters: Dynamo meter type, eddy current type, damping, frequency cy cycle 50Hz , scale length150 mm, current rated upto20A,Volt-300V.p.f. range 0.5 lag-unity0.5 lead, housed in teak wood/ebonite case with anti parallex mirror with knife edge pointer a) Portable type single phase single element type 110V/240Vor1Aor 5A Portable type3-phase single element type 110 V/240V,1Aor5A	1
32	DC Series Generator	DC Motor- Generator set 230 Volt 3Hp 1500rpm DC Shunt Motor Prime mover	1
33	DC Shunt Generator	DC Motor- Generator set 230 Volt 3Hp 1500rpm DC Shunt Motor Prime mover	1
34	BDV Test kit	Input Voltage: S230 V AC, 50 Hz, single phase. Output Voltage: Typically adjustable from 0 kV to 60 kV, 80 kV, or 100 kV. Voltage Ramp Rate: 0.5 kV/s, 1.0 kV/s, 2.0 kV/s, and 3.0 kV/s. Accuracy: The voltage measurement accuracy is typically ±1% of the full scale.	1
35	Single phase lamp load	1 KW, 4 Amps	1

ELECTRICAL AND ELECTRONIC MEASUREMENTS LAB
&
ELECTRIC CIRCUITS LAB

S. No.	Name of Equipment	Broad Specifications	Quantity
1.	PMMC Voltmeter	0-240V DC	02
2.	MI Voltmeter	0-125-250 volts 0-250-500 volts	02 02
3.	PMMC Ammeter	0-5A DC	02
4.	MI Ammeter	0-500 mA-1000 mA b) 0-5-10 amp c) 0-2 amp	02 02 02
5.	Single Phase Wattmeter (750W):	Portable Wattmeter: Dynamometer type, 750W, Current Range: 0-5-10 V; Voltage Range: 0-125-250V	01
6.	Single Phase Wattmeter (1250W):	Portable Wattmeter: Dynamometer type, 1250W, Current Range: 0-5-10 V; Voltage Range: 0-250V-500V	02
7.	Power factor meter	Single phase	01
8.	Clamp on meter	0-240V, 40A	01
9.	Load: 3 phase variable resistive load	415 V, 10 KW, trolley mounted tube type provided with switches to vary the load in twenty steps	01
10.	Load: 3 phase variable inductive load	Continuously variable inductive load, 415 V, 10 kW terminal for end connections	01
12.	Current Transformer:	100-50-25-10/5A	01
13.	Potential Transformer:	230 / 110 V	01
14.	Single Phase Energy Meter	0-240 Volt/0-10 Ampere/50 Hz Frequency	02
15.	Single Phase Lamp Load	100W; 200W	05 each

16.	Digital Multimeter	Digital/type: 3 1/2 digit LCD display manually operated multimeters with AC/DC 10 A and 10 mega ohm, accuracy+ 0.5% for DC and +1% for AC	01
17.	Kelvin's Bridge Experiment kit		01
18.	Digital Insulation testing Kit (Megger)	With auto-ranging, the rated voltage can be -100V, 250V, 500V, 1000V.	01
19.	Digital Earth Tester	Range 0-20Ω	01
20.	CRO	25 MHz, Attenuator probe for CRO	01
21.	Tri Vector meter	Single phase, 0-240V/0-10A	01
22.	Copper Wire	As per requirement	L.S.
23.	Low Resistors (Shunt), Medium Range Resistors and High Range Resistors	As per requirement	L.S.
24	Digital Storage Oscilloscope	Digital Storage Oscilloscope: Dual Trace 50Mhz	01
25	R,L,C Voltage and current response Series/Parallel experimental kit	Mains Supply-220V AC, with Meters Digital cabinet-mild steel/Wooden	05
26	Experimental kit setup to determine Active, Reactive and Apparent power of RL, RC and RLC series/Parallel circuit	Mains Supply-220V AC, with Meters Digital cabinet-mild steel/Wooden	05
27	RLC Series/Parallel Resonance Trainer Kit	Digital DC Ammeter 20mA Digital Frequency Counter Up to 40 Mhz. 0-100 KHz Sine Wave Generator	05
28.	Experimental kit setup to determine Active, Reactive and Apparent power of RL, RC and RLC Parallel circuit	Mains Supply-220V AC, with Meters Digital cabinet-mild steel/Wooden	05
29.	Experimental kit to determine current through an electric network by applying nodal and Mesh analysis.	One DC Regulated Power Supply Two digital Meters Banana Type Sockets for connections	05

30.	Experimental Kit for Thevenin and Norton theorem	Regulated & short circuit proof variable DC voltage source – 01 No, Fixed resistance of different values with DC Voltmeter and Ammeter.	02
31.	Experimental Kit for Maximum Power transfer theorem	Variable power supply 9 V, 500 mA On panel resistor network with load resistor On panel two digital meters	02
32.	Experimental Kit for superposition theorem	One DC Regulated Power Supply Two digital Meters Banana Type Sockets for connections	02
33.	Regulated DC power supply	0-30V, 0-3A	02
34.	Jumper Wires	M to M, M to F, F to F	L.S.
35.	Solderless Breadboard	No. of points as per requirement	L.S.
36.	Resistance, Inductor, Capacitor	1-10kΩ, 0-20W, 0-40W, pFd, mFd	L.S.

FUNDAMENTALS OF POWER ELECTRONICS LAB

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

INDUSTRIAL AUTOMATION AND CONTROL LAB

S.N.	Name of Equipments	Broad Specifications	Quantity
1	PLC Trainer Kit with programming software and cable	As per required application	5
2	PLC	16 DI, 16 DO, 2 AI, 2 AO, 24V DC, 100–240V AC supply	2
3	SMPS Power Supply	24V, 2.5A or more	5
4	Push Button Switches (NO & NC)	Red, Green, Yellow	20
5	Proximity Sensors (Inductive)	PNP type, 24V DC, 1-40mm sensing distance	10
6	Limit Switches	standard	10
7	Stepper Motor + Driver	Unipolar/bipolar,	5
8	AC Lamp Holders + 24V Bulbs	24V indicator lamps	10
9	Relay Modules	4/8 channel 24V DC	5
10	Temperature Sensor	PT100 or K-type with transmitter (4-20 mA or 0–10V output)	10
11	Mini AC Motors (230V or 24V)	1-phase or 24V DC with 0.1–0.25HP rating	5
12	Breadboard	standard	20
13	Wires, connectors, terminals	As per Requirements	L.S.
14	P.C.	I7 core, RAM 8Gb or more	

INDUSTRIAL INSTRUMENTATION AND CONDITION MONITORING LAB

S. No.	Name of Equipment	Broad Specifications	Quantity
1	Proximity sensor kit (Inductive + Capacitive + IR + Ultrasonic)	Inductive (NPN/PNP, 10–30 VDC, sensing 2–10 mm), Capacitive (10–30 VDC), IR emitter/receiver, Ultrasonic module (2–400 cm), mounted demo board with indicators	3
2	Solid State Relay (SSR) evaluation kit & electromagnetic relay set (compare SSR vs electromech)	SSR: 24–280 VAC control, 25–40 A load; Electromagnetic relays: 12/24 V DC coil, 10 A contacts; test board	2
3	Alarm & control demo panel (push/button + relay + buzzer + indicator)	230 VAC/24 VDC inputs, PCB + enclosures, lamps, horn	2
4	RVDT angular displacement trainer	RVDT ±30° range, excitation 5–10 VAC, output conditioner + digital display	2
5	Semiconductor strain-gauge kit + bonded strain gauge set	Semiconductor strain gauge + carrier, bonded foil gauges, wheatstone bridge module, signal conditioner (instrumentation amp)	2
6	Load-cell weighing kit (mini weighing scale)	Load cell 0–5 kg or 0–10 kg, signal conditioner (HX711 or 4–20 mA), indicator	3
7	Humidity & temperature sensor trainer	Capacitive RH sensor (0–100% RH), temp sensor (RTD/thermistor), display & DAQ interface	2
8	Op-amp active filter / signal conditioning trainer (incl. AD620 INA	Dual/quad op-amp sockets (741/LM324/OP07), INA/AD620 module, power supply ±12/15 V, prototyping area	3
9	Instrumentation amplifier (AD620) teaching kit	AD620 module, gain resistors, breakout board, lab manual	3
10	Multi-channel DAS / Data logger (standalone)	8 AI (0–10 V/4–20 mA), logging to SD/PC, sampling >1 kS/s aggregate	1
11	Motor Current Signature Analysis (MCSA) kit	CT clamp, DAQ interface & software for current FFTs (motor fault demo)	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, workload 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 endeavour 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	Weight to be assigned
Knowledge	10-30 percent
Comprehension	40-60 percent
Application	20-30 percent
Higher than application i.e. Analysis, Synthesis and Evaluation	Up to 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 up to 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.
5. Smt. Sakshi Mishra, Lecturer Electrical Engineering, Govt. Poly. Harak, Barabanki.
6. Dr. Preeti Sonkar, Lecturer Electrical Engineering, Govt. Poly. Kanpur.
7. Shri Anurag Agarwal, Lecturer Electrical Engineering, Govt. Poly. Unnao.
8. Shri. Anuj Banswar, Lecturer Electrical Engineering, Govt. Poly. Puranpur.
9. Shri. Ankit Kumar, Lecturer Electrical Engineering, Govt. Poly. Hapur.
10. Shri. Deep Chandra, Lecturer Electrical Engineering, Govt. Poly. Bindki, Fatehpur.
11. Shri. Praveen Kumar Tiwari, Lecturer Electrical Engineering, MMIT, Hariharpur, Gorakhpur.
12. Shri. Homendra Pal Singh, Lecturer Electrical Engineering, Govt. Poly. Debai, Bulandshahr.
13. Shri. Vivek Anand Verma, Lecturer Electrical Engineering, Govt. Poly. Jigirsand, Ballia.
14. Shri. Tilak Singh, Lecturer Electrical Engineering, Govt. Poly. Talbhet, Lalitpur.
15. Shri. Rohit Choudhary, Lecturer Electrical Engineering, Govt. Poly. Kirthal, Bagpat.

13. 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 METHODOLOGY

1. EVALUATION METHOD for THEORY

	Internal Assessment (40 marks)				External Assessment (60 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Written Test**	**Written Test**	**Attendance and Assignments**	**Pre – Semester Examination**	**End Semester Examination**
Portion	2 units	2 units	Regularly	All units	All units
Duration1hr	1hr	1hr	-	3hrs	3hrs
Exam Marks	20	20	20	60	60
Converted to	10	10	15	15	60
Tentative Schedule	5^{th} Week	10^{th} Week	Regularly	12^{th} -13^{th} Week	

IA1 and IA2: A written assessment test worth 20 marks should be conducted for two units. The marks earned (20 marks) will be converted to 10 marks. The best of the two assessments will be evaluated for an internal 10-mark assessment.

IA3: Assignments given after the completion of each unit, along with attendance throughout the semester, will be assessed for a total of 15 marks.

IA4: The pre-semester examination should follow the end-semester examination question pattern. The marks should be adjusted to 15 for internal assessment.

2. EVALUATION METHOD for PRACTICAL

	Internal Assessment (60 marks)				External Assessment (40 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Practical Test**	**Practical Test**	**Attendance and Practical Documentation**	**Practical Test and Quiz – Viva Voce**	**Practical Examination**
Portion	50% Practical	50% practical	All practical	All practical	All practical
Duration	3hrs	3 hrs	Regularly	3 hrs	3hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	5th Week	10th Week	Regularly	12th -13th Week	

IA1 and IA2: Complete all exercises and experiments as outlined and retain them for the practical test. The test should be conducted in accordance with the evaluation scheme. The best of the two practical tests will be internally evaluated for a total of 20 marks.

IA3: Maintain a practical file for each exercise while ensuring attendance throughout the semester. Submit the required documents for the practical file, quiz, and practical test along with a valid certificate (Progress Card). This will be assessed for 20 marks.

IA4: The pre-semester practical examination, quiz, and viva-voce should follow the end-semester practical examination pattern, with marks adjusted to 20 for internal assessment.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Practical Test	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR **EXTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Viva-Voce	**10**
	Total	**40**

3. EVALUATION METHOD for PRACTICUM (End Exam-Practical)

	Internal Assessment (60 marks)				External Assessment (40 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Practical Test**	**Practical Test**	**Attendance and Practical Documentation**	**Micro Project**	**Practical Examination**
Portion	50% practical	50% practical	All practical	All practical	All practical
Duration	3hrs	3 hrs	Regularly	Regularly	3hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	5th Week	10th Week	Regularly	12th -13th Week	

IA1 and IA2: Complete all exercises and experiments as instructed and retain them for the practical test. The test should be conducted according to the evaluation scheme. The best of the two practical tests will be internally assessed for a total of 20 marks.

IA3: Maintain a practical file for each exercise, ensuring attendance throughout the semester. Submit the required documents for the practical file, quiz, practical test, and end-semester examination, along with a valid certificate (Progress Card). This will be evaluated by 20 marks.

IA4: Submit a micro-project report along with a fabrication model or analysis report. The performance of each student in the group will be assessed by both the laboratory supervisor and an internal examiner. This evaluation will contribute 20 marks.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Mini Project	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR **EXTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Viva-Voce	**10**
	Total	**40**

4. EVALUATION METHOD for PRACTICUM (End Exam-Theory)

	Internal Assessment (40 marks)						External Assessment (60marks)
	IA 1		IA 2		IA 3	IA 4	
Mode	**Written Test**	**Practical Test**	**Written Test**	**Practical Test**	**Attendance and Practical Documentation**	**Pre Semester Examination and Micro Project**	**End Semester Examination**
Portion	2 units	Practical related to the units	2 units	Practical related to the units	All unit	All Practical	All unit
Duration	1hr	3hrs	1hr	3 hrs	3hrs	Regularly	3hrs
Exam Marks	10	20	10	20	60	60	60
	30		30				
Converted to	10		10		15	15	60
Tentative Schedule	5th Week		10th Week		Regularly	12th -13th Week	

IA1 and IA2: A written assessment test worth 10 marks should be conducted for two **UNIT**s. Complete all exercises and experiments as outlined and retain them for the practical test worth 20 marks. The practical test should be conducted in accordance with the evaluation scheme. The total marks earned (30 marks) will be converted to 10 marks. The best of the two assessments will be internally evaluated for a total of 10 marks.

IA3: Attendance and the pre-semester examination should follow the end-semester examination question paper pattern. The marks should be adjusted to 15 for internal assessment.

IA4: Maintain a practical file for each exercise. Submit the required documents for the practical file, quiz/viva-voice, practical test, and end-semester examination, along with a valid certificate (Progress Card). This will be assessed for 40 marks. Additionally, submit a micro-project report along with a fabrication model or analysis report. The performance of each student in the group will be evaluated by both the laboratory supervisor and an internal examiner. The total of 60 marks will be converted to 15 marks.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION FOR IA4

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Attendance & Mini Project	**10**
	Total	**40**