STATE COUNCIL FOR TECHNICAL EDUCATION AND VOCATIONAL TRAINING, ODISHA									
TEACHING AND EVALUATION SCHEME FOR 5th Semester (Electrical)(wef 2020-21)									
Subject Number	Subject Code	Subject	Periods/week			Evaluation Scheme			
			L	T	P	Internal Assessment/ Sessional	End Sem Exams	Exams (Hours)	Total
		Theory							
Th.1		Entrepreneurship and Management & Smart Technology	4		-	20	80	3	100
Th.2		Energy Conversion-II	4		-	20	80	3	100
Th.3		Digital Electronics & Microprocessor	5		-	20	80	3	100
Th.4		Utilization of Electrical Energy & Traction	4			20	80	3	100
Th.5		Power Electronics & PLC*	4			20	80	3	100
		Total	21			100	400	-	500
		Practical							
Pr.1		Electrical Machine Lab-II	-	-	6	25	50	3	75
Pr.2		Power Electronics & PLC Lab	-	-	3	25	50	3	75
Pr.3		Digital Electronics & Microprocessor Lab	-	-	3	25	50	3	75
Pr.4		Project Phase– I			3	25	-	-	25
		Student Centered Activities(SCA)		-	3	-	-	-	-
		Total	-	-	*18*	*100*	*150*	-	*250*
		Grand Total	**21**	**-**	**18**	**200**	**550**	**-**	**750**
Abbreviations: L-Lecturer, T-Tutorial, P-Practical. Each class is of minimum 55 minutes duration									
Minimum Pass Mark in each Theory subject is 35% and in each Practical subject is 50% and in Aggregate is 40%									
SCA shall comprise of Extension Lectures/ Personality Development/ Environmental issues /Quiz /Hobbies/ Field visits/ cultural activities/Library studies/Classes on MOOCS/SWAYAM etc. Seminar and SCA shall be conducted in a section.									
There shall be 1 Internal Assessment done for each of the Theory Subject. Sessional Marks shall be total of the performance of individual different jobs/ experiments in a subject throughout the semester									

CURRICULLUM OF 5TH SEMESTER

For

DIPLOMA IN ELECTRICAL ENGINEERING

(Effective from 2020-21 Sessions)

STATE COUNCIL FOR TECHNICAL EDUCATION & VOCATIONAL TRAINING, ODISHA, BHUBANESWAR

Th1. ENTREPRENEURSHIP and MANAGEMENT & SMART TECHNOLOGY

(Common to All Branches)

Theory	**4 Periods per week**	**Internal Assessment**	**20 Marks**
Total Periods	**60 Periods**	**End Sem Exam**	**80 Marks**
Examination	**3hours**	**Total Marks**	**100Marks**

Topic Wise Distribution of Periods

Sl No.	Topic	Periods
1	Entrepreneurship	10
2	Market Survey and Opportunity Identification(Business Planning)	8
3	Project report Preparation	4
4	Management Principles	5
5	Functional Areas of Management	10
6	Leadership and Motivation	6
7	Work Culture, TQM & Safety	5
8	Legislation	6
9	Smart Technology	6
	TOTAL	60

RATIONALE

In the present day scenario, it has become imperative to impart entrepreneurship and management concepts to students, so that a significant percentage of them can be directed towards setting up and managing their own small enterprises. It may be further added that an entrepreneurial mind set with managerial skill helps the student in the job market. The students can also be introduced with Startup and Smart Technology concept, which shall radically change the working environment in the coming days in the face of Industry 4.0

In this subject, the Students shall be introduced/ exposed to different concepts and Terminologies in brief only, so that he/she can have broad idea about different concepts/items taught in this subject. Solving numerical problem on any topic/item is beyond the scope of this subject.

OBJECTIVES

After undergoing this course, the students will be able to :

- Know about Entrepreneurship, Types of Industries and Startups
- Know about various schemes of assistance by entrepreneurial support agencies
- Conduct market survey
- Prepare project report
- know the management Principles and functional areas of management
- Inculcate leadership qualities to motivate self and others.
- Maintain and be a part of healthy work culture in an organisation.
- Use modern concepts like TQM
- Know the General Safety Rules
- Know about IOT and its Application in SMART Environment.

DETAILED CONTENTS

1. **Entrepreneurship**
   - Concept /Meaning of Entrepreneurship
   - Need of Entrepreneurship
   - Characteristics, Qualities and Types of entrepreneur, Functions
   - Barriers in entrepreneurship
   - Entrepreneurs vrs. Manager
   - Forms of Business Ownership: Sole proprietorship, partnership forms and others
   - Types of Industries, Concept of Start-ups
   - Entrepreneurial support agencies at National, State, District Level(Sources): DIC, NSIC,OSIC, SIDBI, NABARD, Commercial Banks, KVIC etc.
   - Technology Business Incubators (TBI) and Science and Technology Entrepreneur Parks

2. **Market Survey and Opportunity Identification (Business Planning)**

   - Business Planning
   - SSI, Ancillary Units, Tiny Units, Service sector Units
   - Time schedule Plan, Agencies to be contacted for Project Implementation
   - Assessment of Demand and supply and Potential areas of Growth
   - Identifying Business Opportunity
   - Final Product selection

3. **Project report Preparation**

   - Preliminary project report
   - Detailed project report, Techno economic Feasibility
   - Project Viability

4. **Management Principles**
   - Definitions of management
   - Principles of management
   - Functions of management (planning, organising, staffing, directing and controlling etc.)
   - Level of Management in an Organisation

5. **Functional Areas of Management**
   a) Production management
      - Functions, Activities
      - Productivity
      - Quality control
      - Production Planning and control

   b) Inventory Management
      - Need for Inventory management
      - Models/Techniques of Inventory management

   c) Financial Management
      - Functions of Financial management
      - Management of Working capital
      - Costing (only concept)
      - Break even Analysis

- Brief idea about Accounting Terminologies: Book Keeping, Journal entry, Petty Cash book, P&L Accounts, Balance Sheets(only Concepts)

d) Marketing Management
- Concept of Marketing and Marketing Management
- Marketing Techniques (only concepts)
- Concept of 4P s (Price, Place, Product, Promotion)

e) Human Resource Management
- Functions of Personnel Management
- Manpower Planning, Recruitment, Sources of manpower, Selection process, Method of Testing, Methods of Training & Development, Payment of Wages

6. **Leadership and Motivation**

a) Leadership
- Definition and Need/Importance
- Qualities and functions of a leader
- Manager Vs Leader
- Style of Leadership (Autocratic, Democratic, Participative)

b) Motivation
- Definition and characteristics
- Importance of motivation
- Factors affecting motivation
- Theories of motivation (Maslow)
- Methods of Improving Motivation
- Importance of Communication in Business
- Types and Barriers of Communication

7. **Work Culture, TQM & Safety**

- Human relationship and Performance in Organization
- Relations with Peers, Superiors and Subordinates
- TQM concepts: Quality Policy, Quality Management, Quality system
- Accidents and Safety, Cause, preventive measures, General Safety Rules , Personal Protection Equipment(PPE)

8. **Legislation**

a) Intellectual Property Rights(IPR), Patents, Trademarks, Copyrights
b) Features of Factories Act 1948 with Amendment (only salient points)
c) Features of Payment of Wages Act 1936 (only salient points)

9. **Smart Technology**
- Concept of IOT, How IOT works
- Components of IOT, Characteristics of IOT, Categories of IOT
- Applications of IOT- Smart Cities, Smart Transportation, Smart Home, Smart Healthcare, Smart Industry, Smart Agriculture, Smart Energy Management etc.

Syllabus to be covered before IA: Chapter 1,2,3,4

RECOMMENDED BOOKS

1. Entrepreneurship Development and Management by R.K Singhal, Katson Books., New Delhi
2. Entrepreneurship Development and Management by U Saroj and V Mahendiratta, Abhishek Publications, Chandigarh
3. Entrepreneurship Development and Management by Vasant Desai, Himalaya Pub.House
4. Industrial Engineering and Management by O.P Khanna ,Dhanpat Rai and Sons
5. Industrial Engineering and Management by Banga and Sharma, Khanna Publications
6. Internet of Things by Jeeva Jose, Khanna Publications, New Delhi
7. Online Resource on Startups and other concepts
8. https://www.fundable.com/learn/resources/guides/startup

TH.2 ENERGY CONVERSION – II

Name of the Course: Diploma in Electrical Engineering			
Course code:	Th.2	Semester:	5th
Total Period:	60 Periods	Examination:	3 Hrs.
Theory periods:	4 P / Week	Internal Assessment:	20
Tutorial:	---	End Semester Examination:	80
Maximum marks:	100		

A. Rationale:

Modern industries are mostly equipped with AC machines. So the students are given a scope to gain the concepts of electrical machines like synchronous machines, 3-phase & 1- phase induction motors and fractional horse power motors and other special machines. The students are required to be familiar with constructional features, working principles, starting and speed control methods and performance characteristics with applications of the machines. Numerical solving makes the student to understand the feature more clearly.

B. Objectives:

After completion of this subject the student will be able:

1. To describe various parts, their material specification with suitable reasoning and working principle of synchronous machines, 3-phase & 1- phase AC motors and fractional horse power and other special machines.
2. To describe their operating principle and working characteristics, torque equation of three phase motors.
3. To describe the losses and efficiency of all machines.
4. To be familiar with starting and speed control of AC motors.
5. To develop problem solving ability on synchronous machines and 3-phase induction motor for better understanding about the concept of machines.
6. To be familiar with different testing methods carried out on such three phase machines.

C. TOPIC WISE DISTRIBUTION OF PERIODS

Sl. No.	Topics	Periods
1.	Alternator (Synchronous Generator)	14
2.	Synchronous Motor	08
3.	Induction motor	14
4.	Single Phase induction motor	08
5.	Commutator motors	06
6.	Special Electric Machine	05
7.	Three phase transformers	05
	Total	**60**

D. COURSE CONTENT:

1. ALTERNATOR:

1.1. Types of alternator and their constructional features.
1.2. Basic working principle of alternator and the relation between speed and frequency.
1.3. Terminology in armature winding and expressions for winding factors (Pitch factor, Distribution factor).
1.4. Explain harmonics, its causes and impact on winding factor.
1.5. E.M.F equation of alternator. (Solve numerical problems).
1.6. Explain Armature reaction and its effect on emf at different power factor of load.
1.7. The vector diagram of loaded alternator. (Solve numerical problems)
1.8. Testing of alternator (Solve numerical problems)
  1.8.1. Open circuit test.
  1.8.2. Short circuit test.
1.9. Determination of voltage regulation of Alternator by direct loading and synchronous impedance method. (Solve numerical problems)
1.10. Parallel operation of alternator using synchro-scope and dark & bright lamp method.
1.11. Explain distribution of load by parallel connected alternators.

2. SYNCHRONOUS MOTOR:

2.1. Constructional feature of Synchronous Motor.
2.2. Principles of operation, concept of load angle
2.3. Derive torque, power developed.
2.4. Effect of varying load with constant excitation.
2.5. Effect of varying excitation with constant load.
2.6. Power angle characteristics of cylindrical rotor motor.
2.7. Explain effect of excitation on Armature current and power factor.
2.8. Hunting in Synchronous Motor.
2.9. Function of Damper Bars in synchronous motor and generator.
2.10. Describe method of starting of Synchronous motor.
2.11. State application of synchronous motor.

3. THREE PHASE INDUCTION MOTOR:

3.1. Production of rotating magnetic field.
3.2. Constructional feature of Squirrel cage and Slip ring induction motors.
3.3. Working principles of operation of 3-phase Induction motor.
3.4. Define slip speed, slip and establish the relation of slip with rotor quantities.
3.5. Derive expression for torque during starting and running conditions and derive conditions for maximum torque. (solve numerical problems)

3.6. Torque-slip characteristics.
3.7. Derive relation between full load torque and starting torque etc. (solve numerical problems)
3.8. Establish the relations between Rotor Copper loss, Rotor output and Gross Torque and relationship of slip with rotor copper loss. (solve numerical problems)
3.9. Methods of starting and different types of starters used for three phase Induction motor.
3.10. Explain speed control by Voltage Control, Rotor resistance control, Pole changing, frequency control methods.
3.11. Plugging as applicable to three phase induction motor.
3.12. Describe different types of motor enclosures.
3.13. Explain principle of Induction Generator and state its applications.

4. SINGLE PHASE INDUCTION MOTOR:

4.1. Explain Ferrari's principle.
4.2. Explain double revolving field theory and Cross-field theory to analyze starting torque of 1-phase induction motor.
4.3. Explain Working principle, Torque speed characteristics, performance characteristics and application of following single phase motors.
    4.3.1. Split phase motor.
    4.3.2. Capacitor Start motor.
    4.3.3. Capacitor start, capacitor run motor.
    4.3.4. Permanent capacitor type motor.
    4.3.5. Shaded pole motor.
4.4. Explain the method to change the direction of rotation of above motors.

5. COMMUTATOR MOTORS:

5.1. Construction, working principle, running characteristic and application of single phase series motor.
5.2. Construction, working principle and application of Universal motors.
5.3. Working principle of Repulsion start Motor, Repulsion start Induction run motor, Repulsion Induction motor.

6. SPECIAL ELECTRICAL MACHINE:

6.1. Principle of Stepper motor.
6.2. Classification of Stepper motor.
6.3. Principle of variable reluctant stepper motor.
6.4. Principle of Permanent magnet stepper motor.
6.5. Principle of hybrid stepper motor.
6.6. Applications of Stepper motor.

7. THREE PHASE TRANSFORMERS:

7.1. Explain Grouping of winding, Advantages.
7.2. Explain parallel operation of the three phase transformers.
7.3. Explain tap changer (On/Off load tap changing)
7.4. Maintenance Schedule of Power Transformers.

Syllabus coverage up to Internal assessment

Chapters: 1, 2 and 3.

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Author**	**Publisher**
1	Electrical Technology – II	B. L. Theraja and A. K. Theraja	S.Chand
2	A Textbook of Electrical Machines	K R Siddhapura, D B Raval	Vikas
3.	Electrical Technology	J. B. Gupta	S.K.Kataria and Sons
4.	Electric Machine	Ashfaq Husain	Dhanpat Rai and Sons
5.	Electrical Machine	S. K. Bhattarcharya	TMH
6.	Electrical Machines	D P Kothari, I J Nagrath	Mc Graw Hill

TH.3 DIGITAL ELECTRONICS & MICROPROCESSOR

Name of the Course: Diploma in Electrical Engineering			
Course code:	Th.3	Semester	5th
Total Period:	75	Examination	3 Hrs.
Theory periods:	5P / week	Internal Assessment:	20
Tutorial:	---	End Semester Examination:	80
Maximum marks:	100		

A. RATIONALE

The tremendous power and usefulness of digital electronics can be seen from the wide variety of industrial and consumer products, such as automated industrial machinery, computers, microprocessors, pocket calculators, digital watches and clocks, TV games, etc., Which are based on the principles of digital electronics? The years of applications of digital electronics have been increasing every day. In fact, digital systems have invaded all walks of life. This subject will very much helpful for student to understand clearly about the developmental concept of digital devices.

B. OBJECTIVES

On comprehend of the subject, the student will able to

1. Comprehend the systems and codes.
2. Familiar with logic gates.
3. Realize logic expressions using gates.
4. Construct and verify the operation of arithmetic & logic circuits
5. Understand and appreciate the relevance of combinational circuits.
6. Know various logic families & flops.
7. Architecture & different instructions of 8085 microprocessor.
8. Assembly language programs and write programs & functions of the interfacing chips like 8255, 8259, 8259 etc.

C. TOPIC WISE DISTRIBUTION OF PERIODS

Sl. No.	Topics	Periods
1	Basics Of Digital Electronics	15
2	Combinational Logic Circuits	15
3	Sequential Logic Circuits	15
4	8085 Microprocessor	20
5	Interfacing And Support Chips	10
	Total	**75**

D : **COURSE CONTENT IN TERMS OF SPECIFIC OBJECTIVES**

1. BASICS OF DIGITAL ELECTRONICS

1.1 Binary, Octal, Hexadecimal number systems and compare with Decimal system.

1.2 Binary addition, subtraction, Multiplication and Division.
1.3 1‘s complement and 2‘s complement numbers for a binary number
1.4 Subtraction of binary numbers in 2‘s complement method.
1.5 Use of weighted and Un-weighted codes & write Binary equivalent number for a number in 8421, Excess-3 and Gray Code and vice-versa.
1.6 Importance of parity Bit.
1.7 Logic Gates: AND, OR, NOT, NAND, NOR and EX-OR gates with truth table.
1.8 Realize AND, OR, NOT operations using NAND, NOR gates.
1.9 Different postulates and De-Morgan‘s theorems in Boolean algebra.
1.10 Use Of Boolean Algebra For Simplification Of Logic Expression
1.11 Karnaugh Map For 2,3,4 Variable, Simplification Of SOP And POS Logic Expression Using K-Map.

2. COMBINATIONAL LOGIC CIRCUITS

2.1 Give the concept of combinational logic circuits.
2.2 Half adder circuit and verify its functionality using truth table.
2.3 Realize a Half-adder using NAND gates only and NOR gates only.
2.4 Full adder circuit and explain its operation with truth table.
2.5 Realize full-adder using two Half-adders and an OR – gate and write truth table
2.6 Full subtractor circuit and explain its operation with truth table.
2.7 Operation of 4 X 1 Multiplexers and 1 X 4 demultiplexer
2.8 Working of Binary-Decimal Encoder & 3 X 8 Decoder.
2.9 Working of Two bit magnitude comparator.

3. SEQUENTIAL LOGIC CIRCUITS

3.1 Give the idea of Sequential logic circuits.
3.2 State the necessity of clock and give the concept of level clocking and edge triggering,
3.3 Clocked SR flip flop with preset and clear inputs.
3.5 Construct level clocked JK flip flop using S-R flip-flop and explain with truth table
3.6 Concept of race around condition and study of master slave JK flip flop.
3.7 Give the truth tables of edge triggered D and T flip flops and draw their symbols.
3.8 Applications of flip flops.
3.9 Define modulus of a counter
3.10 4-bit asynchronous counter and its timing diagram.
3.11 Asynchronous decade counter.
3.12 4-bit synchronous counter.
3.13 Distinguish between synchronous and asynchronous counters.
3.14 State the need for a Register and list the four types of registers.
3.15 Working of SISO, SIPO, PISO, PIPO Register with truth table using flip flop.

4. 8085 MICROPROCESSOR

4.1 Introduction to Microprocessors, Microcomputers
4.2 Architecture of Intel 8085A Microprocessor and description of each block.
4.3 Pin diagram and description.
4.4 Stack, Stack pointer & stack top
4.5 Interrupts
4.6 Opcode & Operand,
4.7 Differentiate between one byte, two byte & three byte instruction with example.
4.8 Instruction set of 8085 example
4.9 Addressing mode
4 .10 Fetch Cycle, Machine Cycle, Instruction Cycle, T-State
4.11 Timing Diagram for memory read, memory write, I/O read, I/O write
4.12 Timing Diagram for 8085 instruction
4.13 Counter and time delay.
4. 14 Simple assembly language programming of 8085.

5. INTERFACING AND SUPPORT CHIPS

5.1 Basic Interfacing Concepts, Memory mapping & I/O mapping
5.2 Functional block diagram and description of each block of Programmable peripheral interface Intel 8255 ,
5.3 Application using 8255: Seven segment LED display, Square wave generator, Traffic light Controller

Syllabus coverage up to Internal assessment

Chapters: 1,2 and 3

Learning Resources:			
Sl. No.	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1	Fundamental of Digital Electronics	Ananda Kumar	PHI
2	Digital Electronics – Principal & Application	S. K. Mondal	TMH
3	Digital Electronics	B. R. Gupta & V. Singhal	S. K. Kateria
4	Digital Electronics	P. Raja	SciTech
5	Microprocessor Architecture programming & Application with 8085	R.S Gaonkar	Peneram
6	Fundamentals of Microprocessor & Micro Computers	B.Ram	Dhanpat rai
7	Microprocessor and Inter facing	Sunetra Choudhury & S. P. Chowdhury	Scitech

TH.4 UTILIZATION OF ELECTRICAL ENERGY & TRACTION

Name of the Course: Diploma in Electrical Engineering			
Course code:	Th.4	Semester:	5th
Total Period:	60 Periods	Examination:	3 Hrs.
Theory periods:	4 P / Week	Internal Assessment:	20
Tutorial:	---	End Semester Examination:	80
Maximum marks:	100		

A. Rationale:

There is great demand for utilization of electrical power in various fields in the form of power for electrolysis, illumination, electrical heating, electrical welding, electrical traction and for electrical drives. Hence these aspects are taken care of, in the subject of utilization of electrical energy and traction to give exposure of the student.

B. Objectives:

The subject will facilitate the student :

1. To acquire knowledge of principle of ionic dissociation and electrolysis and loss involving in the process, usage of this process.
2. To acquire knowledge of types of electrical heating as employed in the electrical oven, induction furnaces and arc furnaces and dielectrically ovens.
3. To acquire knowledge of principle of arc welding and resistant welding,
4. To define various terms used in illumination engineering to design lighting schemes with specific attention to laws of illumination to explain the working and construction and use of fluorescent lamp, SV lamp, H.P. MV, Neon lamps and energy saving lamps.
5. To classify various types of industrial drives and their application.
6. To classify various methods of traction and traction motor with their control and types of braking.

C. TOPIC WISE DISTRIBUTION OF PERIODS

Sl. No.	Topics	Periods
1.	Electrolytic Process	08
2.	Electrical Heating.	08
3.	Principles of Arc Welding.	08
4.	Illumination.	12
5.	Industrial Drives.	10
6.	Electric Traction.	14
	TOTAL	**60**

D. COURSE CONTENTS:

1. ELECTROLYTIC PROCESS:

1.1. Definition and Basic principle of Electro Deposition.
1.2. Important terms regarding electrolysis.
1.3. Faradays Laws of Electrolysis.
1.4. Definitions of current efficiency, Energy efficiency.
1.5. Principle of Electro Deposition.
1.6. Factors affecting the amount of Electro Deposition.
1.7. Factors governing the electro deposition.
1.8. State simple example of extraction of metals.
1.9. Application of Electrolysis.

2. ELECTRICAL HEATING:

2.1. Advantages of electrical heating.
2.2. Mode of heat transfer and Stephen's Law.
2.3. Principle of Resistance heating. (Direct resistance and indirect resistance heating.)
2.4. Discuss working principle of direct arc furnace and indirect arc furnace.
2.5. Principle of Induction heating.
    2.5.1. Working principle of direct core type, vertical core type and indirect core type Induction furnace.
    2.5.2. Principle of coreless induction furnace and skin effect.
2.6. Principle of dielectric heating and its application.
2.7. Principle of Microwave heating and its application.

3. PRINCIPLES OF ARC WELDING:

3.1. Explain principle of arc welding.
3.2. Discuss D. C. & A. C. Arc phenomena.
3.3. D.C. & A. C. arc welding plants of single and multi-operation type.
3.4. Types of arc welding.
3.5. Explain principles of resistance welding.
3.6. Descriptive study of different resistance welding methods.

4. ILLUMINATION:

4.1. Nature of Radiation and its spectrum.
4.2. Terms used in Illuminations. [Lumen, Luminous intensity, Intensity of illumination, MHCP, MSCP, MHSCP, Solid angle, Brightness, Luminous efficiency.]
4.3. Explain the inverse square law and the cosine law.
4.4. Explain polar curves.
4.5. Describe light distribution and control. Explain related definitions like maintenance factor and depreciation factors.
4.6. Design simple lighting schemes and depreciation factor.
4.7. Constructional feature and working of Filament lamps, effect of variation of voltage

on working of filament lamps.

4.8. Explain Discharge lamps.
4.9. State Basic idea about excitation in gas discharge lamps.
4.10. State constructional factures and operation of Fluorescent lamp. (PL and PLL Lamps)
4.11. Sodium vapor lamps.
4.12. High pressure mercury vapor lamps.
4.13. Neon sign lamps.
4.14. High lumen output & low consumption fluorescent lamps.

5. INDUSTRIAL DRIVES:

5.1. State group and individual drive.
5.2. Method of choice of electric drives.
5.3. Explain starting and running characteristics of DC and AC motor.
5.4. State Application of:
  5.4.1. DC motor.
  5.4.2. 3-phase induction motor.
  5.4.3. 3 phase synchronous motors.
  5.4.4. Single phase induction, series motor, universal motor and repulsion motor.

6. ELECTRIC TRACTION:

6.1. Explain system of traction.
6.2. System of Track electrification.
6.3. Running Characteristics of DC and AC traction motor.
6.4. Explain control of motor:
  6.4.1. Tapped field control.
  6.4.2. Rheostatic control.
  6.4.3. Series parallel control.
  6.4.4. Multi-unit control.
  6.4.5. Metadyne control.
6.5. Explain Braking of the following types:
  6.5.1. Regenerative Braking.
  6.5.2. Braking with 1-phase series motor.
  6.5.3. Magnetic Braking.

Syllabus coverage up to Internal assessment

Chapters: 1, 2, 3 and 4.

Learning Resources:			
Sl.No	***Title of the Book***	***Name of Authors***	***Name of the Publisher***
1.	*Utilization of Electrical Energy by Traction*	*G. C. Garg*	*Khanna Publisher*
2.	*Utilization of Electrical Energy*	*E. I. Taylor*	*TMH*
3.	*A Text book on Power system Engineering*	*Soni, Gupta and Bhatnagar*	*Dhanpat Rai & Sons*

TH.5 POWER ELECTRONICS AND PLC

Name of the Course: Diploma in Electrical Engineering			
Course code:	Th.5	Semester:	5th
Total Period:	60 Periods	Examination:	3 Hrs
Theory periods:	4 P / Week	Internal Assessment:	20
Tutorial:	-	End Semester Examination:	80
Maximum marks:	100		

A. Rationale:

The development of high power semiconductor devices has facilitated electronic control techniques for electrical power control in a simple, economic and efficient manner. Thus a new area of power electronics has now emerged which replaced the old and bulky method of power control through the use of small electronic devices. Power electronics application has occupied an indispensible position in industrial applications like heating, welding, uninterrupted power supply, battery charging etc. Industrial drives, lighting control are most efficiently controlled by power electronics devices to achieve optimum performance. The objective of this paper is to familiar students with the principles and operations of Power electronics devices in Industrial applications with drives control.

B. Objectives:

After completion of this subject the student will be able to:

1. Understand construction, working principle & application of various power electronics devices.
2. Know different gate triggering circuits and commutation methods.
3. Understand working principle of phase controlled rectifier.
4. Know the types and working principle of inverter.
5. Understand working principle and voltage control of chopper.
6. Understand frequency variation using Cyclo-converter.
7. Understand control principle of AC & DC industrial drive.
8. Know different application of SCR / Thyristor.
9. Concept in PLC & its Programming

C. TOPIC WISE DISTRIBUTION OF PERIODS

Sl. No.	Topics	Periods
1.	Understand The Construction And Working Of Power Electronic Devices	18
2.	Understand The Working Of Converters, Ac Regulators And Choppers.	12
3.	Understand The Inverters And Cyclo-Converters	08
4.	Understand Applications Of Power Electronic Circuits	10
5.	PLC And Its Applications	12
	Total	**60**

D. COURSE CONTENT:

1. UNDERSTAND THE CONSTRUCTION AND WORKING OF POWER ELECTRONIC DEVICES

1.1 Construction, Operation, V-I characteristics & application of power diode, SCR, DIAC,TRIAC, Power MOSFET,GTO &IGBT
1.2 Two transistor analogy of SCR.
1.3 Gate characteristics of SCR.
1.4 Switching characteristic of SCR during turn on and turn off.
1.5 Turn on methods of SCR.
1.6 Turn off methods of SCR (Line commutation and Forced commutation)
  1.6.1 Load Commutation
  1.6.2 Resonant pulse commutation
1.7 Voltage and Current ratings of SCR.
1.8 Protection of SCR
  1.8.1 Over voltage protection
  1.8.2 Over current protection
  1.8.3 Gate protection
1.9 Firing Circuits
  1.9.1 General layout diagram of firing circuit
  1.9.2 R firing circuits
  1.9.3 R-C firing circuit
  1.9.4 UJT pulse trigger circuit
  1.9.5 Synchronous triggering (Ramp Triggering)
1.10 Design of Snubber Circuits

2. UNDERSTAND THE WORKING OF CONVERTERS, AC REGULATORS AND CHOPPERS.

2.1 Controlled rectifiers Techniques(Phase Angle, Extinction Angle control), Single quadrant semi converter, two quadrant full converter and dual Converter
2.2 Working of single-phase half wave controlled converter with Resistive and R-L loads.
2.3 Understand need of freewheeling diode.
2.4 Working of single phase fully controlled converter with resistive and R- L loads.
2.5 Working of three-phase half wave controlled converter with Resistive load
2.6 Working of three phase fully controlled converter with resistive load.
2.7 Working of single phase AC regulator.
2.8 Working principle of step up & step down chopper.
2.9 Control modes of chopper
2.10 Operation of chopper in all four quadrants.

3. UNDERSTAND THE INVERTERS AND CYCLO-CONVERTERS

3.1 Classify inverters.
3.2 Explain the working of series inverter.
3.3 Explain the working of parallel inverter
3.4 Explain the working of single-phase bridge inverter.

3.5 Explain the basic principle of Cyclo-converter.
3.6 Explain the working of single-phase step up & step down Cyclo-converter.
3.7 Applications of Cyclo-converter.

4. UNDERSTAND APPLICATIONS OF POWER ELECTRONIC CIRCUITS

4.1 List applications of power electronic circuits.
4.2 List the factors affecting the speed of DC Motors.
4.3 Speed control for DC Shunt motor using converter.
4.4 Speed control for DC Shunt motor using chopper.
4.5 List the factors affecting speed of the AC Motors.
4.6 Speed control of Induction Motor by using AC voltage regulator.
4.7 Speed control of induction motor by using converters and inverters (V/F control).
4.8 Working of UPS with block diagram.
4.9 Battery charger circuit using SCR with the help of a diagram.
4.10 Basic Switched mode power supply (SMPS) - explain its working & applications

5. PLC AND ITS APPLICATIONS

5.1 Introduction of Programmable Logic Controller(PLC)
5.2 Advantages of PLC
5.3 Different parts of PLC by drawing the Block diagram and purpose of each part of PLC.
5.4 Applications of PLC
5.5 Ladder diagram
5.6 Description of contacts and coils in the following states
i)Normally open ii) Normally closed iii) Energized output iv)latched Output v) branching
5.7 Ladder diagrams for i) AND gate ii) OR gate and iii) NOT gate.
5.8 Ladder diagrams for combination circuits using NAND,NOR, AND, OR and NOT
5.9 Timers-i)T ON ii) T OFF and iii)Retentive timer
5.10 Counters-CTU, CTD
5.11 Ladder diagrams using Timers and counters
5.12 PLC Instruction set
5.13 Ladder diagrams for following
(i) DOL starter and STAR-DELTA starter (ii) Stair case lighting (iii) Traffic light Control (iv) Temperature Controller
5.14 Special control systems- Basics DCS & SCADA systems
5.15 Computer Control–Data Acquisition, Direct Digital Control System (Basics only)

Syllabus coverage up to Internal assessment

Chapters: 1 and 2.

Learning Resources:			
Sl.No	***Title of the Book***	***Name of Authors***	***Name of the Publisher***
1.	*Power Electronics*	*Dr. P. S. Bhimbhra*	*Khanna Publisher*
2.	*Modern Power Electronics*	*B.K.Bose*	*PHI Publisher*

	and AC Drives		
3.	*Power Electronics*	*M. D. Singh and K.B Khanchandani*	*TMH*
4.	*Power Electronics*	*M H Rashid*	PHI Publisher
5.	*Power Electronics*	*P C Sen*	*TMH*
6.	*Power Electronics*	*N Mohan*	*Willey (India)*
7.	*Programmable logic Controllers*	*Frank D. Petruzela*	TMH
8.	*Programme logic controller*	*Dr.M.Mitra&Dr.S.Sengupta*	*Penram*

Pr.1 ELECTRICAL MACHINE LAB-II

Name of the Course: Diploma in Electrical Engineering			
Course code:	Pr.1	Semester	5th
Total Period:	90	Examination	3 hrs
Lab. periods:	6 P / week	Term Work	25
Maximum marks:	75	End Semester Examination:	50

A. RATIONALE:

The sole objective of the subject is to be familiar with machines and different parts. To perform practice of the experiments and become fit to meet the challenges in practical implementation.

In the beginning the faculties have to illustrate all the tools and instruments required/ used in conducting the experiments.

B. OBJECTIVES:

After completion of this Laboratory the student will be able to:

1. To be familiar with constructional features of 3-phase and 1-phase AC machines.
2. Starting, Speed control of 3-phase and 1-phase motors.
3. To determine efficiency, regulations of different machines.
4. To draw and study performance characteristics.
5. To be familiar with relays used in power system.

C. LIST OF EXPERIMENTS:

1. Study of (Manual and Semi automatic) Direct on Line starter, Star-Delta starter, connection and running a 3-phase Induction motor and measurement of starting current.
2. Study of (Manual and Semi automatic) Auto transformer starter and rotor resistance starter connection and running a 3-phase induction motor and measurement of starting current.
3. Study and Practice of connection & Reverse the direction of rotation of Three Phase Induction motor.
4. Study and Practice of connection & Reverse the direction of rotation of Single Phase Induction motor.
5. Heat run test of 3-phase transformer.
6. OC and SC test of alternator and determination of regulation by synchronous impedance method.
7. Determination of regulation of alternator by direct loading.
8. Parallel operation of two alternators and study load sharing.
9. Measurement of power of a 3-phase Load using two wattmeter method and

verification of the result using one 3-phase wattmeter.

10. Connection of 3-phase energy meter to a 3-phase load.
11. Study of an O.C.B.
12. Study of induction type over current / reverse power relay.
13. Study of Buchholz's relay.
14. Study of an earth fault relay.

Pr.2 POWER ELECTRONICS & PLC LAB

Name of the Course: Diploma in Electrical Engineering			
Course code:	Pr.2	Semester	5th
Total Period:	45	Examination	3 hrs
Lab. periods:	3 P / week	Term Work	25
Maximum marks:	75	End Semester Examination:	50

A. RATIONALE: The sole objective of the subject is to be familiar with solid state devices used in power system. To perform experiments for determining the characteristics of components and become fit to meet the challenges in practical implementation.

B. OBJECTIVE:

After completion of this laboratory the student will be able to:

1. Determine characteristic of semiconductor devices.
2. Develop ability to design drive circuit for above.
3. Design low voltage power circuit to be used in electronics circuit.

C. LIST OF EXPERIMENTS

(I) Power Electronics

1. Study of switching characteristics of a power transistor.
2. Study of V-I characteristics of SCR.
3. Study of V-I characteristics of TRIAC.
4. Study of V-I characteristics of DIAC.
5. Study of drive circuit for SCR & TRIAC using DIAC.
6. Study of drive circuit for SCR & TRIAC using UJT.
7. To study phase controlled bridge rectifier using resistive load.
8. To study series Inverter.
9. Study of voltage source Inverter.
10. To perform the speed control of DC motor using Chopper.
11. To study single-phase Cyclo-converter

(II) PLC Programming

1. Introduction/Familiarization PLC Trainer & its Installation with PC
   (a) Learn the basics and hardware components of PLC
   (b) Understand configuration of PLC system
   (c) Study various building blocks of PLC
   (d) Determine the No. of digital I/O & Analog I/O
2. Execute the different Ladder Diagrams
   (a) Demonstrate PLC and Ladder diagram-Preparation downloading and running
   (b) Execute Ladder diagrams for different Logical Gates
   (c) Execute Ladder diagrams using timers & counters
3. Execute the Ladder Diagrams with model applications
   (i) DOL starter (ii)Star- Delta starter
4. Execute Ladder diagrams with model applications (i) Stair case lighting (ii) Traffic light controller

Pr.3 DIGITAL ELECTRONICS & MICROPROCESSOR LAB

Name of the Course: Diploma in Electrical Engineering			
Course code:	Pr.3	Semester	5th
Total Period:	45	Examination	3 hrs
Lab. periods:	3 P / week	Term Work	25
Maximum marks:	75	End Semester Examination:	50

A.RATIONALE

In this practical work students knowledge about the Digital systems will be reinforced. They will become capable of developing and implementing Digital Circuits. They will also be able to acquire skills of operating A/D and D/A converters, counters and display system.

B. OBJECTIVE

On completion of the Lab course the student will able to

1. Understand and comprehended the simple the Digital design Circuits.
2. Assembly Language Program using 8085 instruction
3. Application of 8085 using interfacing

C.COURSE CONTENT IN TERMS OF SPECIFIC OBJECTIVES

(I) Digital Electronics

1. Verify truth tables of AND, OR, NOT, NOR, NAND, XOR, XNOR gates.
2. Implement various gates by using universal properties of NAND & NOR gates and verify truth table.
3. Implement half adder and Full adder using logic gates.
4. Implement half subtractor and Full subtractor using logic gates.
5. Implement a 4-bit Binary to Gray code converter.
6. Implement a Single bit digital comparator.
7. Study Multiplexer and demultiplexer.
8. Study of flip-flops.
   i) S-R flip flop ii) J-K flip flop iii) flip flop iv) T flip flop
9. Realize a 4-bit asynchronous UP/Down counter with a control for up/down counting.
10. Realize a 4-bit synchronous UP/Down counter with a control for up/down counting.
11. Implement Mode-10 asynchronous counters.
12. Study shift registers.

(II) Microprocessor

(A) General Programming using 8085A development board

1. a. 1'S Complement. b. 2'S Complement.
2. a. Addition of 8-bit number. b. Subtraction of 8-bit number resulting 8/16 bit number.
3. a. Decimal Addition 8-bit number. b. Decimal Subtraction 8-bit number
3. a. Compare between two numbers. b. Find the largest in an Array
5. Block Transfer.

(B) Interfacing using 8085

1. Traffic light control using 8255.
2. Generation of square wave using 8255

Learning Resources:

Electronics Lab premier by Sacikala - (S. Chand)

Pr.4 PROJECT WORK (Phase-I)

Name of the Course: Diploma in Electrical Engineering			
Course code:	Pr.4	Semester	5th
Total Period:	45	Examination	----
Lab. periods:	3 P / week	Term Work	25
Maximum marks:	25	End Semester Examination:	---

A. RATIONALE

Students' Project Work aims at developing innovative skills in the students whereby they apply the knowledge and skills gained through the course covered in many subjects and Labs, by undertaking a project. The individual students have different aptitudes and strengths. Project work, therefore, should match the individual strengths of students. The prime emphasis of the project work is to understand and apply the basic knowledge of the principles of software engineering/ Hardware design and practices in real life situations, so as to participate and manage a large software engineering projects and /or appropriate Hardware with embedded software in future.

Entire Project shall spread over 5th and 6th Semester. Part of the Project covered in 5th Semester shall be named as *Project Phase-I* and balance portion to be covered in 6th Semester shall be named as *Project Phase-II*.

B. OBJECTIVES

After undergoing the Project Work, the student will be able to:

- Implement the theoretical and practical knowledge and skills gained through various subjects/courses into an application suitable for a real practical working environment, preferably in an industrial environment.
- Develop software packages or applications and implement these for the actual needs of the community/industry.
- Identify and contrast gap between the technological knowledge acquired through curriculum and the actual industrial need and to compensate it by acquiring additional knowledge as required.
- Carry out cooperative learning through synchronous guided discussions within the class in key areas, asynchronous document sharing and discussions, as well as prepare collaborative edition of the final project report.
- Field computing and to achieve real life experience in software/hardware design.

C. GENERAL GUIDELINES

The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. The activity of problem identification should begin well in advance (right from beginning of 5th semester).

Students should be allotted a problem of interest to him/her as a project work. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments for their students. The project assignment can be individual assignment or a group assignment. Preferably there should not be more than 5 students if the project work is given to a group. The project work identified in collaboration with industry should be preferred.

Following are the broad suggestive areas of project work

- ✓ Speed control techniques using thyristor.
- ✓ Battery design & its maintenance.
- ✓ Energy management Techniques.
- ✓ Dynamic models of Electrical machine.
- ✓ Solar based cooker, lamp, water heater etc. & Solar operated vehicles.
- ✓ Remote control operated Electrical devices.
- ✓ Advanced energy meter.
- ✓ Design of Illumination techniques using advanced luminaries etc.
- ✓ Dynamic models of Electrical Machine.
- ✓ PLC & Microprocessor based project.
- ✓ Any other related area found worth.

A suggestive criterion for assessing student performance by the external (preferably person from industry) and internal (teacher) examiner is given in table below:

Sl. No.	**Performance Criteria**
1.	Selection of project assignment
2.	Planning and execution of considerations
3.	Quality of performance
4.	Providing solution of the problems or production of final product
5.	Sense of responsibility
6.	Self-expression/ communication/ Presentation skills
7.	Interpersonal skills/human relations
8.	Report writing skills
9.	Viva voce

The teachers are free to evolve other criteria of assessment, depending upon the type of project work.
It is proposed that the institute may organize an annual exhibition of the project work done by the students and invite leading Industrial organizations to such an exhibition.

D. PROJECT PHASE-I AND PHASE-II

The Project work duration shall cover two semesters (5^{th} and 6^{th} sem). The Grouping of students, selection of Project, assignment of Project Guide to the Group shall be done in the beginning of 5^{th} sem under Project Phase-I. The students may be allowed to study literature, any existing system and then define the Problem/objective of the Project. Requirements specification, Circuit Diagram with brief description and Design of the system have to be complete in Phase-I. Preliminary analysis/modelling/simulation/experiment/feasibility can also begin in this phase. Project Milestones are to be set so that progress can be tracked. In Phase-II Design, Testing, Documentation have to be complete. Project Report have to be complete in Phase-II. All Project reports should be organized uniformly in proper order, irrespective of group. Teacher Guides can make suitable alteration in the schedule.
At the end of Project Phase-I in 5^{th} semester there shall be one presentation by each group to mark to progress and also to judge whether the Project is moving in right direction as per the objective of the Project.

EQUIPMENT LIST

1. 3-phase Squirrel Cage Induction Motor
2. 3-phase Slip Ring Induction Motor
3. DC Shunt Motor coupled with Alternator set with Synchronization panel of Two Alternators
4. 1-phase Capacitor Start Capacitor Run Motor
5. 3-phase Transformer
6. 3-phase wattmeter
7. 1-phase wattmeter
8. 3-Phase Variac
9. DOL starter
10. Star-Delta Starter
11. Rotor Resistance starter
12. Auto Transformer Starter
13. 3-Point Starter
14. Field Regulator
15. DC Voltmeter
16. DC Ammeter
17. AC Voltmeter
18. AC Ammeter
19. 3-Phase Resistive Load Box
20. 3-Phase Energy meter
21. Demonstrational model of Oil Circuit Breaker
22. Reverse Current Relay kit
23. Demonstrational model of Buchholz's Relay Trainer Kit
24. Earth fault relay test kit
25. Power Electronics trainer kit to perform (a) switching characteristics of a power transistor (b) V-I characteristics of SCR, TRIAC, DIAC (c) Drive circuit for SCR & TRIAC using DIAC & UJT (d) phase controlled bridge rectifier using resistive load (e) series Inverter (f) voltage source Inverter (g) speed control of DC motor using Chopper (h) single-phase Cyclo-converter
26. 8085 microprocessor trainer kit
27. Traffic Light controller interfacing module
28. Digital electronics trainer kit
29. PLC trainer kit